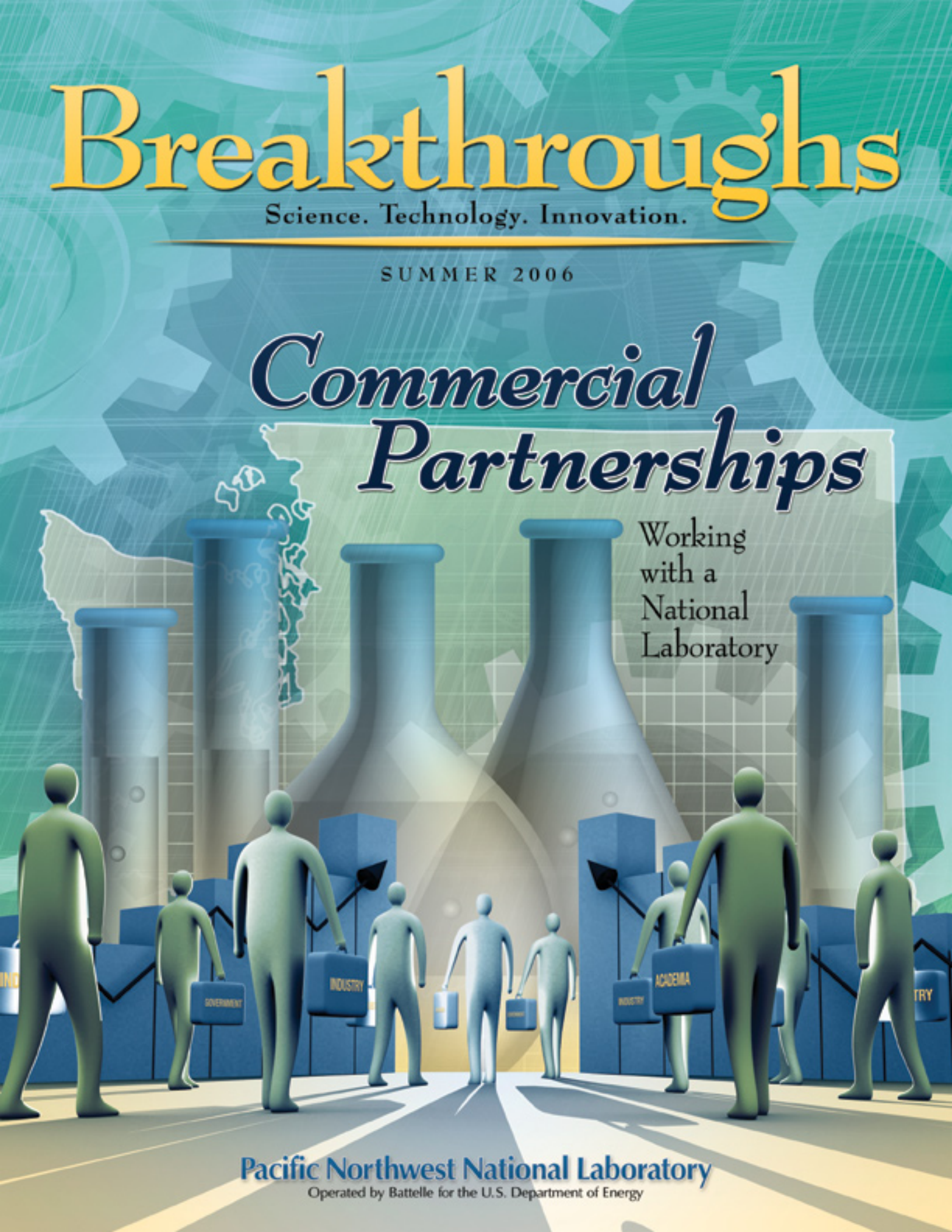
Breakthroughs

Science. Technology. Innovation.

SUMMER 2006

Commercial Partnerships

Working with a National Laboratory



Pacific Northwest National Laboratory
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Breakthroughs

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Staff:

Editor: Lisa Teske
Writers: Sue Chin, Jonni Dron, Sallie Ortiz, Rosalind Schrempf, Virginia Sliman, Andrea McMakin, Kathy Bryson, Anna Tensmyer, Julie Fisher, and Lisa Teske
Graphics: Tyler Borders, Chris DeGraaf, Nathan Johnson, Shannon Neely, Mike Perkins and Justin Yonk

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Direct general inquiries and distribution questions to:

Lisa Teske
Phone: 509-372-6850
Fax: 509-375-6550
E-mail: lisa.teske@pnl.gov

Direct business inquiries to:

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

Direct media inquiries to:

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

editor's screen

Inside a national laboratory

In just over a year working at Pacific Northwest National Laboratory, I often wonder how a place like this exists without being swarmed by industry giants looking for that next advancement that will surely delight their stakeholders and investors alike.

PNNL can fill the gap for companies who have problems that cannot be solved with in-house R&D, either because they do not have in-house capabilities or because they need a solution to a problem faster than they can develop it with available resources. But why would a client choose one research organization over another? It boils down to the kind of expertise they seek and how the solution will add bottom-line value.

The average person isn't concerned with what goes into solving problems as long as the solutions work. But be assured that PNNL has its fingerprint on many modern innovations used everyday. Our discoveries combine best-in-class staff studied in biology, chemistry, physicals, life sciences, geology, computational sciences, and more. The collective energy here is phenomenal; if need be, a biologist can walk down the hall and consult with a chemical engineer on a project. With more than 20 percent of our staff holding Ph.D.s, that's a lot of collaborative brain power at work—and a common occurrence.

