Breakthroughs

Science. Technology. Innovation.

FALL 1999

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PACIFIC NORTHWEST NATIONAL LABORATORY

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

Anyone who has ever found a great bargain at a garage sale knows the truth to the old adage about one man's trash being another man's treasure. A special report in this issue of *Breakthroughs* illustrates how innovation at the U.S. Department of Energy's Pacific Northwest National Laboratory is turning waste and byproducts such as potato vines and paper mill sludge into valuable products for industry and medicine.

As the new editor of *Breakthroughs*, and a new member of Pacific Northwest's staff, working on this issue has been a real learning experience for me. From the perspective of a recent outsider, what I found most remarkable is the laboratory's wide variety of capabilities and expertise and how applicable they are to the world in which we live. We've tried to capture some of that impressive diversity in this issue.

From helping communities save money with energy-efficient buildings to mounting tracking devices on honeybees to locate landmines, the knowledge and technologies developed at Pacific Northwest are more than scientific breakthroughs. These pages highlight solutions and opportunities—from the newest developments to technologies already available commercially and many at stages in between. ●

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If you'd like to know more about any of these articles or Pacific Northwest, please contact us. We'll answer your questions or put you in touch with the person responsible for business development in your area of interest.

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- **To read more about how potato plants are producing valuable enzymes and tobacco plants are producing human blood factors as featured in the "Trash to Treasure" section, see http://www.pnl.gov/news/1999/99-30.htm and http://www.pnl.gov/news/1999/99-29.htm.**
- **Dive deeper into the "Habitat Research Blooming at Seawater Greenhouse" by checking out Pacific Northwest National Laboratory's Marine Sciences Laboratory at http://www.pnl.gov/techcap/marine.htm.**
- **More information about remote access to the capabilities of the William R. Wiley Environmental Molecular Sciences Laboratory discussed in "Access to High-Powered Instrument Available 'Virtually' Anywhere," is at http://www.emsl.pnl.gov:2080/docs/collab/.**
- **If you're interested in investigating "Putting Crime Scene Technology to the Test," check out http://www.pnl.gov/remote/projects/scenepro.htm.**

Honeybees *all the buzz* in landmine detection

The latest in fashion for bees this summer—a high-tech tracking backpack—also may help find millions of landmines scattered throughout the world.

If honeybees can be trained to seek the chemical components of explosives, the ability to track bees and analyze their hives could help pinpoint landmines or unexploded ammunition on firing ranges or old battlefields.

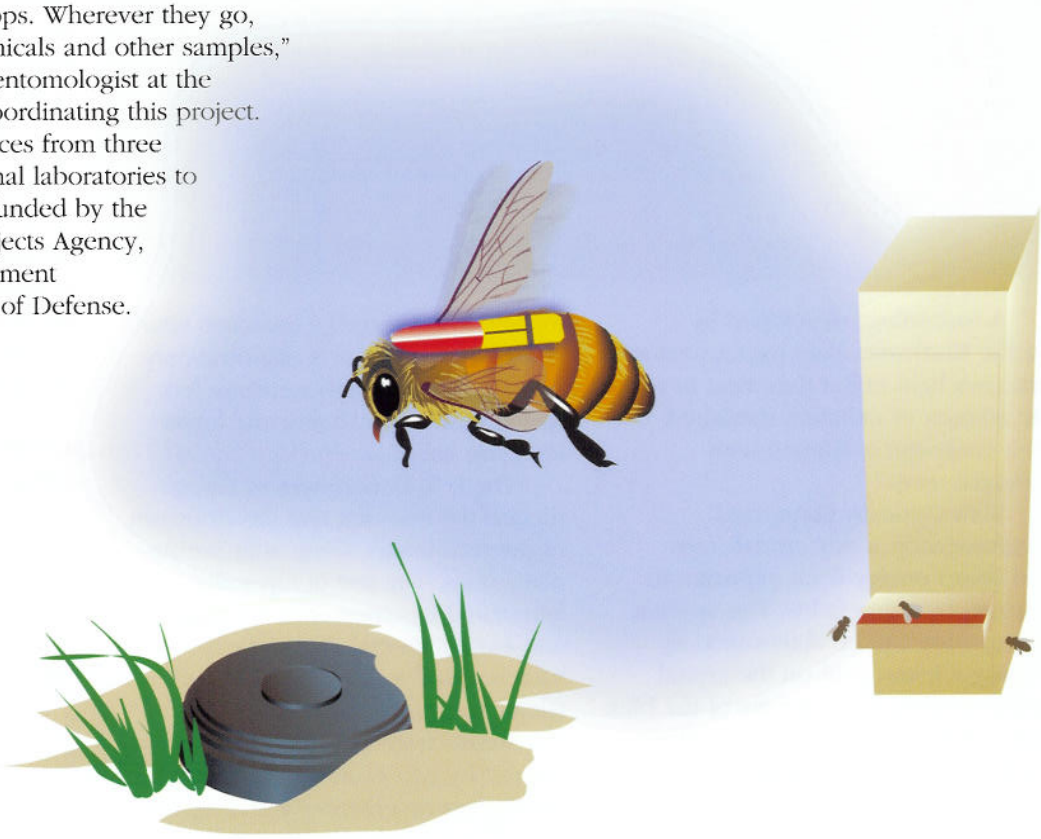
Engineers at Pacific Northwest National Laboratory have modified commercially available radio-frequency tags for bees to "wear" so they can be identified. Special electronics and software also designed by Pacific Northwest are mounted on man-made beehives to "read" the identification of each bee from the tiny tags.

