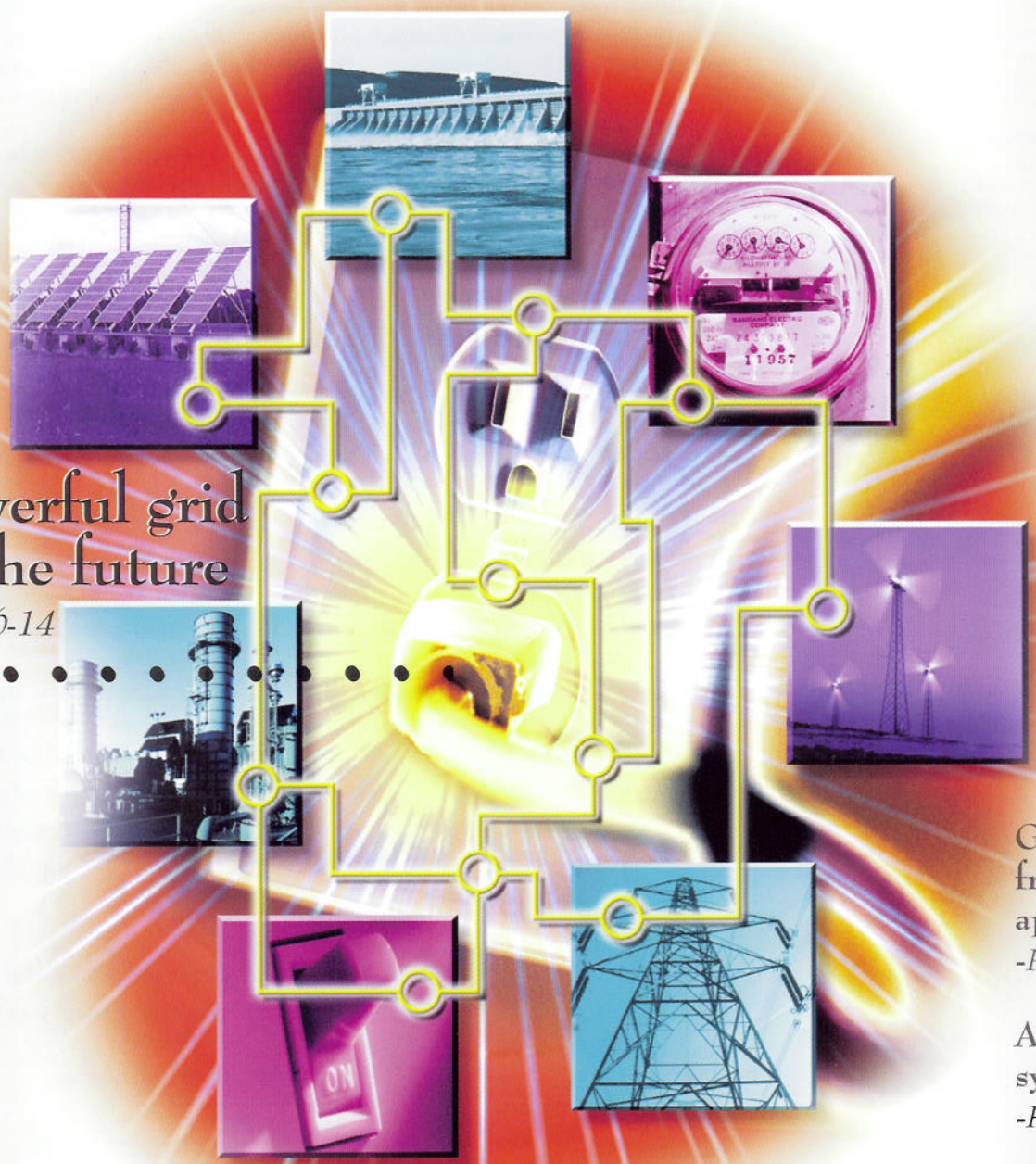
Breakthroughs

Science. Technology. Innovation.

FALL 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

The people are energetic.

As I worked on the stories that appear in this issue of *Breakthroughs*, I noticed that the researchers here at Pacific Northwest National Laboratory have their own inner electricity. Their creativity and innovations power their enthusiasm.

For example, we have been talking with people who are anxious to create solutions that might change the way the energy system works. They are excited about developing new technologies that will affect how people will generate power, buy it, sell it, use it and save it in the future. Some of these projects appear in our special section devoted to energy.

Other topics we explored for this issue included a new waste treatment technology, the addition of a high-powered research instrument and efforts to protect the nation's cyber security. The people involved in these projects are excited to be contributing to breakthrough science and technology—and their excitement is contagious.

If you'd like more information about the projects that make these researchers' eyes light up, or would like to know if they can help develop a solution for you, please contact us. *—Pamela Harrington, editor*

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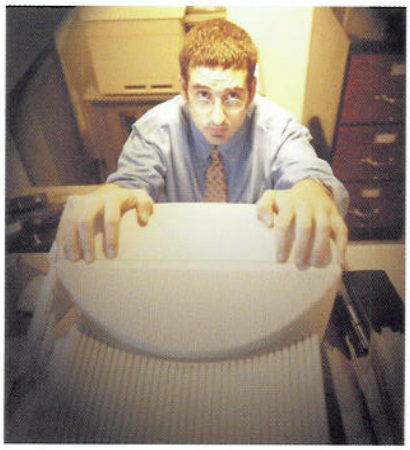
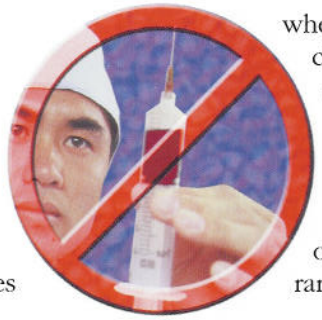


AT A *glance*

Saliva monitoring system could end the need for the needle

Researchers at Pacific Northwest National Laboratory are developing a saliva monitoring approach that may prove to be a noninvasive, faster alternative to typical methods for monitoring exposure to harmful chemicals. The technology would rely on easy-to-obtain saliva samples rather than the costly and time-consuming collection and analysis of blood or urine samples. It would determine within minutes whether a person has been exposed to harmful chemicals, which would be especially useful in emergency situations.

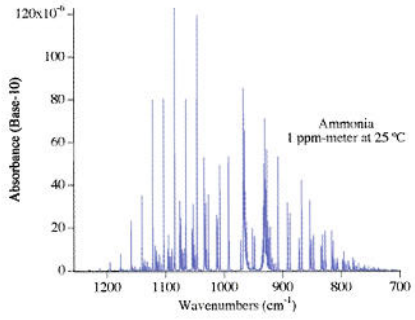


The system is designed to be portable and is undergoing bench-scale laboratory testing. It potentially could be used for home and workplace monitoring of trace metals and organics. It also may be applicable to a broad range of drugs and environmental contaminants. ●

Spectra library ready for check out

A new e-commerce site introduced by the William R. Wiley Environmental Molecular Sciences Laboratory at Pacific Northwest National Laboratory may provide information that can be used, for example, in monitoring trace gases in the atmosphere or in improving chemical processes to demonstrate compliance with government guidelines.

