Breakthroughs

Science. Technology. Innovation.

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PACIFIC NORTHWEST NATIONAL LABORATORY

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

Welcome to the second issue of *Breakthroughs*, the magazine that brings you information about science, technology, and innovations developed at the U.S. Department of Energy's Pacific Northwest National Laboratory.

In this issue, you'll read a special report on Russia's struggle to diversify its economies in "Closed Nuclear Cities," learn how "small" is often bigger and better when it comes to inventory tracking, and discover how Popeye's veggie of choice can neutralize dangerous explosives. We have even included a poster predicting the top ten environmental technology breakthroughs for 2009.

In our world of science and innovation, you'll discover research advances that may affect your business in the long term as well as award-winning technologies with immediate applications.

If you have questions or comments about any of these articles, please contact us by phone, fax, or e-mail. We will be happy to respond or link you with business development staff responsible for these and other Laboratory resources. ●

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A special note of thanks to interim editor N. Lee Prince and contributing writers Mary Ace, Holly Carpenter, Jodi Hamm, Tim Ledbetter

Front cover: Nesting dolls or "Matreshka" have long been associated with Russian culture and history. For our story about Russia's closed cities, the dolls depict the evolution of new career opportunities.

Web sites provide additional information

- For greater detail about DOE and the nation's efforts to halt the proliferation of weapons of mass destruction as discussed in "New Center Widens Regional Role in International Security," see http://www.nn.doe.gov/nonprol1.htm
- The article, "United States Partners with Russia to Create Economic Opportunities in Closed Cities" has more in-depth information on the Nuclear Cities initiative at http://nci.pnl.gov/
- If you check into the article, "Molecule Motel is an Absorbing Experience for Metals," an informative video on the SAMMS project awaits your viewing at http://www.pnl.gov/etd/product/ptd.htm#27
- From the article "Breakthrough Systems to Detect Nuclear Explosions," read more information about DOE's work on the Comprehensive Nuclear Test Ban Treaty at http://www.ctbt.rnd.doe.gov/ctbt/introduction/radionuclide_mon.html/
- To know more about R&D 100 awards as found in article "Pacific Northwest Targets a New Record," see http://www.manufacturing.net/magazine/rd/rd100/100award.htm

Pacific Northwest earns DOE's *Outstanding* rating

On Dick Clark's American Bandstand, dancing teens got to "Rate the Record." At radio and TV stations, competition is keen during the Arbitron Ratings Sweep, while scientists, writers, and prominent leaders strive for their highest rating, the Nobel prize. Ratings are also a part of the U.S. Department of Energy. All DOE national laboratories participate in an annual appraisal with ratings ranging from unsatisfactory to outstanding.

In fiscal year 1998, the Pacific Northwest National Laboratory, operated by Battelle for DOE, received its first ever rating of Outstanding for performance. This rating is the highest achievable in DOE's appraisal process. Previously, DOE has issued ratings of Excellent for Pacific Northwest operation.

The rating came in the third year under a new appraisal system to track performance against key objectives. "Pacific Northwest highlights for the year included outstanding scientific performance, exceptional first-year achievements at the Environmental Molecular Sciences Laboratory, excellent corporate citizenship, successful verification of their integrated safety management system, and continuation of a strong partnering relationship with DOE," said Bob Rosselli, assistant manager of Science and Technology for DOE's Richland Operations Office.

Highest achievement for work well-done. It's a record rating for Pacific Northwest. ●

41 FLC awards and *still counting*

In 1984, the Federal Laboratory Consortium established an awards program to recognize outstanding accomplishments in technology transfer from all federal laboratories to the public and private sectors. Since the award's inception, Pacific Northwest National Laboratory has received 41 of these awards, exceeding the record of any other national laboratory.

The FLC, a nationwide network with over 600 laboratories and 16 federal agencies, provides a forum to develop strategies and opportunities for linking technology with the marketplace. A maximum of 30 awards are made each year, and four nominations are the most that any lab can submit. In 1999, Pacific Northwest National Laboratory received two new awards for

■ **MICLEAN™/MICARE™ Systems**, highly effective, environmentally friendly dry cleaning and industrial parts cleaning systems. These systems provide the same cleaning power as organic solvents but without the hazards.

■ **Fiber-Optic Neutron and Gamma Ray Sensor**, a sensor using glass fibers to detect the presence of radionuclides. One of the biggest potential applications for the new sensor is monitoring plutonium in spent fuel rods.

These technologies demonstrate new avenues of thought and opportunity while tailoring commercialization solutions to the demands of the marketplace. ●

United States partners with Russia to create *economic opportunities*

For decades during the Cold War, the Soviet Union and the United States competed for nuclear superiority. Now Russia and the U.S. are cooperating to bring about peaceful enterprises in what are known as "closed" cities.

In September 1998, U.S. Energy Secretary Bill Richardson and Russian Minister of Atomic Energy Yevgeny Adamov signed the Nuclear Cities Initiative and launched a major economic diversification effort in Russia's ten closed nuclear cities. Behind their guarded fences, these secret facilities housed scientists and engineers working on the design, assembly, and production of the Soviet nuclear arsenal.

What must be done?

The initiative's goal is to enable the Russian government to "right-size" the weapons complex for post-cold-war realities by creating viable businesses in the nuclear cities to absorb ex-weapons workers. Neither Russia nor the U.S. wants skilled workers, with the knowledge of fabricating nuclear devices, leaving for countries with possible proliferation aspirations—such as North Korea, Iraq, and Libya.

Efforts will focus on commercial enterprises that will create jobs in the nuclear cities. The U.S. will lend its business expertise and seek matches between private sector companies and Russian facilities for manufacturing, marketing, and sales of commercial goods.