Researchers hope that while bees are out foraging for pollen they'll also pick up traces of the chemicals found in explosives that leak from landmines into soil and water.

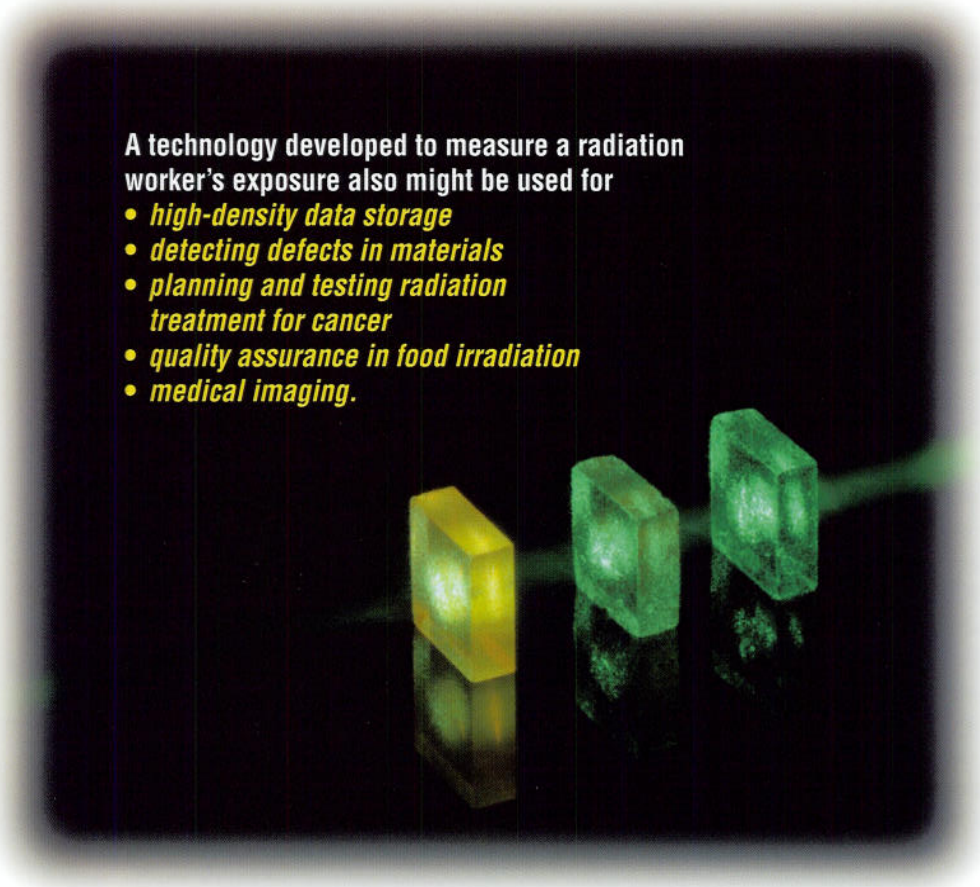
"Bees are like flying dust mops. Wherever they go, they pick up dust, airborne chemicals and other samples," said Dr. Jerry Bromenshenk, an entomologist at the University of Montana, who is coordinating this project. Bromenshenk has pooled resources from three federal agencies and three national laboratories to conduct this research, which is funded by the Defense Advanced Research Projects Agency, the central research and development organization for the Department of Defense.

In a field test in May, several bees were outfitted with the tags, each weighing less than a grain of rice. Pacific Northwest engineers determined that the radio-frequency fields didn't interfere with bee activity, but that the tags should be made smaller to lessen the impact on bees' flight. Sokymat of Switzerland and its U.S. representative, North American Research Inc., are working to reduce the size of the tags.

A second field test at Sandia National Laboratories will study 50 tagged bees to determine the greatest distance bees can forage and how long it would take them to reach the landmines. In that test, a reader will track each time a bee leaves the hive, which way it is heading and when it returns. A system of analysis tools being developed by Sandia, Oak Ridge National Laboratory and the Environmental Protection Agency will be installed in the hives to scan for chemicals such as TNT. ●



A bright *idea:* dosimetry technology has far-reaching *applications*



A technology developed by Pacific Northwest National Laboratory that uses light rather than heat to read the amount of radiation measured by a dosimeter is shining with potential uses.

With Optically Stimulated Luminescence, a tiny crystal traps and stores energy from exposure to ionizing radiation fields. The amount of exposure can be determined by shining a green light on the crystal and measuring the intensity of the blue light emitted. This technology allows for instantaneous readings that can be repeated. Traditional dosimeters take 20 or 30 seconds for a one-time-only reading. Other benefits include less handling, less packaging and lower life cycle costs.

The U.S. Department of Energy funded the research and development of the technology along with private companies. The use of Optically Stimulated Luminescence for personnel and environmental dosimetry is now licensed to Landauer Inc., of Glenwood, Ill.

Sunna Systems Corp., a company formed by two Pacific Northwest employees on entrepreneurial leaves of absence, is licensed for other specific applications, including high-dose dosimetry. This technique may be used in the medical industry and in the emerging market for food irradiation.