The Web site provides unlimited access to the Laboratory's unique infrared absorption spectra library for a one-time registration fee of $200. The information is designed to help interpret data collected by spectrometers used to monitor gas emissions. Collected data can be matched against those contained in the library. By comparing the amount of absorption at certain wavelengths, the user can accurately identify the compound or compounds being released.



The library currently contains close to 100 compounds with new compounds being added every three months. Researchers plan to create a database of more than 400 compounds by 2005. The high-resolution data are taken according to National Institute of Standards and Technology protocols.

For more information and to register, see **http://nwir.pnl.gov**. ●

New faces take their places

Two new leaders—one at Pacific Northwest National Laboratory and one at Battelle, which manages the Laboratory for the U.S. Department of Energy—are taking their places in October.

Reinhold Mann joins Pacific Northwest National Laboratory as deputy laboratory director for science and technology. He was previously director of life sciences at Oak Ridge National Laboratory in Tennessee. Mann's duties at Pacific Northwest will include ensuring that key scientific initiatives—including systems biology, computational science and engineering and nanoscience and nanotechnology—are integrated with the Laboratory's other research activities.

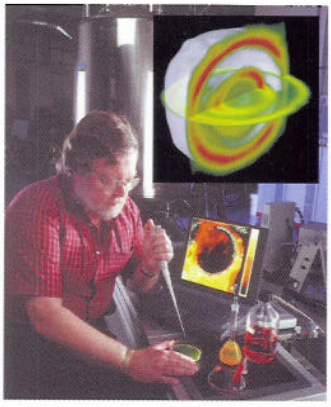
Carl Kohrt, former executive vice president and chief technology officer at Kodak, was named the next president and CEO of Battelle in August. Kohrt will succeed Douglas Olesen, who is retiring later this year. During his distinguished 29-year career at Kodak in Rochester, New York, Kohrt served in numerous senior executive, international and technical positions including vice president and general manager of the health sciences division, director of the photographic R&D laboratories, R&D manager, project manager and research scientist. ●

Reinhold Mann

Carl Kohrt

NOTABLE Achievements

Landmine detector, cellular research honored by *Discover Magazine*



Two scientists at Pacific Northwest National Laboratory were among the nine Discover Magazine Innovation Award winners named in June. *Discover Magazine* and the Christopher Columbus Foundation recognized Robert Wind and Richard A. Craig, both physicists, for their technologies that address vital health and humanitarian issues.

Wind accepted the top honor in Discover's Health category for inventing a combined optical and magnetic resonance microscope that has potential for improving the detection and diagnosis of diseased cells and in evaluating a patient's response to chemotherapy.

The combined microscope allows scientists to study live cells and how they respond to stresses over time. It couples the advantages of extremely high-resolution images with the ability to capture physical and chemical information of cells.

The Christopher Columbus Foundation granted Craig a $100,000 fellowship for development of a technology that quickly and inexpensively locates metal and plastic landmines. The portable Timed Neutron Detector recognizes the presence of hydrogen in landmines' casings and explosive materials.

"This device can be produced for use by Third World countries at a relatively low cost, yet the savings in human life and suffering could be priceless," said Rosalyn Queen Alonso, Christopher Columbus Foundation chair.

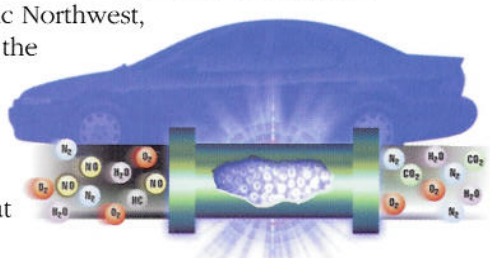
For more, see **www.pnl.gov/news/2001/01-21.htm**.

Laboratory wins four R&D 100 Awards

Four technologies developed by researchers at Pacific Northwest National Laboratory and their collaborators are on R&D Magazine's list of the 100 most significant technology developments for 2000.

The R&D 100 Awards honor the most promising new products, processes, materials or software developed throughout the world. Including the four selected in June, the Laboratory has won a total of 58 R&D 100 Awards since it submitted its first entries in 1969.

Catalyst materials that convert harmful engine exhaust emissions into components of clean air— Researchers at Pacific Northwest, Ford Motor Co. and the Delphi Energy & Chassis Division of Delphi Automotive Systems developed catalyst materials that make possible a promising engine exhaust treatment. The plasma-catalysis treatment technology enabled by these materials reduces oxides of nitrogen (NO_x) in exhaust from next-generation energy-efficient vehicles. NO_x contributes to acid rain and is a precursor to ozone, the major component of smog.



Decision Support for Operations and Maintenance™—A suite of analysis procedures, software and hardware that has proven to reduce life-cycle operations and maintenance costs by as much as 25 to 50 percent. These tools improve process efficiency, cut maintenance costs, extend equipment life and reduce energy consumption.

Long-range semi-passive radio frequency identification system— Radio frequency tags that can identify, locate and even determine the condition of any item to which they are attached. This technology originated at the Laboratory and now is marketed by Wave ID, a newly created company.

MilliWave Viscometer—A Pacific Northwest researcher was among the developers of a high-temperature viscosity measurement for process monitoring of hot, molten materials such as glass or metals. The technology uses millimeter-wave electromagnetic radiation to probe the movement of liquids. It allows active feed-back control of these processes, helping improve product quality and manufacturing efficiency and lower costs.

For more information about these and past winners, see **http://www.pnl.gov/main/welcome/awards/rd100/**.

An in-stream waste treatment technology

A waste storage lagoon at a Washington dairy is being converted into a waste treatment facility with the help of a new technology that enhances naturally occurring biological activity.

Pacific Northwest National Laboratory brought Battelle's InStreem™ technology to the George DeRuyter Dairy in Outlook, Wash., installing a floating unit at the dairy in January as part of a one-year demonstration test. Battelle operates the Laboratory for the U.S. Department of Energy.

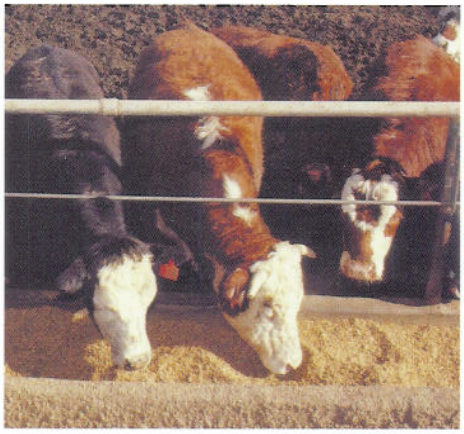
The InStreem™ unit is equipped with 10 aeration discs, each 54 inches in diameter. Powered by a 5-horse-power motor, the discs displace water in adjustable horizontal and vertical planes around a barrier that divides the lagoon. Used this way, the InStreem™ treatment is similar to municipal biological wastewater treatment technologies used at more than 400 community waste treatment plants across the United States and Canada.

Using a dairy's existing infrastructure, the InStreem™ technology combines aerobic and anaerobic processes within a single lagoon for waste treatment. The aerated-anoxic process is designed to remove nitrogen, while the circulation created by the device promotes odor reduction and formation of water-insoluble forms of phosphorous, reducing the amount of nutrients available for contamination of water resources.