"The Laboratory has already facilitated workshops involving delegates from three of the ten Russian closed cities—Sarov, Snezhinsk, and Zheleznogorsk," said Ken Ames, manager at the Pacific Northwest National Laboratory. "The Laboratory involved local community resources such as Tri-Cities Economic Development Council, Tri-Cities Enterprise Center, and Washington State University in these workshops."

What will it take?

The initiative draws on the experience of the U.S. in restructuring former nuclear weapons laboratories and production complexes, including Hanford, Washington, and Oak Ridge, Tennessee. Technical assistance to the Russian cities includes training in business planning and outreach activities to attract businesses to the area. It will also include training and support services to get new businesses off the ground.

"Creating economic diversification in a nuclear city is something that citizens of the Tri-Cities have been doing longer than anyone else," Ames said. "In fact, Pacific Northwest National Laboratory was created almost 35 years ago to focus Hanford's intellectual capital to non-weapons missions such as environmental restoration."

Pacific Northwest has extensive involvement in DOE programs in the former Soviet Union, including weapons material safeguards, nuclear power plant safety, proliferation prevention, and environmental monitoring and cleanup. ●

> **"Creating economic diversification in a nuclear city is something that citizens of the Tri-Cities have been doing longer than anyone else. In fact, Pacific Northwest National Laboratory was created almost 35 years ago to focus Hanford's intellectual capital to non-weapons missions such as environmental restoration."**
>
> —Ken Ames, Manager
> Nuclear Cities Initiative, Pacific Northwest

New center widens *regional role* in international security

National Journal,12/12/1998
"Department of Energy Secretary Bill Richardson, left, says, 'Stopping the proliferation and potential terrorist use of weapons of mass destruction has become, during the Clinton years, one of the hottest topics in national security policy.'"

Secretary Richardson recently visited Pacific Northwest National Laboratory to discuss these and other security issues with Pacific Northwest Center for Global Security Director Jim Fuller, center, and Laboratory Director Bill Madia, right.

A center was recently created in the Northwest in response to a growing role for the U.S. Department of Energy's Pacific Northwest National Laboratory in proliferation prevention and arms control of weapons of mass destruction.

Pacific Northwest established the Pacific Northwest Center for Global Security to coordinate nonproliferation work within the lab. The center, within the National Security Division, will provide better service to the DOE Office of Nonproliferation and National Security. It will also involve organizations throughout the region, particularly universities and non-governmental organizations, in nonproliferation activities.

"The Pacific Northwest Center for Global Security symbolizes the lab's commitment to proliferation prevention and arms control. With its vast available resources, the lab has an important role in the Northwest," said Jim Fuller, director of the Center and leader of the Laboratory's nonproliferation and national security sector.

The center's mission includes promoting collaboration among Northwest academic, private, and non-governmental stakeholders. Education efforts include a seminar series to increase interactions and strengthen relationships among the stakeholders' leaders, strategic planning workshops, newsletters, and special issue workshops.

Laboratory assistance

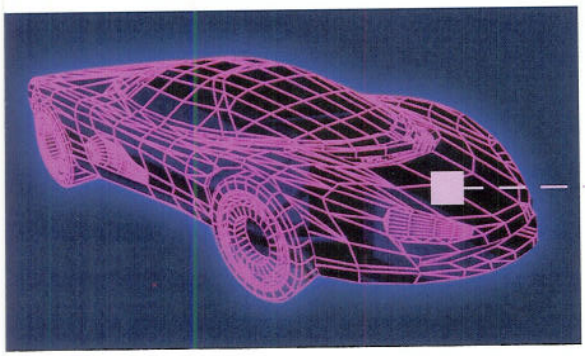
Pacific Northwest has a strong history of proliferation prevention work that includes

- advising and assisting the Russian government on security improvements at weapons production facilities as part of DOE's Materials, Protection, Control and Accountability Program
- developing technology to detect evidence of nuclear explosions; worldwide installation will help to verify the Comprehensive Nuclear Test Ban Treaty
- providing technical and policy expertise during the successful canning of more than 7,800 plutonium-bearing fuel rods in North Korea
- improving safety at Soviet-designed nuclear plants in Russia and its federated states through the International Nuclear Safety Program
- working with the U.S. Customs Service to train foreign border enforcement officers on materials, commodities, and components for the development and deployment of nuclear, chemical, and biological weapons of mass destruction and their missile delivery systems.

Pacific Northwest's nuclear nonproliferation and arms control program represents more than $100 million annually in ongoing research and includes programs such as assisting with warhead dismantlement, diversifying economies of nuclear cities, and improving safety near nuclear installations in Russia. ●

Superplastic Forming—

Creating superlight *parts and components* for autos, aircraft, trucking, *and* aerospace



- ✔ **Drive 55 miles per hour on the freeway**
- ✔ **Purchase the smallest car available**
- ✔ **Use cruise control**
- ✔ **Keep the engine tuned**