"Now that the FDA approved high-dose irradiation for red meat, high-dose dosimetry will get a lot of attention," said Steve Miller of Pacific Northwest's dosimetry research and technology group and an owner of Sunna. "They're going to need a low-cost way to measure how much radiation the meat is getting."

For medical applications, the same materials used to make tiny crystals for personnel dosimeters are fabricated into flat sheets. Two-dimensional dose mapping of radiation fields can help ensure that devices used to treat cancer are working correctly and delivering radiation to the appropriate parts of the body.

Flat sheets of the material also can be used to detect defects in materials such as airplane wings. This use of Pacific Northwest's technology, called industrial radiography, also is licensed to Sunna. Miller said that Sunna is seeking investment capital to help further its marketing, manufacturing and distribution efforts.

At the same time, Pacific Northwest is exploring opportunities to commercialize even more ways that the technology can be used. For example, it could be used in medical imaging as an alternative to typical x-rays and has high-density storage capabilities better than compact discs and even digital video discs or "DVD." ●

Science of doing business

Six-Phase Heating™ a powerful *innovation* in environmental cleanup

Industry is warming up to a new way to treat contaminated soil and groundwater that uses electricity to heat soil and strip contaminants from the ground.

Commercial and industrial sites around the country are using Six-Phase Heating™ to remove contaminants such as gasoline, chlorinated solvents and other volatile and semi-volatile compounds from the soil and groundwater quickly and cost effectively.

"One advantage of Six-Phase Heating is that there is no need to excavate contaminated sites," said Bill Heath, a senior development engineer at Pacific Northwest who helped develop the technique. Heath is on part-time entrepreneurial leave to serve as the vice president of technology for Current Environmental Solutions, a limited liability company that was formed in 1997 to offer the technology commercially.

The process uses electric current to create heat, raising the temperature until the moisture in a contaminated aquifer boils and turns to steam.

The steam, carrying the stripped contaminants, rises to the surface where it is captured by extraction wells and treated. Compared to traditional vapor extraction methods, Six-Phase Heating is much less sensitive to the type of soil being treated or how easily the contaminants will vaporize. "It works well in tightly packed soil such as clay or silt or very wet soils that would otherwise be difficult if not impossible to treat." Heath said.

The process separates standard three-phase electrical current into six electrical phases and delivers each phase below the surface through separate electrodes. The electrical gradient between the electrodes causes electrical current to flow through the soil and groundwater, creating a uniform heating zone.

Earlier this year, Six-Phase Heating was used to remove tetrachloroethylene from the soil beneath a former dry cleaning business and the adjacent alley where the chemicals had spread. While the actual storefront was closed, neighboring retail shops and the alley remained open throughout the entire cleanup process.

Pacific Northwest developed Six-Phase Heating for the U.S. Department of Energy as a faster and cheaper cleanup method for difficult-to-treat sites. Battelle, the company that operates Pacific Northwest, is a partner in Current Environmental Solutions, which is completing its fifth project to date. ●

Future fill-ups may use *paper* mill waste

One man's trash is another man's treasure, or so goes the popular saying. At the U. S. Department of Energy's Pacific Northwest National Laboratory, waste materials such as byproducts from paper mills are becoming treasure thanks to a process that enables the cost-effective production of environmentally friendly fuels and other promising chemicals from low-value or waste biomass.

Paper mill sludge, an organic waste product that can be damaging to the environment, is cumbersome for mill operators to manage since it accumulates rapidly during operation. Current management options include drying and spreading the sludge on land, composting or transporting the material for deposit at landfills.

Research and technology demonstrations show that an important, multipurpose chemical called levulinic acid, which normally is produced from refined petroleum, can be produced from biomass such as paper mill sludge at a whopping one-tenth the cost of current manufacturing processes.

Building upon the levulinic acid production process developed by Biofine Corp., Pacific Northwest provides a patented catalysis process that upgrades the levulinic acid to produce methyltetrahydrofuran, or MTHF, for use in clean, alternative fuels and chemicals. This process doesn't create harmful pollutants or emit greenhouse gases and requires less energy for production.

The environmental benefits of combining these two processes are so promising and crosscutting to the chemical industry that it received one of five 1999 Presidential Green Chemistry Challenge Awards. "Green Chemistry" is the use of chemistry for pollution prevention and the design of chemical products and processes that reduce negative impacts to human health and the environment.

"This is an exciting technology emerging from DOE's investments in biomass conversion, a field where we are literally just touching the surface of the potential for using low-value and waste biomass material for valuable products," said Dennis Stiles, manager of Pacific Northwest's Agriculture and Food Processing Technology programs. "In the near future, we'll be expanding the technology to produce levulinic acid from other organic materials, such as straw left over from grain production, as well as producing a variety of other chemical products, such as solvents, herbicides and plastics, in addition to MTHF."