A single cow produces 85 pounds of waste a day, contributing to health and environmental concerns such as *E. coli*, fecal coliforms and contaminated surface water and groundwater. In the Northwest alone, InStreem™ is a potential solution for 950 large dairies—each having about 1,500 cows. One InStreem™ unit can treat a lagoon 1 to 1.5 acres in size.

Soil Search of Finley, Wash., is assessing the one-year demonstration at the Outlook dairy, monitoring the site for a number of conditions.

"According to Soil Search, in the first three months, the depth of solids dropped from six feet to six inches, and that was during the coldest part of the year," said John Jaksch, who is the program manager for the project in the Northwest and grew up on a dairy farm. In addition to reducing the quantity of waste, the technology has successfully reduced odors at the dairy operation.



"We want to gather data for the entire seasonal life cycle, benchmark it against existing waste lagoon management practices and other alternative approaches and technologies, then nail down the technical and economic story for the dairy industry," Jaksch said.

Soil Search has licensed the right to sell InStreem™ for use at dairies in Washington, Oregon, California, Idaho, North Carolina and South Carolina. The Choctaw Manufacturing and Development Corp. in Hugo, Okla., manufactures the units while Tierra Environmental Services of New Mexico is the national distributor. ●

Energy

A system in transformation

For decades, the energy system has done exactly what people need it to do. Flip the switch—the lights come on. Reliable service, at least for most, came at a reasonable price. But in the last few years, things began to change. Energy policy is a hot topic. Consumers in California have seen rolling blackouts. Utilities are paying more for wholesale power than they've ever imagined.

Steve Hauser, senior account manager for Pacific Northwest National Laboratory's Energy Science and Technology Division, is leading activities that could help address the current energy crisis and may change the way the nation thinks about the energy system. We talked to him about the transforming energy system.

If the system worked well for so many years, what led to the energy crisis that is in the headlines every day?

There are many elements that brought us here. The growing economy is one. We need to meet increasing needs for energy. Determining what kind of generation capacity to add and where it should go puts new challenges on the system. Of course, changes in energy policy are another factor. Discussions at the national and state level include the concept of regional transmission organizations and deregulation of retail energy markets.

Consumer demands are changing. The situation in California has made everyone more aware and focused on energy. Businesses are becoming interested not only in the direct cost for energy, but about how other aspects like backup generation, insurance and business risk affect their bottom line. As consumers realize their unique energy and power needs, there is more demand for mass customization, which is happening already in other unregulated businesses.

There is a need for a new and more complicated infrastructure that simply must make better use of capital investments. Energy resources—all of them—are somehow limited by availability, climate or environmental requirements. New energy technologies are being introduced, like fuel cells, microturbines and photovoltaics. There are a myriad of issues that are changing and influencing the way the system operates and will operate in the future.

What is Pacific Northwest National Laboratory's view of the changing energy system?

We believe that an inevitable change is taking place and we've only begun to get a glimpse of it. Some pieces are clear—like the greater use of fuel cells, storage and renewable resources—others involve emerging technologies. We're imagining a much more complex future, but we certainly don't have all the details.

We are just beginning to study and understand implications of a new energy system where we would have the ability to know energy load details and system conditions at any time. As more powerful computers and communications become available, information technology will be key. An information-rich energy system will allow a much more comprehensive understanding of each individual part of the system.

For example, we would like to know how much energy is required or supplied by every device linked to the system, when it might be needed and what it could do in response to other system signals.

How soon do you expect to see this energy system transformation?

It will be an evolutionary process. Today the system is generally passive. A generator runs over here, someone turns on a hair dryer over there. The only interactions occur when gas or electricity flows to the consumers or when consumers pay their bills and the money flows back.

In the near future, many more generators—particularly smaller ones—will be on the system and more technologies will be available. Utilities will have a greater desire to control your appliances, for example. They might offer a financial incentive if you agree to allow them to shut off your water heater during peak hours. Commercial businesses might install their own generator to improve reliability and sell excess power back to the local utility. In fact, these things already are happening in some places.

In about five years, the system will be even more interactive. Parts of it will be Web-enabled and consumers will be able to choose their energy providers online in real time. Even further in the future, the system will be transactive, a term I use to describe the millions and even billions of transactions, both financial and commodity, that will be taking place constantly.

In what other ways will the system of the future be different than today's?

As I mentioned before, information will be flowing between every device on the system and these devices will react and respond appropriately. This will present opportunities for a much more integrated approach to managing the system—a complex optimization resulting in a system that is more efficient, clean, robust and cost-effective.

The ideal energy system of the future will deal with apparent dichotomies like both central and distributed power. It will have to make better use of assets and provide lower life cycle costs. It will be efficient, using the least amount of resources and creating the least impact on the planet while being flexible enough to survive serious disruptions.

The new system will enable the broad exchange of information; however, added communication cannot come at the expense of consumers' privacy or the ability to audit information. The future will require the system to be adaptable, adjusting to changes in weather, the economy and customer needs.

Where does the Laboratory fit into these changes?

Fundamental research is needed to understand a system with this level of complexity. We have to build new models and test them to provide insights into potential efficiencies and costs. New technologies and innovations must be developed to take advantage of the better information that will be available. Plus, new information management tools are needed for the system of the future to become a reality.

We will need mathematicians, economists, computer scientists and engineers to work on these solutions—and the Laboratory has all of these resources. One of our unique contributions will be the ability to provide such a broad range of expertise in one team.

I expect that we can contribute to changes in communications, infrastructure and information networks that will be required for the system to become transactive. New controls and diagnostics will be added to manage the system differently. There will be a need for experiments and pilot tests to validate the expected outcomes on the system.

Lastly, what I think is the key, is the need to simulate the system, not just how it operates in an engineering sense, but the economics and market responses as well. If we can help understand how the system operates and how its various parts impact each other, then we can begin designing innovative technologies and crafting appropriate economic structures and regulatory policies that realize the promise of this transformation.

Why is it important to begin looking at the energy system in a new way?

This region and the nation have to invest in new generating sources and new infrastructure that will cost billions of dollars. We don't have a choice. We need to be sure we're doing it right.

People are beginning to realize that there are more options available than the traditional way of thinking about the energy system. We may not understand them all right now, but we know new ideas are needed.

The Laboratory's work in this area can help ensure that future decisions are cost-effective and that the investments being made result in the best value. Already we have developed new partnerships and collaborations in this area and I expect many more to be formed in the months and years ahead.