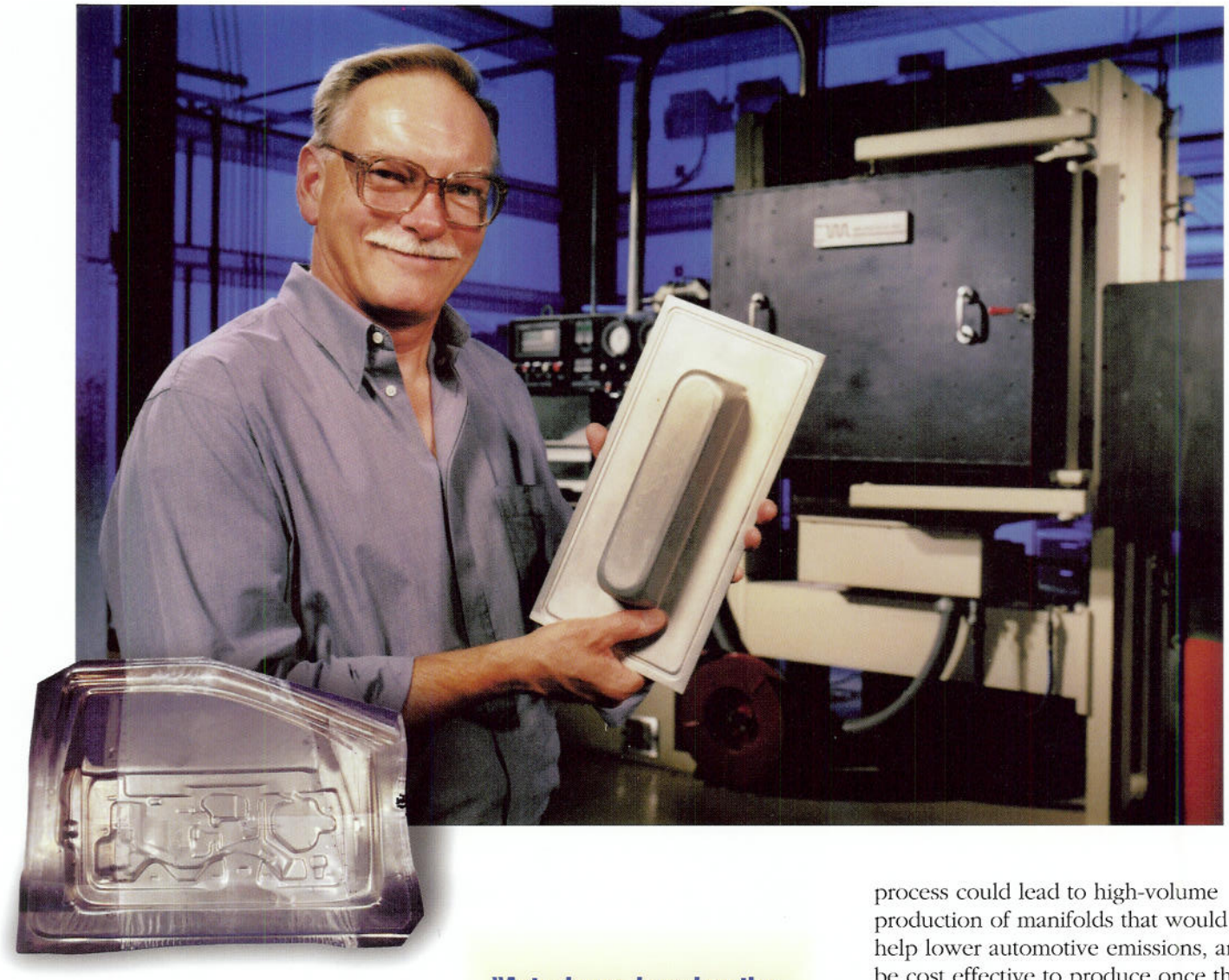
In the future, this checklist for better gas mileage might include "buy a car made with the superplastic forming process."

Researchers at Pacific Northwest National Laboratory are working to perfect superplastic forming which produces strong, lightweight auto, truck, aerospace, and aircraft parts. Lighter vehicles, especially large trucks and sport utility vehicles, will use less gasoline and experience increased performance and reduced emission output.

Doors, trunks, and hoods made with the superplastic forming process have proved more crashworthy than the standard steel components used on today's autos. They lack the traditional seam welds, which increases the strength of the part because the points of weakness are nonexistent.

"Auto doors, based on the Laboratory's process, will be featured on at least one major automobile manufacturer's luxury car in 1999. The carmaker is expected to make an announcement regarding this special feature when the auto rolls off the line and into the marketplace," said Gary McVay, director of the Northwest Alliance for Transportation Technologies at Pacific Northwest.

The aviation and aerospace industries could also benefit from the superplastic forming process for the manufacture of aluminum doors and other airplane parts. The superplastic-formed parts can significantly reduce the weight of an aircraft simply by eliminating the need for thousands of rivets to hold the aluminum sheeting in place. Aircraft doors and other parts use honeycomb designs that can be engineered to absorb the energy of a crash and offer greater protection to passengers.