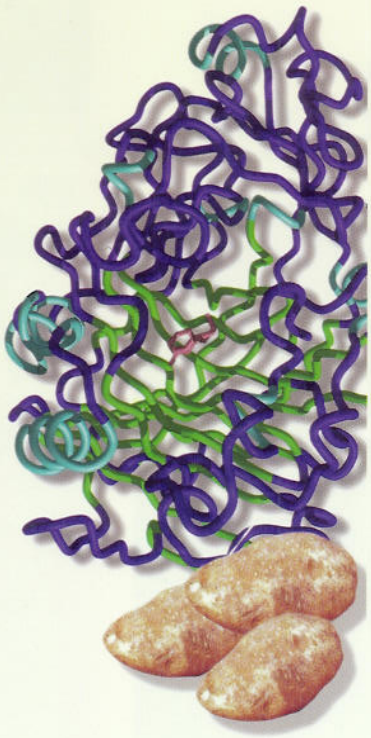
The levulinic acid conversion technology, which has been demonstrated in Biofine's pilot-scale facility in New York, is ready for commercialization. A search is underway to site a manufacturing plant in a major pulp and paper producing region, providing the capacity to produce levulinic acid and to upgrade this material to alternative fuels and other products, while reducing the cost of managing the waste sludge. ●

Green Chemistry Award

The "Oscars" of green chemistry were awarded by the Environmental Protection Agency in June, with the Pacific Northwest National Laboratory earning recognition as a contributor to one of the five 1999 Presidential Green Chemistry Challenge Awards. Pacific Northwest contributed to the winning technology that turns waste such as paper mill sludge and agricultural residues into a chemical building block that can be used to make environmentally friendly chemicals and alternative fuels.

EPA leads the Green Chemistry Program, which President Clinton announced in 1995. The program is designed to foster research, development and

Stories on this page written by Mary Ace.



Beyond french fries

Researchers at Pacific Northwest National Laboratory have found a use for potatoes beyond french fries and hash browns. They have found a way for potato plants to produce cellulase, a valuable enzyme that can be used in detergent and textile manufacturing, food processing and fuel processing.

Normally, the tubers beneath the soil are harvested as food while the rest of a potato plant goes to waste. By inserting specific genes, however, the leaves of potato plants will produce cellulase without affecting the edible part of the plant or its use as a food crop. The same method can produce enzymes that can be used in medical diagnostics or as pharmaceuticals.

Working with plants in this way could bring additional profits for farmers who can harvest two products from a single crop—one for eating and the other for producing chemicals. ●

Another helping *of potatoes*

Scientists at Pacific Northwest National Laboratory are experimenting with strains of yeast and bacteria that can feed on agricultural waste products and produce proteins for industrial biocatalysts and animal feeds.

"With molecular biology and advanced bioprocessing techniques, we can modify natural starch-degrading yeast strains to produce valuable foreign proteins directly from starch-rich byproducts," said Jianwei Gao, a senior research engineer. "In addition, this is an environmentally benign process since it only produces industrial biocatalysts in one stream. Its biomass byproduct, in the other stream, will be processed as high-quality cattle feeds, discharging no waste into the environment."

The use of these specialized strains of yeast may allow waste products from potato, wheat and corn processing plants to take the place of refined chemicals such as methanol, glucose and glycerol often used to feed protein production. The benefit of using yeast to produce proteins from waste products is twofold. With as much as 340,000 pounds of starch byproducts produced each day at a typical potato processing plant, this method can help alleviate a waste problem. It also could reduce the cost of producing proteins because it would eliminate the need for refined chemicals. ●

deployment of scientifically sound and cost-effective chemical technologies that prevent pollution. EPA receives more than 120 entries annually from organizations and institutions vying for the prestigious green chemistry awards. From the submittals, EPA selects a winner from two categories: academia and small business, and from three focus areas; alternative synthetic pathways, alternative reaction conditions and designing safer chemicals.

An independent panel selected by the American Chemical Society judges the nominated technologies. To earn the Presidential Award, the technologies must display scientific merit, offer benefits to human health or the environment and be widely applicable to chemical manufacturers, users or society at large. ●

Nuclear waste *delivering* a dose of hope

Nuclear waste and cancer may be among society's most serious concerns, but researchers have found a way to use one to treat the other.

An innovative cancer therapy relies on a derivative of waste from nuclear weapons production. Through a process patented by Pacific Northwest National Laboratory, an ultra-pure form of the medical isotope yttrium-90, used to treat a variety of cancers, is being extracted from the weapons production byproduct strontium-90.

Final trial results are expected this year from Switzerland's University Hospital in Basel, where brain cancer patients are receiving the therapy.

Patients receive an injection of yttrium-90 linked to specially engineered peptides that seek out brain tumor cells. Once inside the tumor, the peptides bind to the tumor cells, delivering a high dose of radiation to cancerous cells while minimizing impact to surrounding healthy tissue. The treatment causes few side effects and can be administered on an outpatient basis.

Pacific Northwest is in the final phases of commercializing the production, distribution and sales of yttrium-90. A private company, New England Nuclear Life Sciences Products Inc., of Boston, Mass., is leasing 40 curies of strontium-90 from Pacific Northwest each week and has licensed the patented process for "milking" yttrium-90 from the isotope. ●

New tobacco products *good* for *health*

Forget cigarettes! Scientists at Pacific Northwest National Laboratory have found a use for tobacco plants that doctors actually may condone. They have genetically modified tobacco plants to produce human blood proteins and tissue growth factors, which may lead to safer and more cost-effective medical treatments.

Using plants to produce human blood proteins is better than conventional processes that use human blood, animal cell cultures or whole animals for several reasons. Plant-produced proteins eliminate the possibility of transmitting blood-borne pathogens such as HIV or hepatitis, are substantially less expensive and provide a stable production source with a higher yield.