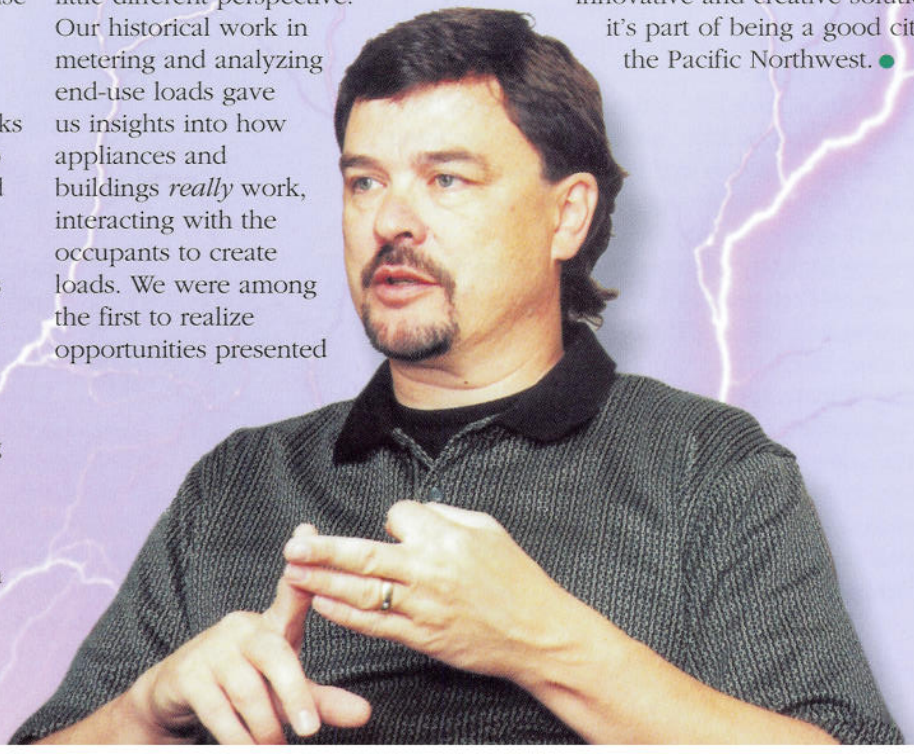
Why do you think the Laboratory can succeed?

We have many of the unique capabilities that will be necessary to build an understanding of the entire system. I've worked in the Department of Energy laboratory system for almost 25 years and I can't think of a challenge better matched to our expertise. We've always looked at things from a little different perspective. Our historical work in metering and analyzing end-use loads gave us insights into how appliances and buildings *really* work, interacting with the occupants to create loads. We were among the first to realize opportunities presented by debugging these systems and changing their control strategies.

We are forecasting technology penetrations and economic impacts for DOE; developing grid-friendly appliances, advanced diagnostics and plug-and-play controls for buildings and distributed generation; and studying transmission networks. We also are exploring completely different, nontraditional ways of doing things. We are applying complexity theory to detect price manipulation in energy markets, and looking at a conversion and distribution technology called Flexbus that allows different voltages and frequencies to be delivered to different circuits in a building.

As we're putting these diverse pieces together, we're starting to see the whole story. It's a little unusual in that we're creating a transformation—not just a business, not just a technology, not just science—but we'll need all of those elements for success. We think we can paint a pretty good picture of the future, but the details will evolve. It's exciting. I expect a lot of opportunities and a lot of challenges.

Right now, the Pacific Northwest is facing some very difficult choices about its energy options. Innovation and careful decisions are critical to ensuring that the region can meet its energy needs in the next decade while keeping the economy strong. This Laboratory can apply DOE's science and technology to address these issues. I think we can be an asset in helping the region find innovative and creative solutions—it's part of being a good citizen in the Pacific Northwest. ●



Water and energy—managing powerful partners

The millions of gallons of water in the mighty Columbia River are a valuable resource that serves many purposes in the Pacific Northwest—hydropower generation, fish and wildlife habitat, fish hatcheries and agricultural irrigation. The challenge, however, is to manage the river system in such a way that balances and optimizes the river's numerous uses.

Pacific Northwest National Laboratory is beginning to tackle that challenge by developing an integrated and focused management process that links natural resource management with electricity generation, transmission and distribution systems.

"It's a natural extension of our work," said Rick Skaggs in the Laboratory's natural resources group. "Some of the same conditions that affect the timing and abundance of water availability for the hydro system also affect the demand for water for other uses including power generation."

Researchers at Pacific Northwest have been studying the connection between fish passage and power production at hydroelectric dams for decades. "We use science and technology to track fish upstream and downstream of dams to understand the conditions in the aquatic system," Skaggs said.

Some of the Laboratory's ongoing activities include:

- Deploying an acoustic camera at Columbia River dams to assess its potential for studying fish behavior. Originally developed by the University of Washington for the Navy, the camera provides detailed underwater images that could be useful in evaluating fish bypass measures.
- Modifying the sensor fish, a simulated salmon that made its first splash in 2000, measuring the conditions that real fish encounter at hydroelectric dams. The new version will be small enough to embed in a real fish to collect more accurate data.
- Developing hydrodynamic models of water flow, temperature and oxygen content.
- Conducting watershed-scale and in-stream natural resource assessments.
- Applying climate variability and climate change models to evaluate how climate will impact the potential for hydropower production and competing needs for water resources.

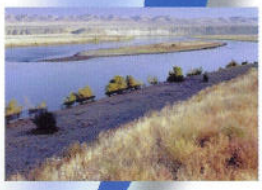
As part of the Laboratory's internally funded Integrated Natural Resource Management Initiative, researchers are developing the Adaptive Management Platform that integrates physical, ecological and economic process models to enable decision-makers to make robust, reliable decisions in the face of uncertainty.

California's power crisis in early 2001 brought national attention to the critical relationship among power, water and environmental quality. During the crunch, water from reservoirs—a precious reserve—was sent through the turbines of Columbia and Snake River dams in Washington and Oregon to produce electricity and send it south.

At the same time, however, the region's low snow pack increased the need to manage the rivers' in-stream flow to support salmon protection and recovery measures required by the Endangered Species Act. Farmers, who rely on the same water for irrigation later in the year, faced water shortages and potential crop loss. Researchers at the Laboratory are hoping that their work can help federal, state and local agencies in their challenge of meeting these competing needs in the coming decades.

"We're extending our tools and capabilities to provide integrated management of natural resources and hydropower generation," Skaggs said. "As we connect physical and biological process models to provide distributed modeling linked to management processes, decision-makers can better understand and balance the potential outcomes—and trade-offs—of river operation alternatives."

The Laboratory has been working with the U.S. Department of Energy's Office of Science, the Bonneville Power Administration, the Washington Department of Transportation and others on aspects of this approach.



For BPA alone, improvements in water resource systems analysis, risk management, information management and regional climate-based forecasting could help reduce the more than $400 million annual price tag on costs associated with fish and wildlife measures, lost revenue from reduced power production and purchasing replacement power.

"We plan to develop and demonstrate our capabilities in the Northwest, but ultimately these concepts will be applicable throughout the United States and internationally," Skaggs said. ●

Some photos on this page courtesy of the U.S. Army Corps of Engineers.

Refrigerators may help keep the lights on

A major transmission line gets knocked down during a violent storm. The region's electrical grid becomes unstable. Without even noticing, your refrigerator turns off momentarily. Thousands of appliances around the region do the same. Success! A major blackout is avoided.

Researchers at Pacific Northwest National Laboratory have developed a prototype of a device that may become the heart of grid-friendly appliances that can respond to critical conditions of the electrical system.

It may not be much to look at yet, but the almond-colored box about the size of a laptop computer can sense critical conditions on the grid at the receptacle and control refrigerators, water heaters, air-conditioners and other home appliances to avoid power outages.

"The idea is to have devices like this control appliances, but to do it with very little or no noticeable effect on the appliance use," said Michael Kintner-Meyer, who helped develop the prototype. "By turning things off for a few seconds, the system has time to stabilize. It is the least inconvenient way to reduce loads."

In the future, appliances may have built-in grid-friendly controls that operate much like the Laboratory's prototype. Kintner-Meyer said that energy service providers might provide incentives for consumers to buy the grid-friendly appliances because they would help keep the system stable.