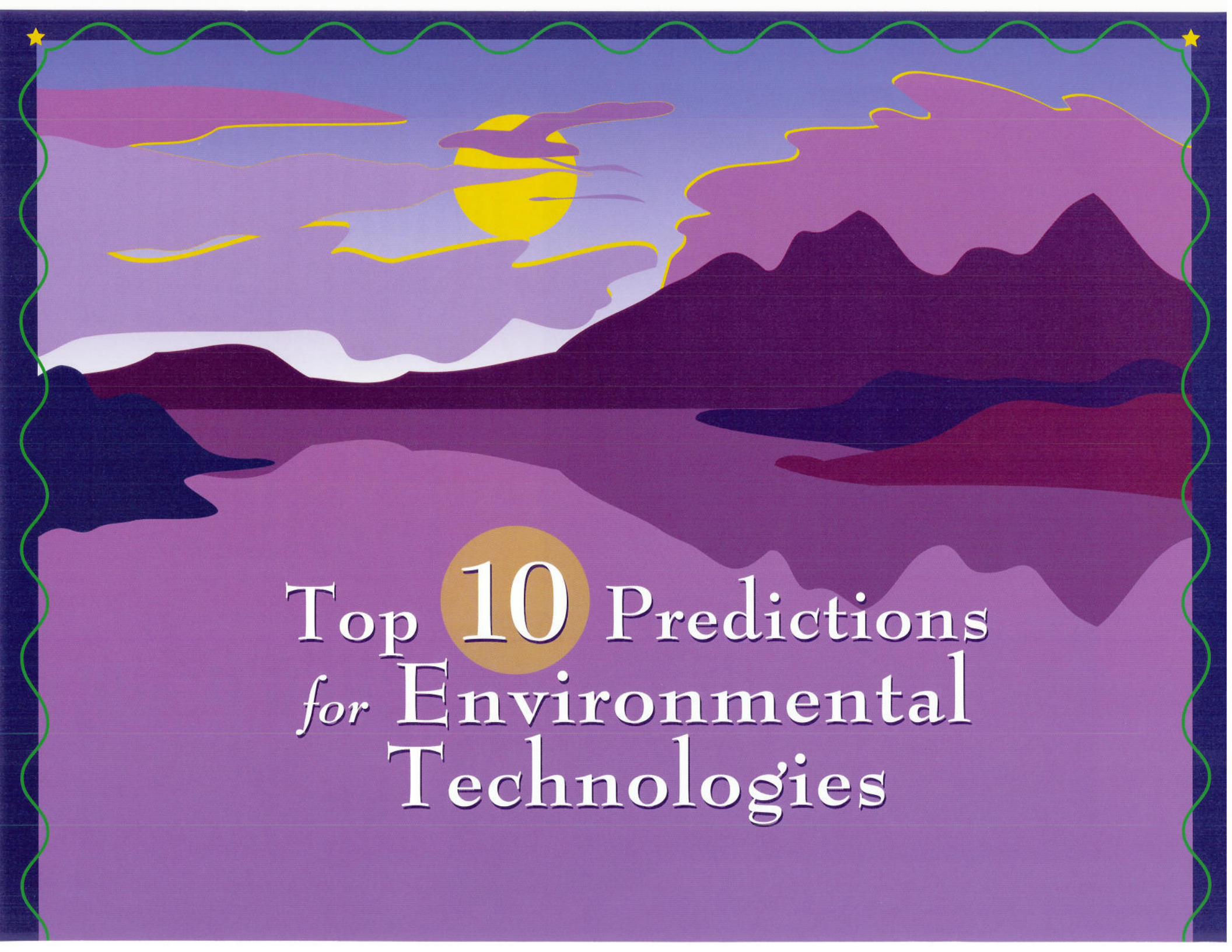


Materials used in the superplastic forming process include aluminum, titanium, nickel, stainless steel, and some ceramic-reinforced metals, such as metal matrix composites materials. These materials first are formed into flat sheets in a variety of sizes and thicknesses. In one forming process, the aluminum sheeting is heated to five times the boiling point of water, making the metal act like a plastic.

"With the edges held in a huge press, air is blown between the sheets to force them into the shape of a three dimensional mold," explained McVay. "This method is well suited for producing parts, such as complex exhaust manifolds. Eventually, this process could lead to high-volume production of manifolds that would help lower automotive emissions, and be cost effective to produce once the process is perfected."

"Auto doors, based on the Laboratory's process, will be featured on at least one major automobile manufacturer's luxury car in 1999. The carmaker is expected to make an announcement regarding this special feature when the auto rolls off the line and into the marketplace." —Gary McVay, director of the Northwest Alliance for Transportation Technologies at Pacific Northwest

Ceramic-reinforced aluminum metal matrix composite gears also are being researched and tested to determine their strength and wear resistance. Traditionally, gears have been manufactured from steel because of its tensile strength and wear resistance. Pacific Northwest researchers found that by spinning the gear when it is being manufactured, the ceramic particles then migrate to where the gear must be the strongest—the teeth. The center of the gear remains free of ceramic reinforcements so it is easy to machine and attach. As a result of this process, the gears are 50 percent lighter, but have a user life equal to that of steel gears. ●


Top 10 Predictions
for Environmental
Technologies

We may not be living on the moon or driving "flying" cars by 2009. However, researchers at the Department of Energy's Pacific Northwest National Laboratory predict we'll be drinking safer water, eating genetically engineered food, and heating/cooling our homes and buildings with micro heat pumps that fit in the palm of a hand. Here are their top ten choices for environmental technolgy advances:

Agrogenetics—Genetic engineering and plant manipulation will reduce agricultural impacts on the environment. Growing crops will require less pesticide due to greater resistance to pests. Other crops will be engineered to use their nutrients efficiently, requiring less fertilizer or water while providing higher yields.

Smart Water Treatment—Smart membranes, or filters, will improve water treatment of sewage plants and municipal water supplies by adjusting simply or even automatically to unclog themselves. Membranes and other techniques will remove organic compounds, which currently can result in undesired reactions with chlorine. Sponge-like grains of sand will attract and hold nitrates and heavy metals to further protect drinking water in large and small systems.

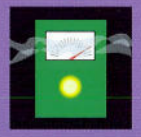
Renewable Energy Storage—Improved power storage will increase the use of electricity from solar and wind power. Solar power collected during the day could be stored in rapidly spinning flywheels and used at night. The result will be power on demand instead of when the sun shines or wind blows.

Micro Is Beautiful—Micro technology for producing and using everything from chemicals to energy will provide economic and environmental advantages. Room air will be heated and cooled more efficiently in tiny channels of micro heat pumps, saving energy. Micro chemical plants will produce industrial chemicals as needed, thereby eliminating storage and transportation safety issues.

Paperless—Innovative displays, wireless communications, and customized web magazines will help reduce mounds of paper as well as the environmental impacts from paper and ink manufacturing and use. Advanced display systems may imitate paper in their flexibility and portability. One approach will project images directly on the retina of the eye. This capability, coupled with cellular phones, could provide everyone with faxes and customized news virtually anywhere.