Scientists have used tobacco plants to produce blood coagulation Factor VIII, which is critical in treating hemophiliacs. The same approach also has produced thrombin and Factor XIII—clotting enzymes that help wounds heal and could be alternatives to sutures and other surgical sealants. ●

Rebuilding America, *one* community *at a time*

Schools want to buy more books but are short on funds. Cities would like to hire additional police officers when there's no money in the budget. For the last five years, a national program has helped communities overcome financial obstacles like these by assisting with projects that result in lower utility bills.

The U.S. Department of Energy created Rebuild America to establish self-sustaining community partnerships that pursue opportunities to save energy. The Pacific Northwest National Laboratory provides technical assistance and coordinates the products and services for the $7 million national program.

"The focus is communities. They have the resources but often lack the technical knowledge or coordination to make it happen," said Chip Larson of Pacific Northwest who serves as Rebuild America's nationwide product and services manager and as a program representative for several partnerships.

A school district, an assisted housing development, a city or even an entire state can form a partnership. Some of the 220 partnerships in place include the city of Portland, Ore., the state of Nebraska and the University of Idaho.

Portland's partnership brings together the two private electric utilities and the gas company that serve the city, the Portland Public School District, the Oregon Department of Energy and the local chapter of the Building Owners and Managers Association.

"It gives us an opportunity to work together and we're seeing results," said Curt Nichols of the city of Portland's energy office. Focusing primarily on commercial buildings and multifamily dwellings, more than 47.5 million square feet of building space have been improved, helping businesses save $3.6 million a year.

Partnerships choose which buildings to renovate, how much energy they should try to save and the best technologies to use—whatever best meets local needs. As the umbrella organization, Rebuild America provides a nationwide network of support and technical assistance, bringing together laboratory resources, subcontractors and other partnerships in the program.

Pacific Northwest developed two tools that have proven extremely useful to the Rebuild America program. The Information Management System provides partnerships a system for web-based information exchange with library and reporting features. The Facility Energy Decision System software quickly and easily determines the optimum energy-efficiency improvements for a building or set of buildings. ●

> **"The focus is communities. They have the resources but often lack the technical knowledge or coordination to make it happen."**

Making the most of energy savings

Would replacing a building's heating system save enough in energy costs to be worthwhile? Scientists at the U.S. Department of Energy's Pacific Northwest National Laboratory have created a tool to help answer how to make a building more energy efficient and whether it's worth the cost.

Windows-based and user-friendly, the Facility Energy Decision System software quickly and objectively identifies the energy improvements that offer maximum savings. The software creates a building prototype from simple information such as the building's size, location and the year it was built. From there, users can review and edit all of the inferred engineering inputs if they desire.

Whether assessing a single office building or every school in an education district, the program can identify the best retrofits based on minimum life cycle costs and economic opportunity. It develops an optimum set of retrofits from a database of thousands of proven technologies in heating, cooling, lighting, motors, building shell and water heating.

The software even can provide information about how projects will impact carbon monoxide, carbon dioxide, nitrogen oxides and sulfur dioxide emissions.

DOE is funding the software package specifically for use on federal and state projects and programs. Pacific Northwest is interested in licensing the software to a commercial partner so that private companies can use it as well. ●

Building a defense for cyber attacks

Like a thief in the night, competitors or adversaries can creep in undetected and seriously harm businesses, or even worse, threaten national security.

In the age of the Internet, the theft or manipulation of critical information poses a much more serious problem than vandalism or the mysterious disappearance of physical goods—and it's much harder to detect or prevent.

Pacific Northwest National Laboratory is creating a unique facility to conduct comprehensive research on detecting and defending cyber attacks. The main feature of the Critical Infrastructure Protection Analysis Laboratory is a completely isolated network for simulated attacks without the potential of harming real-world applications.

"When it comes to hacking, you can't test your system while its working," said Wayne Meitzler of Pacific Northwest's information science and engineering organization. "Imagine an airline learning about a security problem by bringing down the entire reservation system during a test."

Meitzler and his colleagues are pulling together a representative sample of the various types of computers, operating systems and even simulated remote monitoring and control systems, and putting them all in one place. "The different versions of Windows, UNIX, different architectures and different kinds of chips—we'll have one of everything," Meitzler said.

The facility is being developed to support Pacific Northwest's national security and counterterrorism efforts. It will serve as a safe test-bed for evaluating existing technology, for research and development and for independent verification and validation of cyber systems. Eventually it also will be a training tool. The system will feign cyber attacks, creating unique scenarios every time, so people can learn how to defend their systems and test what they've learned.

In addition to using the facility to meet internal needs, Pacific Northwest is looking for clients who are interested in technology, capabilities, services or collaboration to protect national critical infrastructure and in the broader area of information assurance. ●

Air quality study above it all

Pacific Northwest National Laboratory atmospheric scientists make preparations for airborne measurements of ozone, other trace gases and particulate matter. Staff from Pacific Northwest operated its Gulfstream-1 aircraft in Philadelphia for three weeks this summer during one of the U.S. Department of Energy's Atmospheric Chemistry Program collaborative projects. Researchers were investigating the atmospheric formation and transport of ozone in urban settings. To control ozone pollution, more information is needed about man-made and naturally occurring trace gases in the atmosphere where ozone is formed. Pacific Northwest conducted other balloon-borne and radar measurements as part of this project.