"This is just the beginning," Kintner-Meyer said. "In addition to keeping the lights on, one day smarter appliances also could adjust how and when they operate based on the cost of electricity, helping consumers save money." ●

Regular checkups reduce energy use

A prototype of software developed by researchers at Pacific Northwest National Laboratory is providing buildings across the United States with the equivalent of their own full-time doctor.

Much like physicians who perform routine physicals to determine a patient's health, the Whole Building Diagnostician monitors a building's heating, ventilating and air-conditioning systems and uncovers problems that could be leading to wasted energy and occupant discomfort.

The Whole Building Diagnostician's module that monitors the performance of air-handling units and detects problems with outside-air control has been installed in a total of 35 air-handling units in 10 buildings for field-testing. Test sites include the air traffic control facilities at the Denver International Airport, a high-rise office complex in San Diego, California's Alameda County Courthouse and a building on the University of Maryland's campus.

"We've found problems in virtually all the air-handlers so far," said Rob Pratt, a staff scientist in the energy and engineering technical resource group. "About a quarter of the time we're finding major problems—where systems are using 50 percent more energy than they should."

The software turns data from building automation systems and digital control systems into valuable information about the root cause of problems in system design and installation, operator error and equipment failure.

A separate component of the Whole Building Diagnostician tracks overall building energy use. It is analyzing data from 21 buildings near the Laboratory on the U.S. Department of Energy's Hanford Site and is being tested at the District Energy St. Paul's headquarters in Minnesota, where it is analyzing data from 90 buildings.

The Laboratory plans to commercialize the Whole Building Diagnostician, expecting potential users to include building operators and maintenance staffs, electric utilities, energy service companies, building control and equipment companies and third-party suppliers of software.

For more information, see **http://www.buildings.pnl.gov:2080/wbd/intro.htm**. ●

Better lighting—the next bright idea in improving productivity?

A consortium of major building companies, government agencies and nonprofit organizations is exploring the connection between productivity and a well-lit workplace.

The Light Right Consortium hopes to quantify the relationship between the lighted environment and human and organizational benefits and translate the results into the workplace. Their project, which has been managed by Pacific Northwest National Laboratory since the group formed in 1998, includes a four-year scientific analysis that began in 2000.

The analysis employs research models and tools from disciplines such as psychology, human factors, ergonomics and econometrics. The project includes laboratory experiments, field studies and demographic research.

As the research activities continue, Light Right will work to eliminate the market barriers to worker-friendly lighting and increase awareness of the concept of "ergonomic lighting." Consortium members share a common interest in conserving resources, promoting new and better lighting products and improving workplace environments.

The project's proposed next phase involves developing a tool based on research results that would help people predict the benefits of ergonomic lighting and make informed purchasing decisions.

The group contends that beyond initial costs and energy savings, those making building lighting choices should consider human and business benefits. If better lighting leads to improved comfort and mood, it also could translate into higher staff retention and worker output. ●

Hello air-conditioner, how are you?

The air-conditioner technician of the future might need more telephones and fewer ladders if researchers at Pacific Northwest National Laboratory have their way.

Researchers have designed and built a system to remotely monitor and diagnose the performance of rooftop air-conditioners. The easy-to-install system measures air intake and temperatures from within the unit. The measurements then appear in real-time on a Web page that is automatically generated.

"Technicians can connect to the unit by phone or through the Internet to get clues about what the problem might be," said Dave Chassin in the Laboratory's energy technology development group.

Looking at the air-conditioning unit's Web page, technicians can point at particular places to obtain the same readings that they normally would take by physically putting probes into the air-conditioner. The remote readings are even more accurate because they can be taken without stopping or opening the unit.

"The diagnostic system can identify component failures, help avoid sick building syndrome, reduce energy use and help technicians schedule regular maintenance calls," Chassin said. "It also would help service companies send the right person and the right equipment to the job."

Unlike conventional monitoring systems that require complex programming and expensive installations, the new remote diagnostic and monitoring system requires the connection of just 12 wires and no software programming. Added features planned for future models would track energy consumption, provide remote control operation and compare the equipment's current operation to historical trends.

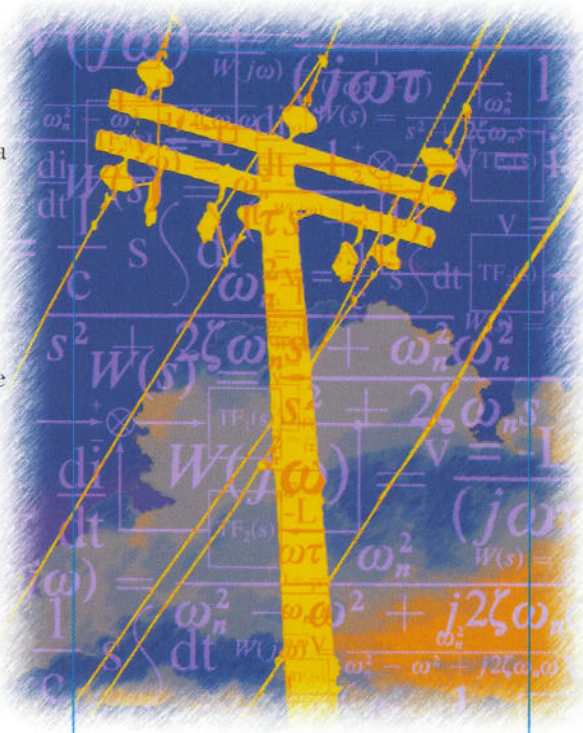
Researchers are testing the systems in southeast Washington state and at selected sites on the East Coast with hopes of commercializing the technology. ●

Taming the power of power

Two researchers at Pacific Northwest National Laboratory say they feel like they are attempting the impossible.

Joe Oliveira, Janet Jones-Oliveira and a team of engineering experts are taking the first steps toward developing a computer model of the way our country's electrical generating and transmission, distribution and end-user systems operate. This is a daunting challenge because the systems have changed radically in recent years.

"There are more variables in the power generation and transmission systems than ever before. And there are more variables in the economics of power generation and transmission than ever before," Oliveira said. "This is the first time that we know of that anyone has tried to couple these two highly variable systems in order to show how changes in either or both systems will impact each other. We're also going to create a model that changes and evolves on its own—just like the real economy—to understand the likely outcomes of introducing policies and technologies, and ultimately, the impact on consumers."



"We must be able to accurately reflect the cause-and-effect relationships between all of these factors simultaneously."

Until recently, companies or public utilities generated or purchased power, distributed that power through their own transmission systems and sold it to their customers at a price that recovered costs and allowed for a profit, or an operating reserve, depending on whether it was a private or public utility. There were usually price breaks based on the amount of power being used, but overall, the system was simple and worked well.

Today, however, driven mostly by rising prices, power distributors don't always own the generating stations. Whether public or private, they are buying their power from a variety of sources at different rates. Utilities are able to sell power for blocks of time ranging from a year down to periods as short as ten minutes. The more urgent the need for power, the higher the price on the short-term market.

Jones-Oliveira explained that solar and wind power are beginning to play more important roles in supplying the nation's energy needs, which disrupts the model for a centralized power generation and distribution. "We need to account for these resources in terms of the amount of electricity generated, its availability and, of course, its price," she said.