Molecular Design—An understanding of how materials behave at the molecular level will help in the development of advanced materials and more efficient solar cells. Molecular design of catalysts could make chemical reactions and processing so precise that little or no wastes are produced. And sensors designed at the molecular level will monitor manufacturing of materials and chemicals more precisely, halting or correcting processes sensitive to temperature changes and other parameters.

Bioprocessing Grows more Products—Microorganisms and plants will "grow" environmentally friendly chemicals and biological products such as drugs, proteins, and enzymes for many uses.



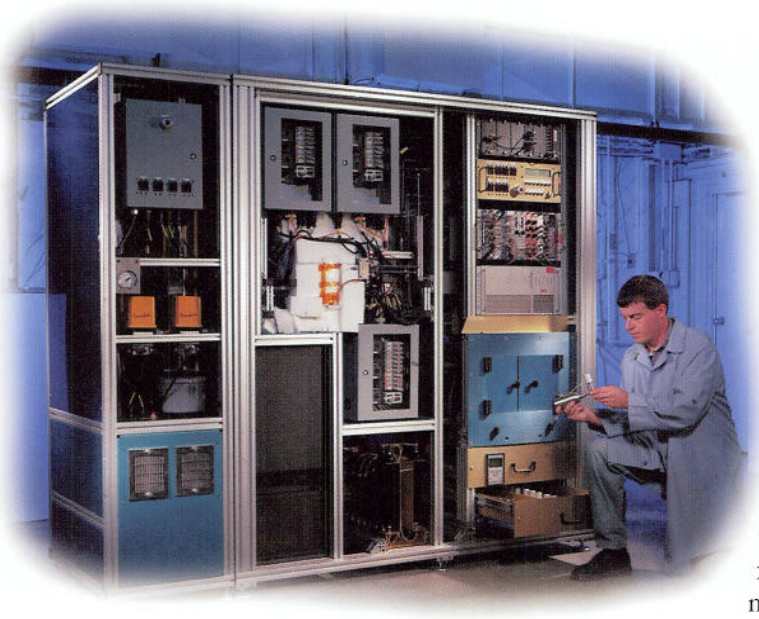
Real-time Environmental Sensors—These innovative sensors will be a major boon to public health. Supermarkets will use sensors to detect E. coli and other dangerous pathogens in food. Workplace air quality will be monitored to prevent "sick building syndrome." Other benefits include monitoring the environment in airplanes, in hospitals to prevent infections, and in municipal water supplies. The same technology will help guard against pathogens used in biological terrorism.

Enviromanufacturing and Recycling—"Green" companies will create products that are environmentally friendly from cradle to grave. Plastics, paper, beverage containers, and inks, as well as cars and computers will be more biodegradable or recyclable. Also, newer processes, such as dry cleaning with liquid carbon dioxide, will minimize or eliminate waste. Hazardous chemicals no longer will be used to clean clothes, and carbon dioxide will be captured and recycled so as not to add to atmospheric carbon.

Lightweight Cars—Squeezing every ounce possible out of cars will mean a family sedan that gets at least 80 miles per gallon of gas, generates less pollution, and uses less gas. Lighter cars will be built with less steel and more lightweight aluminum, magnesium, titanium, and composites. Advanced metal-forming techniques will provide precisely the strength needed at every point, eliminating all excess weight from today's designs.

Breakthrough systems to detect *nuclear explosions* worldwide

Scientists at the U.S. Department of Energy's Pacific Northwest National Laboratory have developed two breakthrough devices that can detect nuclear detonations by analyzing the atmosphere for traces of radioactive material.



ARSA, the Automated Radioxenon Sampler/Analyzer, and RASA, the Radionuclide Aerosol Sampler/Analyzer, were created to verify the Comprehensive Nuclear Test Ban Treaty. An international monitoring system is being set up to use the latest technology to watch for evidence that nuclear weapons are being tested. ARSA and RASA will compose a large part of the technology employed in an 80-station radionuclide network.

"These new technologies enhance the ability of the U.S. and the international community to detect and confirm nuclear explosions," said Under Secretary of Energy Ernest Moniz. "This advancement in our ability to verify nuclear tests creates more impetus for Senate debate and vote to ratify the Comprehensive Nuclear Test Ban Treaty."

ARSA / RASA

The two new detonation identification devices represent a quantum leap beyond existing monitoring devices, with greater sensitivity, full automation, near real-time reporting, and novel nuclear radiation detectors.

"ARSA is the most valuable radionuclide detection method available to the Comprehensive Nuclear Test Ban Treaty," said Ted Bowyer, Pacific Northwest principal investigator for ARSA. "These two systems allow us to capture a tiny part of the weapon. Radionuclides are a smoking gun. They are positive confirmation of recent nuclear fission."

ARSA analyzes air samples for radioactive xenon, or radioxenon, that seeps from underground nuclear explosions, the most common testing method today but the most difficult to detect. ARSA has a detection sensitivity 10 to 100 times greater than other systems being used. In addition, it is the only completely automated radioactive xenon monitor.

ARSA collects air samples, then processes them to trap the radioactive xenon on cold charcoal. The system purifies the radioactive xenon, then transfers it to a nuclear counting system. The different isotopes of xenon are automatically measured, then the results are automatically passed to a data center by communication link. ARSA can be accessed by modem and programmed remotely.

RASA detects fission products from atmospheric nuclear explosions. This basic technique has been available for 30 years, but Pacific Northwest researchers have created the most sensitive automated system ever—more than 100 times as sensitive as the best previous technology.

RASA filters a huge volume of air each day to check for evidence of fission products from a nuclear explosion that attach to dust particles. The automated system draws air through a series of filters, which remove practically all of the atmospheric particles. The filters are sealed, bar coded, then passed to a radiation detection system. Radiation from weapons debris is then registered and translated to prove a violation of the treaty.