Habitat research *blooming* at seawater greenhouse

Researchers are finding that watching the grass grow can be more exciting than the old saying might indicate. They're learning more about growing vegetation that provides habitat for sea life in a newly constructed marine greenhouse at Pacific Northwest National Laboratory's Marine Sciences Laboratory in Sequim, Wash.

The greenhouse is unique because it isn't limited to freshwater research. "I don't know of any other flowing seawater greenhouse on the West Coast," said Ron Thom, a staff scientist at the Marine Sciences Laboratory.

The facility will be used to help force eelgrass plants to flower and produce seeds so that more plants can be cultivated. Eelgrass, which grows only in saltwater, provides habitat for several aquatic species including juvenile salmon that use it for protection on their way to the North Pacific.

"Ultimately, this could help replace eelgrass meadows in the Puget Sound that have been damaged or destroyed," said Amy Borde, the Pacific Northwest scientist who is responsible for the eelgrass propagation project. "Because salmon are protected under the Endangered Species Act, restoring eelgrass meadows and finding donor plants is becoming a big issue."

Researchers will use the greenhouse to test how plants react to various levels of temperature, light and water salinity. In the future, the facility may be used for other projects such as growing fungal species that degrade contaminants. ●

Access to *high-powered* instrument available *"virtually" anywhere*

Without ever having to pack a suitcase or board a plane, scientists from around the world are working at the William R. Wiley Environmental Molecular Sciences Laboratory, the U.S. Department of Energy's newest user facility. Pacific Northwest National Laboratory operates the facility, which is located in Richland, Wash.

Internet and web technologies allow remote access to the facility's unique collection of nuclear magnetic resonance spectrometers. Researchers using the "virtual" NMR facility can control instruments, communicate with local staff, retrieve and process data and share notes—all from the comfort of home. Nearly every step of an experiment, aside from preparing the final sample and physically inserting it into the instrument, can be performed remotely with a modern desktop computer.

The first group to use the virtual NMR facilities was a collaboration of Pacific Northwest researchers on-site and researchers at Lawrence Berkeley National Laboratory in Calif. The two groups didn't meet in person for the first several months of their study of protein structures. Instead, they communicated and collaborated in a real-time environment using technologies developed by Pacific Northwest and integrated with publicly available audio and video-conferencing capabilities.

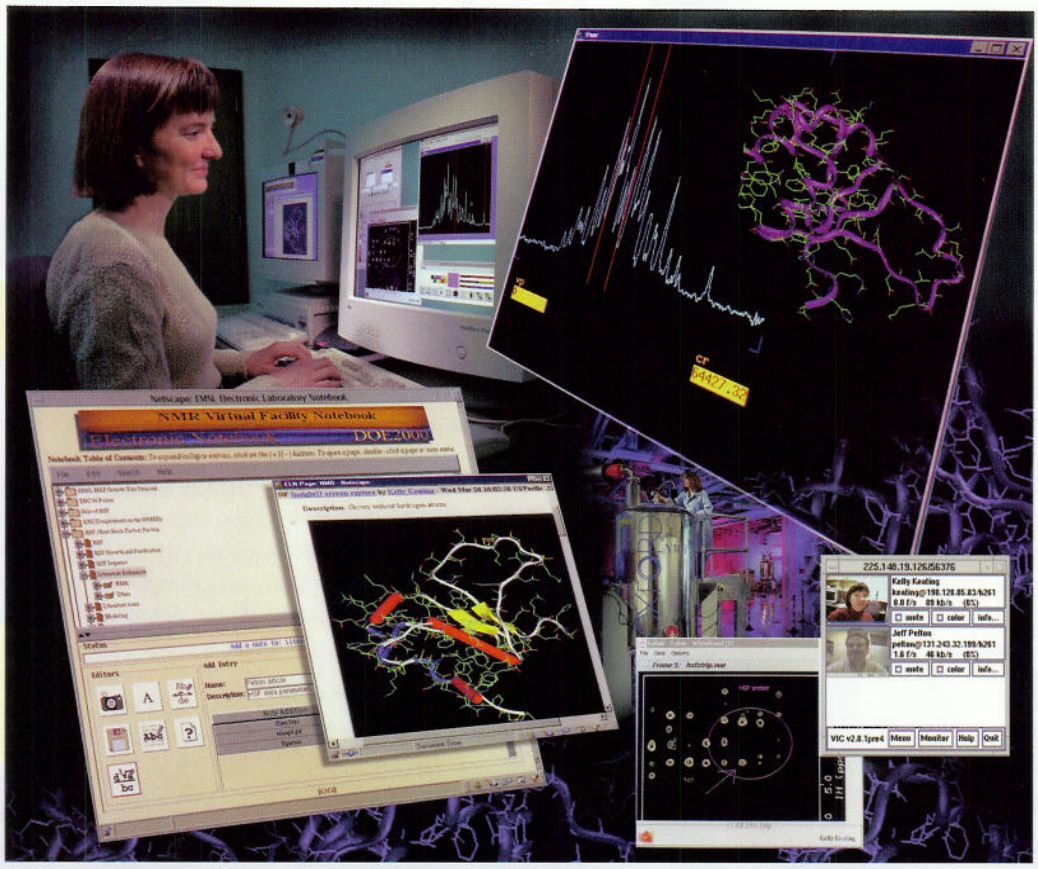
"Videoconferencing by itself isn't enough," said Jim Myers, a senior research scientist at Pacific Northwest. "But you can really do detailed scientific work together when everyone is sharing the same screen and discussing what they see while an instrument or analysis software is running."