Another factor that must be considered in developing a computer model is the growth or contraction of economies in individual areas within a larger distribution region. One area may be adding homes and small businesses while a factory may close in another. There also is another growing concern that is new to the equation...the long-term and short-term impacts of climate change.

"It's like a very complex game where the rules are always changing," Oliveira said. "We need tools to help us assess the impact of these changes, to make the best use of them and certainly before they create crises. We must be able to accurately reflect the cause-and-effect relationships between all of these factors simultaneously."

The computer model will be most useful to companies that buy and sell electricity, to those needing to evaluate the potential for new technologies and to policy makers who want to encourage fairness in a free market. It also may help anyone from large farming operations to individual families that have their own generation sources or are interested in trading between electricity and other sources of energy when prices are more favorable. "Right now, power companies hold all the cards because they hold all the power. The program we are trying to develop will be a tool that the entire nation can use to ask questions, get answers and make decisions," Jones-Oliveira said.

This is not the first time the husband and wife team has worked on a project together, but they say it is certainly their most difficult. Fortunately, the duo has experience in developing complex computer models that respond to multiple variables and uncertainties, where one can drive another. "It will take us a year to create the first model. We see a clear path forward but we don't know what obstacles we may encounter. It's a very sobering challenge," Oliveira said. ●

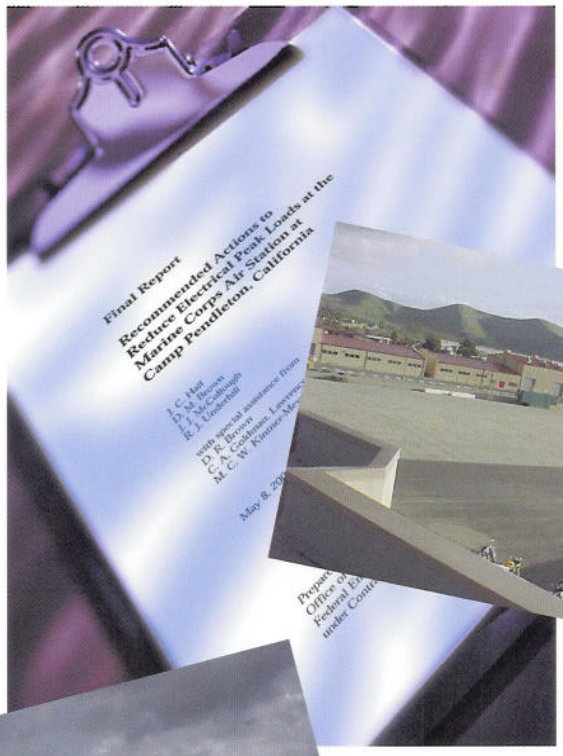
Special thanks to Mike Berriochoa, contributing writer.

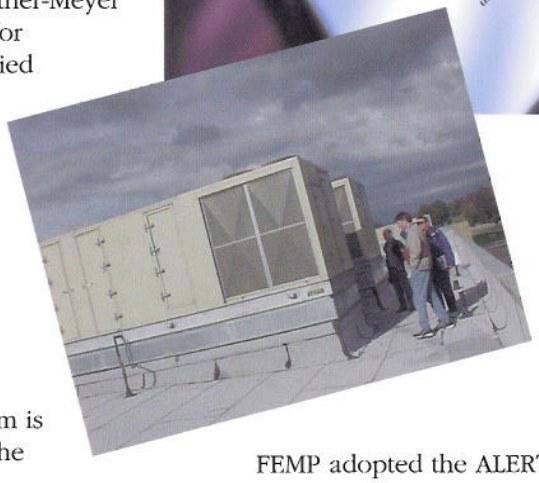
On ALERT for energy savings

Looking for ways to save energy? Sometimes the best opportunities are just waiting to be uncovered.

"The idea isn't to make people stop doing something to save energy," said Pacific Northwest National Laboratory's Bill Sandusky, who manages the Laboratory's activities for the U.S. Department of Energy's Office of Federal Energy Management Programs (FEMP). "The idea is to find things that can be fixed quickly and easily. Maybe a building is being heated or cooled longer than necessary or the lights are on when no one is there."

In early 2001, Pacific Northwest's Michael Kintner-Meyer developed the concept for the program later identified as ALERT—Assessment of Load and Energy Reduction Techniques. His idea was to conduct assessments of federal facilities to identify and implement low-cost or no-cost measures to reduce energy demand and consumption when California's energy system is at its peak, minimizing the potential for blackouts.





While the emphasis is on high-impact measures that can be taken in a matter of days, the assessments identify additional energy-saving options, such as installing more efficient lighting or distributed energy systems. The assessment gives facility managers the key information they need to submit an application for funding under California's Public Benefit Program.

FEMP adopted the ALERT program recommended by the Laboratory for rapid deployment just months before the President issued his directive to reduce peak consumption at federal facilities by 10 percent during summer 2001.

Sandusky and his colleagues formulated the assessment protocols, which primarily relate to re-tuning the operation of the building's heating, air-conditioning and ventilation equipment. Before bringing them to California, however, they ran pilot tests at ten facilities in Washington and Oregon.

In March, the first ALERT team headed to the Marine Corps Air Station at Camp Pendleton in California. According to the team's report, the assessment identified several opportunities that would reduce the facility's electric load during the summer peak by an estimated 7 percent or 233 kilowatts. The team's recommended actions also could reduce annual energy consumption by about 23 percent, saving nearly $300,000 annually.

While Pacific Northwest staff participated on many ALERT teams, they also trained other national laboratories to conduct the two-day assessments. In two months, the teams covered 25 federal facilities in California.

Sandusky said that he expects Washington state and the Northeast to be part of next year's ALERT focus. ●

Contributing to a nuclear renaissance

In May 2001, President Bush's National Energy Policy Development Group estimated that during the next 20 years, the demand for electricity in the United States will rise by 45 percent. Among the Group's recommendations for ways to meet this projected growth in electricity demand was the statement that "nuclear power, . . .which causes no greenhouse gas emissions, can play an expanding part in our energy future."

That was a resonant statement to a number of scientists and engineers at Pacific Northwest National Laboratory. Their expertise in nuclear science and technology was already at work on, or could be applied to, projects that would help nuclear power rise to this challenge.

The Laboratory is launching an Advanced Nuclear Science and Technology Initiative (ANSTI), under the leadership of senior scientist Leonard Bond. "Nuclear science and technology is a major component of the Laboratory's current activities," Bond said. "ANSTI is building on our existing capabilities to support a national nuclear renaissance."