Information collected by ARSA, RASA, and other monitoring systems at the global stations will be passed to an international data center. A prototype is currently located in Arlington, Virginia, and planned for permanent housing in Vienna, Austria, as part of the Comprehensive Nuclear Test Ban Treaty's international monitoring system. The other systems under development or in use include seismic, infrasound, and hydroacoustic monitors. ●

Small and mighty... it's all in the tag

They're tiny, but they do a big job. Innovative radio frequency tags, under development at Pacific Northwest National Laboratory, are an inexpensive method for accurately tracking, inventorying, and monitoring a variety of items. Currently, RF tagging has been successfully used to track and update inventories of everything from large shipping containers and rail cars to single clothing items.

Laboratory-developed RF tags use a tiny microchip with micro antennae that store information about an item. The tag is attached to an item and can be read by a scan system interrogator. This process effectively allows a variety of new functions to be performed that

- determine the location of an item
- determine the date and time an item was manufactured and inventoried
- route an item
- disable and activate equipment.

"Pacific Northwest's system would be very useful in tracking and inventorying items that are perishable in nature and must be delivered to their end market expeditiously," said Ron Gilbert, research scientist at the Laboratory. "High-priority, high-security items, such as ammunition and weaponry, also are examples of items that could be tracked and inventoried with ease and reliability."

The Laboratory's new, innovative RF tags are inexpensive and passive, thus allowing for normal operation of other incidental equipment. When special readers are placed in the proximity of these tags, information within the tag is read. In turn, the user can "write" to the tag, changing information embedded therein. The reader also enables high-speed inventorying of multiple tags in the same location.

Current commercially available RF tagging capabilities have proven effective, but have limitations. These systems can read only one tag at a time and are not capable of writing information to the tag.

"RF tagging creates solutions for a wide range of tracking and inventory needs in fields as diverse as national security and the clothing industry," Gilbert said. ●

Technology to prevent *engine failure* in tanks

Pacific Northwest National Laboratory provides advanced science and technology planning and technology insertion to the U.S. Army Logistics Integration Agency. In one of these projects, Pacific Northwest is developing a prototype diagnostic/prognostic system for the Army's M1 series main battle tank that uses artificial neural network diagnostics and fault prediction. The system will be an integral part of the real-time focused logistics systems of the future, providing efficient maintenance and effective readiness status for warfighters. ●

Spinach—an explosive discovery

Popeye may have been on to something. At least that's what researchers at Pacific Northwest National Laboratory discovered. The cartoon character gulped down spinach and instantaneously had brute strength, but those same enzymes found inside the veggie's leaves soon may be used to neutralize dangerous explosives.

Researchers discovered that nitroreductase enzymes found in spinach and other natural compounds can eat, digest, and transform explosives such as TNT. This emerging biotechnology is called the Environmentally Benign Digestion Process. It reduces dangerous explosives to low toxicity byproducts that can be used by industry or reduced further to harmless products like carbon dioxide and water.

The Environmentally Benign Digestion Process, addresses a dire need of the U.S. military to eliminate, in a cost-effective and secure manner, its nearly 500,000 tons of explosives stockpiled around the country.

"The primary risk of storing explosives at any site is explosions because they create panic, can cause injury, and are a trigger to releasing biological and chemical agents stored nearby," said Manish Shah, the project's principal investigator. "The Environmentally Benign Digestion Process destroys explosives in a very benign manner." According to Shah, it could replace current methods of burning and incinerating explosives that are risky and expensive.

If field tests prove effective, the Environmentally Benign Digestion Process would be more cost effective than other methods of explosives disposal. The process does not require any special equipment, hardware, or software, and thus has very low capital costs. As a result, the enzyme digestive process may be conducted at sites such as military bases or explosives stockpile depots rather than moving explosives cross-country to incinerators. The process also could be more energy efficient because it is done at room temperature, compared with other methods that require heating to extreme temperatures.

It may be possible to convert the byproduct for commercial use. Research suggests the byproduct could be used in chemical processes that use free radical chemistry. For example, researchers have determined the enzymes convert nitrobenzene into p-aminophenol, which is used in the pharmaceutical industry to make headache medicine. The digestion byproduct also could be reduced completely to a gaseous state, such as ammonia or carbon dioxide, through a second digestive process using microorganisms. ●

Clean H_2O, the *absolute* in trend setters

Clean water

Whether it's in a trendy bottle for personal consumption, shimmering in a lake, or flowing beneath the soil, a high value is placed on ensuring safe water supplies. A new, award-winning technology developed at Pacific Northwest National Laboratory will make cleaning up contaminated groundwater safer, easier, and less expensive than conventional methods.

As a 1998 winner of the prestigious R&D 100 Award, In Situ Redox Manipulation ranks as a major, innovative technology. The process is being successfully tested by Pacific Northwest researchers at the U.S. Department of Energy's Hanford Site on underground plumes of chromate, a corrosion inhibitor used years ago in nuclear reactors. If left unchecked, the contaminant would seep into the nearby Columbia River, potentially causing harm to fish and wildlife.