The researchers shared notes, sketches, data—anything normally recorded in a paper notebook—through an Electronic Laboratory Notebook that could be viewed by both parties at the same time. Off-site researchers even could use the Internet to gain secure access to the facility, directly control the spectrometers and work with their data as well as ask staff for assistance anytime throughout the experiment.

The user facility's NMR capabilities include high-field spectrometers as powerful as 800 megahertz. These instruments enable researchers to characterize molecular structures of materials in solid or liquid form and can be used in experiments to determine the effects of the environment on biological health. ●

Electronic notebooks aid remote research

An on-line *laboratory*



As a national scientific user facility, the William R. Wiley Environmental Molecular Sciences Laboratory does more than support the concept of collaborative use. It has created a Collaboratory that offers researchers remote access to the facility's unique equipment, instruments, computer resources and staff expertise.

The Collaboratory allows researchers to share information displayed on their desktop workstations, record and review data in electronic notebooks and even control some instruments remotely. These features are integrated with scientific resources such as data analysis software and scientific literature as well as videoconferencing and e-mail capabilities. ●

Instead of putting pencil to paper in a traditional laboratory notebook, researchers are beginning to take advantage of the benefits offered by the William R. Wiley Environmental Molecular Sciences Laboratory's electronic notebook technologies.

Much like its paper counterpart, the Electronic Laboratory Notebook serves as a scientist's tool for planning projects, organizing experiments, and entering results and interpretations. In addition, electronic notebooks allow researchers in more than one location to review the same information at the same time.

Researchers quickly can search electronic notebooks and organize information for ease of understanding rather than flipping through pages. Perhaps one of the most sigificant advantages is the capability to integrate electronic notebooks with laboratory instruments so that data and analyses are recorded directly in the notebook.

With this free software available publicly on the Internet, anyone can put the electronic notebook technology to use.

A chemistry professor at Eastern Oregon University is developing on-line lessons. Industrial mentors for student interns at Northwestern University provide assistance and evaluations based on electronic notebook entries. ●

Putting *crime scene* technology to the test

Baltimore police officers have a vested interest in a technology that will help gather information at a crime scene. They're testing a vest teeming with special tools to quickly capture, store and relay vast amounts of data while they're in the field.

ScenePro is an interactive system developed by Pacific Northwest National Laboratory that brings together geographic information systems, laser mapping and multimedia computing—and stores it all in a piece of clothing that can be worn by the person collecting evidence. This technology could improve the accuracy and efficiency of investigations in situations like the tragic shooting at Colorado's Columbine High School, where many people spent days combing a large crime scene for evidence, likely logging much of what they found by hand.

"So far the feedback from Baltimore has been positive," said Dan Irwin, who was with Pacific Northwest as a research scientist during ScenePro's development. The tests revealed the need for some minor modifications, but that was expected. "We'll tweak the system to make it just right," he said.

The Los Angeles Sheriff's Office also will give ScenePro a try before it's made available later this fall by Nichols Research, the company that worked with Pacific Northwest to commercialize the technology.

Technicians using ScenePro can create a digital map of the crime scene, including the dimensions of rooms and the precise locations of evidence. Further descriptions, including digital photographs, handwritten or keyed text, spoken comments and sketches, can be linked to the map electronically.

Rather than make guesses when collecting unfamiliar types of evidence, ScenePro allows technicians to refer to volumes of on-line documentation for assistance. Bar-coding tools give technicians the ability to tag and document each piece of evidence as it's discovered. ScenePro even will generate digital forms that can be completed in the field, eliminating the time-consuming process of transferring information from handwritten forms into a computer. ●

Narrowing the focus for mass spectrometry

Anyone who has poured liquids from a large container into a smaller one understands the benefits of a funnel.

That simple concept has led to a new tool that will improve significantly the sensitivity of instruments used to weigh atoms and molecules.

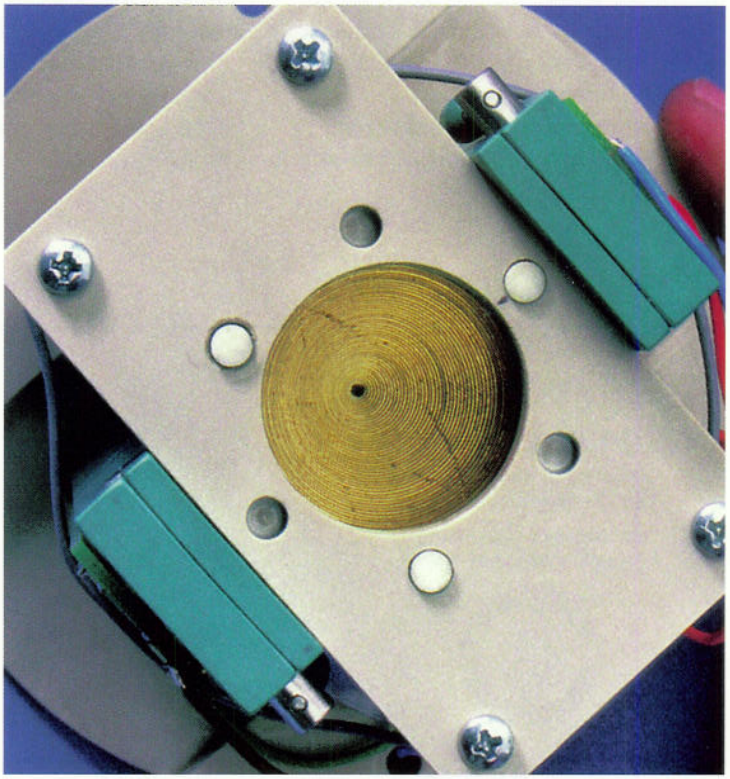
Instruments used for environmental, biological, medical and other scientific research will be 40 to 80 times more sensitive with the help of a new tool developed by scientists at the William R. Wiley Environmental Molecular Sciences Laboratory, a national user facility operated by Pacific Northwest National Laboratory.