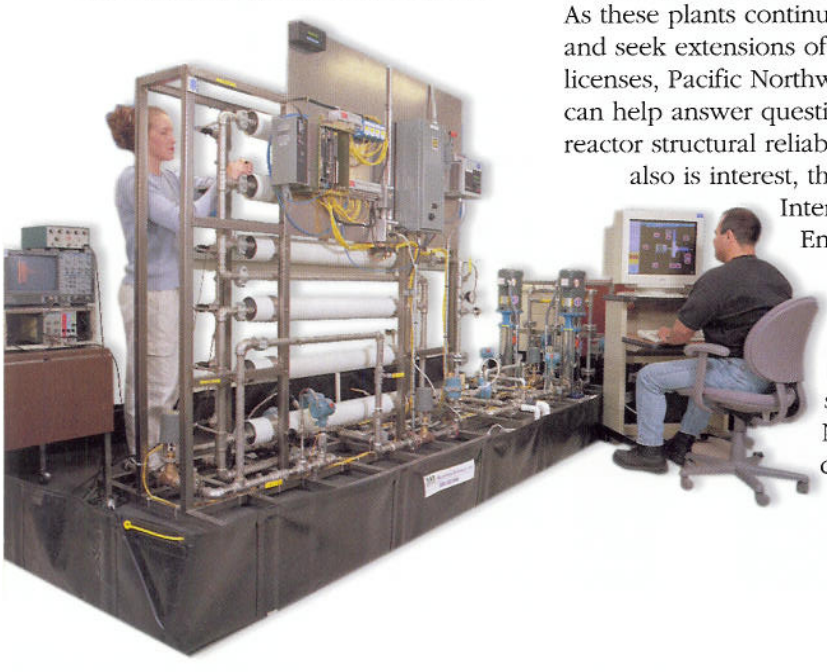
Through the initiative, Bond and his team intend to:

- become recognized national leaders in actinide science, radiation materials science and modeling, and in advanced diagnostics, prognostics and controls
- support the U.S. Department of Energy missions and other government clients by developing advanced nuclear research and technology capabilities
- play an integral role regionally and nationally in the development of future nuclear science and engineering professionals.

Resources available at Pacific Northwest for nuclear research and development include 12 facilities containing a total of more than 350 laboratories equipped for work with radiological materials, 11 large specially designed facilities in which staff can work with highly radioactive materials remotely and more than 460 staff who have training and experience in radiological work.

In the area of actinide science research, the Laboratory can fill gaps in the national research program by contributing to development of actinide chemical separations, studying the environmental fate and transport of actinides and contributing ultrasensitive detection technology to DOE's nuclear nonproliferation program. Actinides are a series of chemically similar radioactive elements with atomic numbers ranging from 89 through 103 such as uranium, with atomic number 92.

Today, nuclear power plants generate about 20 percent of the electricity used in the United States. As these plants continue to operate and seek extensions of their operating licenses, Pacific Northwest's research can help answer questions about reactor structural reliability. There also is interest, through DOE's International Nuclear Energy Research Initiative, in development of next-generation nuclear energy systems. Pacific Northwest is developing new materials for these energy systems, and has a novel on-line intelligent self-diagnostic monitoring technology that is applicable to present as well as next-generation nuclear power plants.



Energy production is not the only challenge for nuclear science and technology. The Nuclear Energy Research Advisory Committee reports that the United States faces a crisis relative to its own internal capabilities in nuclear science and engineering. Without strong, decisive action, within 10 years this nation will find it increasingly difficult to:

- effectively complete the cleanup of its nuclear complex
- prevent proliferation of nuclear materials
- guarantee nuclear stockpile stewardship
- support nuclear-related national security requirements
- realize the potential and meet the demand for isotopes and radiochemical materials in medical, industrial and space-power applications
- sustain the pool of workers needed to operate and maintain commercial nuclear reactors.

The Laboratory's new initiative will address these concerns by developing a strategy to address the supply of nuclear science professionals, including providing a focus for establishing educational initiatives through collaborations with DOE, other national laboratories, educational institutions and professional societies.

"These activities will be a catalyst for the development of a robust ANSTI program to meet the needs of the 21st century and they will provide a unique scientific resource that can be used for everything from nuclear power to environmental cleanup," Bond said. "We also will recruit and develop highly qualified staff with nuclear expertise, and develop a regional education network for nuclear science and engineering." ●

Special thanks to Richard Romanelli, contributing writer.

Pumping up safety in refining gasoline

Researchers at Pacific Northwest National Laboratory have developed a new solid acid catalyst that may provide oil producers worldwide with a safer approach for refining unleaded gasoline with reasonably high octane.

The Silica Supported Solid Acid Catalyst is an innovative technology that eliminates the need for toxic and corrosive acids in the process of converting crude oil to gasoline.

Refineries produce gasoline to operate the more than 500 million vehicles in the world.

Gasoline used in much of the Third World still contains lead, which can cause learning disabilities, hearing loss, high blood pressure and heart disease. Furthermore, some of the current crude oil refinery processes use corrosive and dangerous sulfuric and hydrofluoric acids that present a danger to the environment and the public if accidentally released.

The petrochemical industry has been seeking alternative processes that would create higher-octane unleaded gasoline without using dangerous liquid acids.

"The Silica Supported Solid Acid Catalyst can help refineries safely manufacture the component alkylate that can serve as a replacement for lead as an octane booster in gasoline," said Chuck Peden, associate director for the interfacial chemistry and engineering group. "Alkylate lends excellent anti-knock characteristics to unleaded gasoline, and the solid acid catalyst is highly efficient at synthesizing alkylate. These new catalysts also are noncorrosive and nonpoisonous so they can be handled with minimal protective gear."

UOP, Inc., a leader in supplying technology and products to the petrochemical industry for more than 50 years, has been a partner with Pacific Northwest in the development of these new catalysts. The U.S. Department of Energy's Office of Science has funded the research at the Laboratory. ●

Habitat mapping

Using a combination of side-scan sonar and underwater videography, researchers at Pacific Northwest National Laboratory have successfully characterized a large section of shoreline habitat on Washington's Puget Sound. "This is the first time anybody has developed a comprehensive, continuous map of a large section of shoreline with this combined technique," said Dana Woodruff, project director at Pacific Northwest's Marine Sciences Laboratory.

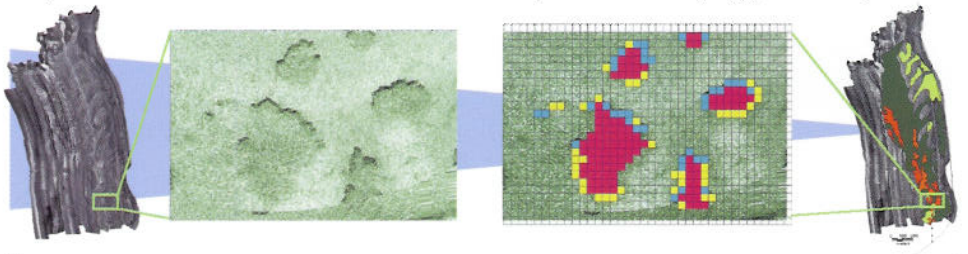
Researchers acquired sonar images and video data for nearly 14 miles of shoreline to assist the King County Department of Natural Resources in determining the location for its new wastewater treatment plant outfall. Using the combined equipment, researchers identified and characterized the substrate, vegetation and fisheries resources to determine an area of least environmental impact.

According to researcher Ron Thom, King County was pleased. "They said it was the most useful product they've gotten on near-shore characterization," Thom said. "And our effort has helped them to narrow down the location for siting the outfall to a few sites with the least environmental impact."

In addition to creating baseline maps and identifying potentially sensitive areas, the assessments are useful for determining future restoration scenarios and other applications.

The combined technologies of sonar and video provide much greater accuracy and detail in characterizing shallow water habitats than more traditional methods such as diver transects or video alone. Researchers are continuing to work on system refinements that will save time, such as neural-network-based pattern recognition capabilities that would automatically characterize and extract features from the sonar imagery in the near-shore environment. A neural network is a matrix of electronic neurons that imitates a biological brain.