Safer, more effective, costs less

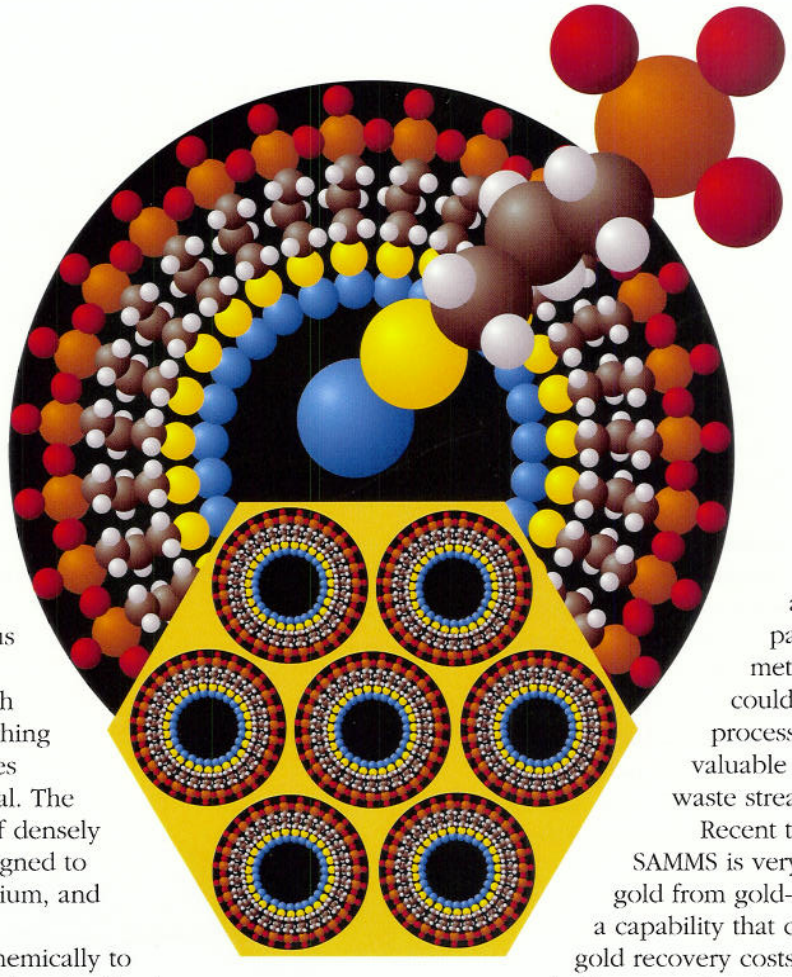
"This technology is a prime example of how Pacific Northwest is working to solve environmental problems within both the federal arena and commercial industry," said Bob Rosselli, Assistant Manager for Science and Technology at DOE's Richland Operations Office. "At Hanford, the ISRM technology is proving to cost 60 percent less than conventional pump and treatment methods, and is a more effective and safer technology to deploy—clearly a winning solution," said Rosselli.

The process decreases the risk of exposing workers to contaminants. Small groundwater wells are placed at the site to be treated. A chemical solution of sodium dithionite is injected into the wells for about 10 hours. Once the solution reaches the groundwater, it reacts with iron in the soil to form a large barrier. When the groundwater flows through the barrier, the targeted contaminants are destroyed or immobilized. Pacific Northwest researchers anticipate that many contaminated sites will require only one injection, with the barrier remaining effective for up to 30 years and requiring minimal worker oversight.

The technology also is suitable for treating waste streams associated with petroleum, chemical, and electronics production. In addition to DOE-site testing, the ISRM process is being applied at Army and Navy bases in Washington state and California to treat groundwater contaminated with chlorinated hydrocarbons, which result from degreasers and super cleaners used to maintain equipment. ●

— Bob Rosselli,
Assistant Manager of Science and Technology,
U.S. Department of Energy, Richland Operations Office

Molecule motel is an *absorbing* experience for metals



Once metals check in at SAMMS, they can't check out.

Self-Assembled Monolayers on Mesoporous Supports integrates mesoporous ceramics technology first created by Mobil Oil Corp, with an innovative method for attaching monolayers to the pore surfaces throughout the ceramic material. The monolayers are single layers of densely packed molecules custom designed to seek out mercury, lead, chromium, and other toxic or precious metals.

"SAMMS can be tailored chemically to selectively bind a wide range of contaminant types, including radionuclides," said Jun Liu, a staff scientist at Pacific Northwest who directed the fundamental research. "And SAMMS can be used effectively in water and non-aqueous solution streams."

SAMMS is produced in bead or powder form. Each tiny grain of ceramic material contains an array of cylindrical caverns or pores, giving it a honeycomb appearance. The monolayers reside within the pores, with the molecules strongly binding at one end to the ceramic material. The free ends of the tethered molecules then are available for binding to a targeted metal species passing through the pore. The small pore size precludes the metal from leaving and resolubilizing into a more toxic and/or mobile form.

The U.S. Department of Energy is interested in exploring the use of SAMMS for cleanup activities at sites where mercury contamination is prevalent. In addition, SAMMS has potential applications in industry, particularly mining and metal finishing, where it could be used to clean processing water and retrieve valuable metals present in waste streams.

Recent testing has shown that SAMMS is very effective in removing gold from gold-cyanide leach solutions, a capability that could lead to reduced gold recovery costs. Compared to the current method, results indicate SAMMS does a better job of selectively binding gold (versus other metals) and significantly increases the amount of gold captured. And after the recovered gold is stripped from SAMMS, the material can be reused.