The Electrodynamic Ion Funnel prevents ions in a sample from becoming lost as they're transferred into mass spectrometers—instruments used to accurately weigh atoms and molecules. Samples must be transformed into gas phase ions before these instruments can analyze them. Without the funnel, many of the ions are lost as they pass from areas of high pressure where they are created into the lower pressures where the spectrometer functions.

The Ion Funnel concentrates the sample ions into a small stream, ensuring that more sample material makes it into the instrument for analysis. This reduces the chance that ions present in low concentrations will go undetected.

"By focusing more ions into the mass spectrometer, we can collect better data and improve our understanding of the substances being analyzed," said Richard Smith of Pacific Northwest, who invented the Ion Funnel.

More accurate and sensitive measurements help scientists study complex cell systems. This may contribute to new ways to diagnose diseases and a better understanding of the immune system, cellular signaling related to diseases such as cancer and how the environment affects health. At least two of the mass spectrometers at the user facility will be retrofitted with Ion Funnels this summer. ●



The Ion Funnel received an R&D 100 award for 1999, recognizing it as one of the year's most significant advancements in technology. *See story Page 16.*

Six technologies **score** home runs

In the world of science and technology, earning an R&D 100 Award is like hitting a ball out of the park—it's a highly prized sign of accomplishment. Pacific Northwest National Laboratory had a winning season in 1999 with six technologies appearing among *R&D Magazine's* top 100 technologies of the year.

Each year, *R&D Magazine* honors the scientists, engineers and technicians who contribute to the 100 most significant technology products and advancements. Since 1969, Pacific Northwest has received a total of 51 R&D 100 Awards.

These award-winning technologies represent the innovation and dedication of some of Pacific Northwest's most valuable players.

The **Centrate Ammonia Recovery Process** controls the spread of ammonia and resulting nitrates to waterways and drinking water. The cost-effective process extracts ammonia from sewage treatment liquid and livestock waste and converts it to standard, commercial-grade ammonium sulfate fertilizer, which is dry and odorless.

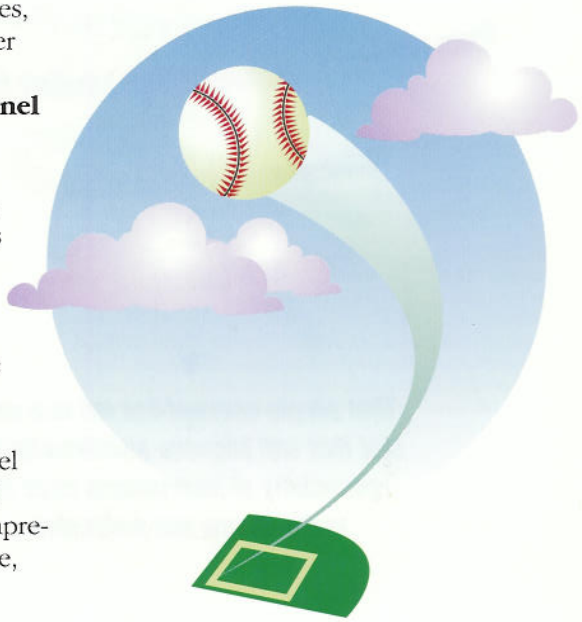
The **Compact Microchannel Fuel Vaporizer** brings cars powered by fuel-cells one step closer by shrinking the fuel vaporization component to the size of a soda pop can with a weight of only 4 pounds. The technology contains integrated microcombustors and microchannel heat exchangers and makes it possible to manufacture compact fuel processing units for portable applications.

Another microtechnology, the **MicroHeater**, is a palm-sized combustion unit weighing less than 5 ounces that can provide heat for portable personal heating and cooling devices, indoor heating devices, in-line water heaters and fuel cell systems.

The **Electrodynamic Ion Funnel** greatly increases the sensitivity of analytical devices such as mass spectrometers by focusing the ions in gases and improving the process by which they are transmitted into the devices (*see related story Page 15*).

Molecular Sciences Software Suite is the first general-purpose software that provides access to high-performance, massively parallel computers for chemists on a broad range of applications. MS^3, the comprehensive, integrated suite of software, enables computational chemists to focus their advanced techniques on finding solutions to complex environmental issues involving chemical systems.

The **PUMA Fiber Optic Neutron and Gamma Ray Sensor** is a revolutionary radiation monitoring system that uses glass fibers to detect the presence of radionuclides such as plutonium. It has potential applications in countering the threat of nuclear terrorism and nonproliferation efforts. ●



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