Development of this new system, managed by Karen Steinmaus, is a joint U.S. Department of Energy and National Imagery and Mapping Agency project. ●



Special thanks to Sue Chin, contributing writer for the stories on this page.

Arming against online attacks

Pacific Northwest National Laboratory researchers specializing in cyber security believe that when it comes to computer hackers, prevention is the best medicine.

"If you detect a cyber attack, it's too late," said Wayne Meitzler, a program manager in the national security science and technology department. Pacific Northwest's growing cyber security program is focused on how to defend software and computer systems against unwelcome invasions.

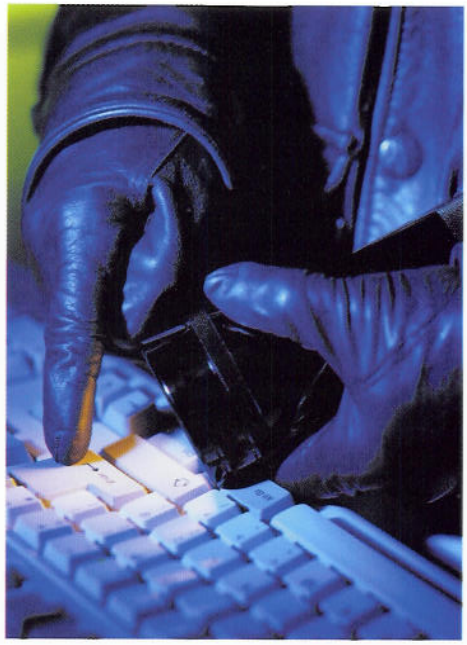
For example, the Laboratory is developing tools that can analyze programming and identify where it could be susceptible to attacks. By doing so, vulnerabilities can be eliminated while software is being developed and before it is deployed.

"The computer industry has tended to focus on speed and efficiency, not on security," Meitzler said. For the same reason, researchers are exploring how to meet the need for security tools to keep up with the ever-increasing power of high-speed networks.

In a project funded by the U.S. Department of Defense's Defense Advanced Research Projects Agency, researchers are building a super virus scanner that will identify unintentional "back doors" in software and uncover potential security risks. These tools may be used one day by independent agencies that test software or by end users who want to assess the security of their software.

A prototype training program developed at the Pacific Northwest's Critical Infrastructure Protection and Analysis Laboratory, or CIPAL, allows systems administrators to gain hands-on cyber security experience while keeping their own systems out of harm's way.

CIPAL is a dedicated cyber research and development laboratory created specifically to counter cyber threats. "CIPAL provides a safe environment for developing and testing tools by exposing them to a variety of attacks," Meitzler said.



With as many as 20 ongoing projects, Steve Martin, manager of the Laboratory's protection, interdiction and enforcement technology product line, sums it up by saying, "We're working on solutions ranging from policy level discussions and decisions to developing precise pieces of code to fix specific problems."

Because of their expertise in computational science, systems engineering and information visualization, Laboratory staff members often are asked to participate in groups that are focused on cyber security issues.

Researchers are actively involved with groups such as a national interagency panel that assesses potential cyber threats; Computer Law Enforcement of Washington, a working group that strives to educate and protect the citizens of Washington state from computer crimes; and a Northwest cyber security consortium that includes the Idaho National Engineering and Environmental Laboratory, Microsoft, Oracle, Unisys and the University of Idaho. ●

Real-life training without the risks

Much like flight simulators that provide real-world experience to pilots without jeopardizing lives, a new cyber security training capability will give computer system administrators experience defending against cyber attacks without compromising their networks.

Scientists at Pacific Northwest National Laboratory have created a prototype Systems Administrator Simulation Trainer to rapidly develop the cyber security experience of system administrators in any type of organization. Launched through an automated system, the network of training tools simulates the cyber environment to teach system administrators to identify, circumvent or recover from hacker activity.

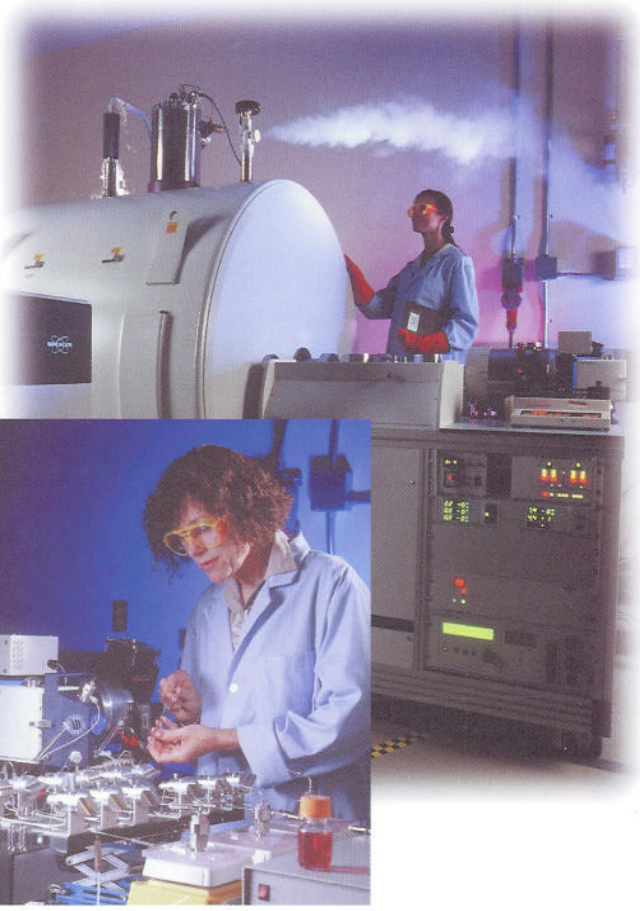
"This environment includes realistic attacks to really give students experience to learn about—and sweat about—what to do next," said Ron Melton, who leads the Laboratory's cyber security group. When these tools are fully developed, students would use them remotely, reducing training costs and allowing continual access.

The simulation trainer was developed for the Department of Defense's Technical Support Working Group, which conducts the national interagency research and development program for combating terrorism through rapid research, development and prototyping. ●

A new addition for weighty research

The name of a new instrument in the U.S. Department of Energy's William R. Wiley Environmental Molecular Sciences Laboratory may be a mouthful, but its function is not nearly as complicated as it sounds. To put it simply, the 9.4 tesla fourier transform ion cyclotron mass spectrometer weighs peptides.

The latest addition to the Laboratory's collection of FTICR mass spectrometers is the most powerful available commercially. It measures the mass of peptides—small structural units obtained by cutting proteins into pieces—with such sensitivity and precision that scientists can detect hundreds of thousands of peptide species in a single analysis.



Identifying peptides is an important part of proteomics research to determine the role that proteins play in cells and living systems. Researchers expect that more than a million peptides are available in the proteins expressed within human cells.

Pacific Northwest National Laboratory scientists at EMSL are collaborating with the manufacturer on modifications that will make the new instrument even more sensitive. It is intended to serve as a prototype for as many as a dozen mass spectrometers that will be put to use at the Laboratory in the next few years for high throughput proteomics research. ●

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