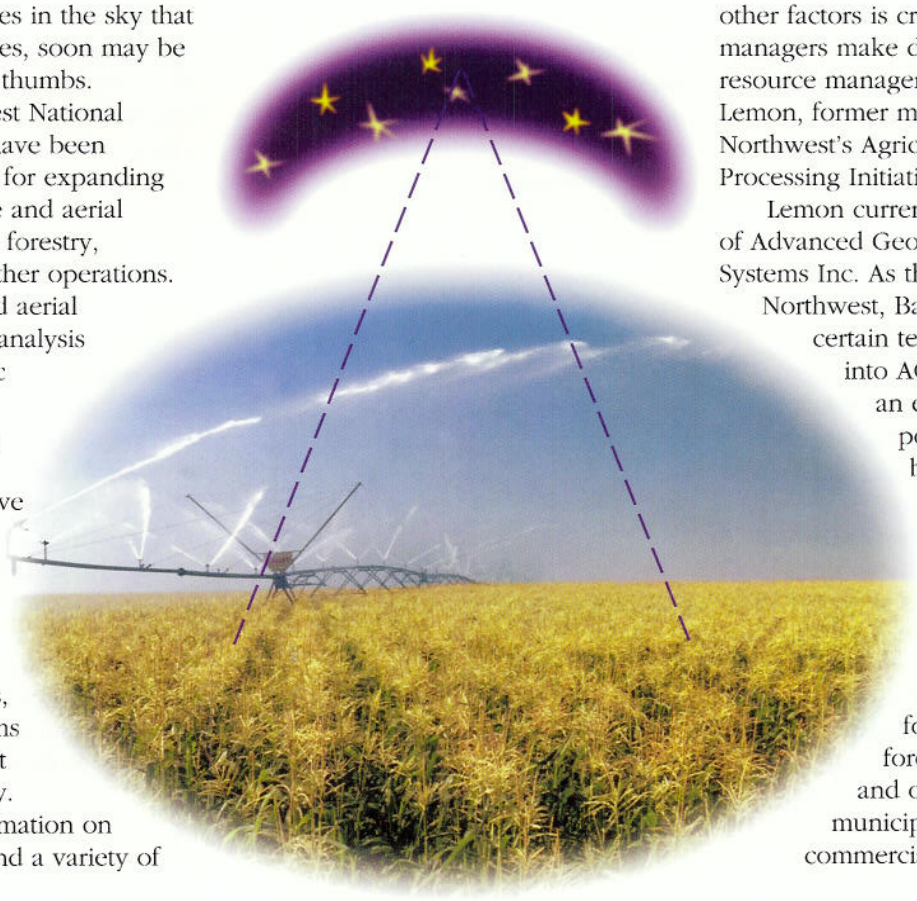
Liu and his team also have explored "reversing" the use of SAMMS. The researchers have learned how to impregnate pesticides into the pores and release the pesticides very slowly over long periods of time—up to six months. The next step is to find ways to control the release so that insects would be exposed during specified times, such as at night or when temperatures fall below certain thresholds. This would reduce the amount of pesticides needed and avoid overexposing the pests to specific chemical compounds. ●

The eyes in the *sky* have it

Satellites, those eyes in the sky that monitor earthly activities, soon may be known for their green thumbs.

At Pacific Northwest National Laboratory, scientists have been pioneering techniques for expanding applications of satellite and aerial imagery to agriculture, forestry, marine, mining, and other operations. Integrating satellite and aerial images with statistical analysis techniques, geographic information systems, and global positioning systems can provide accurate and informative bird's eye views of crops, forests, and other environments. They indicate where there may be water stress, pest infestations, and additional problems that could impact plant health and productivity.

"Site-specific information on crops, soil moisture, and a variety of other factors is critical in helping managers make decisions about resource management," said Doug Lemon, former manager of Pacific Northwest's Agriculture and Food Processing Initiative.



Lemon currently is the president of Advanced Geographic Information Systems Inc. As the operator of Pacific Northwest, Battelle is putting certain technologies and staff into AGIS in exchange for an equity ownership position. The firm, based in Richland, Washington, is focused on making remote sensing and geographic information systems developed at Pacific Northwest available for agriculture, forestry, marine, mineral and oil exploration, municipal planning, and commercial operations. ●

Speaking of ...

The Pacific Northwest National Laboratory offers a wide range of presentations available for your groups at no charge. Contact the Pacific Northwest Speakers Bureau, 509-375-5953. ●

Pacific Northwest *targets* a new record

Delivering high quality science and technology solutions that solve problems is often an inventor's own reward. But at the Pacific Northwest National Laboratory, the year of 1998 brought very tangible recognition in the form of seven highly prized R&D 100 Awards. This number sets a record as the most awards won by Pacific Northwest in a single year.

In 1963, *R&D Magazine* began to honor scientists, engineers, and technicians by citing the 100 most technologically significant products and advancements. Competition is keen and the winners hold places of honor and prestige among their peers and laboratories. Since Pacific Northwest began to compete in 1969, it has garnered 45 R&D 100 Awards.

The seven technologies to receive the 1998 R&D 100 Awards include:

In Situ Redox Manipulation is a new groundwater remediation technique that is safe, permanent, and cost-effective. This technology destroys or immobilizes toxic and carcinogenic contaminants within an aquifer.

Life-Cycle Advantage™ is a software package that characterizes lifetime energy and environmental implications in products, processes, and services. It helps with recyclable product designs, environmentally friendly raw materials selection, zero-waste technology development, and the formulation of competitive environmental business strategies and policies.

Radionuclide Aerosol Sampler/Analyzer (RASA) is a completely automated radionuclide monitoring system that detects airborne radioactive particles. The device can measure debris from nuclear weapons testing to a variety of non-nuclear monitoring needs.

Rapid Microdialyzer quickly removes and cleanses biological and other liquid mixture samples that naturally contain high concentrations of salts and other compounds. It is expected to expand significantly in medical, clinical, and analytical applications of mass spectrometry.

Self-Assembled Monolayers on Mesoporous Supports is a new class of materials that can remove metals and radionuclides from aqueous and organic liquids and gaseous streams. SAMMS seeks out mercury, lead, chromium, and other metals and has potential applications in soil and water cleanup sites.

MICLEAN™/MICARE™ Systems is an industrial cleaning process that increases the scrubbing power of liquid carbon dioxide. Used to clean garments or metal parts, the system provides industry and consumers a recyclable, environmentally safe, yet equally effective alternative to ozone-depleting or hazardous cleaning compounds.

R-TiC Metals Emission Monitor provides continuous monitoring of hazardous metal emissions. Fast, accurate, and sensitive, the monitor can handle compliance issues with environmental regulations and identify problems in thermal processes. ●

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