But all of that knowledge paired with cutting edge instruments and facilities alone cannot help industry find the solutions that will keep their companies—and our nation—competitive in the world economy. DOE and Battelle know that, which is why PNNL is equipped to provide a variety of partnering options for industry so this government resource may be leveraged for a greater good. It is my hope that this *Breakthroughs* issue answers some of the more common questions about the Laboratory so that our value proposition to industry is much more obvious than before you started reading. – LT

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At a *glance*

"Smart" energy devices + real-time pricing = increased options for consumers

About 200 volunteers in the Pacific Northwest are testing equipment that is expected to make the power grid more reliable while offsetting huge investments in new transmission and distribution equipment.

Pacific Northwest National Laboratory recently launched the Pacific Northwest GridWise™ Testbed Demonstration, a regional initiative to test and speed adoption of new smart grid technologies that can make the power grid more resilient and efficient.

Homeowners can use energy use and cost information to adjust their consumption.

A new combination of devices, software and advanced analytical tools will give homeowners more information about their energy use and cost. Researchers want to know if this will modify homeowners' behaviors.

Approximately 100 homes receive real-time price information through a broadband Internet connection and automated equipment that adjusts energy use based on price. In addition, some customers have computer chips embedded in their dryers and water heaters that can sense when the power transmission system is under stress and automatically turn off certain functions briefly until the grid can be stabilized by power operators.

"The technologies we're testing will turn today's appliances, which are as dumb as stones with regard to the power grid, into full partners in grid operations," said Rob Pratt, PNNL's GridWise™ program manager.

In the pricing study, automated controls adjust appliances and thermostats based on predetermined instructions from homeowners. The volunteers can choose to curtail or reduce energy use when prices are higher. At any point, homeowners can override even their preprogrammed preferences to achieve maximum comfort and convenience.

In the smart appliance portion of the study, a computer chip developed by PNNL is being installed in 150 Sears Kenmore dryers produced by Whirlpool Corporation.

The Grid Friendly™ Appliance Controller chip could help prevent widespread power outages by briefly turning off certain parts of an appliance when it senses instability in the grid. On a large scale, this instant reduction in energy load could serve as a shock absorber for the grid by giving grid operators time to bring new power generation resources on-line to stabilize the grid.

The study is part of the Pacific Northwest GridWise Testbed Demonstration, a project funded primarily by the U.S. Department of Energy. Northwest utilities, appliance manufacturers and technology companies also are supporting this effort. ●

WSU and PNNL break ground on new facility

Washington State University and Pacific Northwest National Laboratory broke ground April 13, 2006, on the Bioproducts, Sciences, and Engineering Laboratory. The BSEL is a $24-million joint effort between WSU and PNNL. Located on the WSU Tri-Cities campus, researchers will use the laboratory to develop processes for converting low-value agricultural byproducts and residues into value-added chemicals for products like plastics, solvents, fibers, pharmaceuticals and fuel additives.

The joint research done at the BSEL could play a significant role in developing a biobased products and fuels industry for Washington and the Northwest. The facility also will provide much needed classrooms and laboratories for science education at WSU Tri-Cities.

Washington Governor, Chris Gregoire said, "The BSEL is the wisest investment we can make for the future of the Tri-Cities and for the entire state."

The BSEL will provide a unique opportunity for researchers and faculty to collaborate on projects that could reduce our nation's dependence on imported oil and develop and deploy clean, efficient energy technologies. ●

PNNL Laboratory Director Len Peters along with Washington Governor Chris Gregoire (left) and Senator Maria Cantwell (right) at the groundbreaking for the Bioproducts, Sciences, and Engineering Laboratory.

Lightweight materials pave the road for energy-efficient vehicles

In efforts to shorten the long road to fuel efficiency, researchers at Pacific Northwest National Laboratory are working to develop cost-effective, high-strength, lightweight materials that will reduce vehicle weight without compromising cost, performance or safety.

PNNL is assisting the Department of Energy's Office of FreedomCAR and Vehicle Technologies by performing materials research with auto and truck manufacturers and suppliers in the transportation industry. The primary focus is the development of lightweight, fuel-efficient cars and trucks, and pursuing research in the development and characterization of new methods for joining dissimilar materials.

In 2006, PNNL partnered with MeadWestvaco, a major player in the paper and specialty chemicals business, to investigate lowering the cost of carbon fiber composites through the processing of lignin-based precursors.

"A by-product of the papermaking process called kraft-based lignin seems to offer the best opportunity to meet the FreedomCAR carbon fiber cost goals," said Mark Smith, who leads the Energy Materials group for PNNL.

Carbon-fiber composites weigh about one-fifth as much as steel but are comparable in terms of stiffness and strength, depending on fiber grade and orientation. They have the potential to reduce vehicle weight by as much as 60 percent, significantly increasing fuel economy.

All of these benefits come with no sacrifice in safety. Computer crash simulations performed at Oak Ridge National Laboratory indicate that cars made with some carbon fiber composites would be just as safe—if not safer—than today's cars.

The problem with carbon-fiber composites is that they cost at least 20 times as much as steel, and the automobile industry is not interested in using them until the price drops dramatically.

"The number one goal of the FreedomCAR Program is to develop and produce low-cost carbon fiber that would be in the $3- to $5-per-pound range compared to today's cost of $8 to $10 per pound," Smith said.

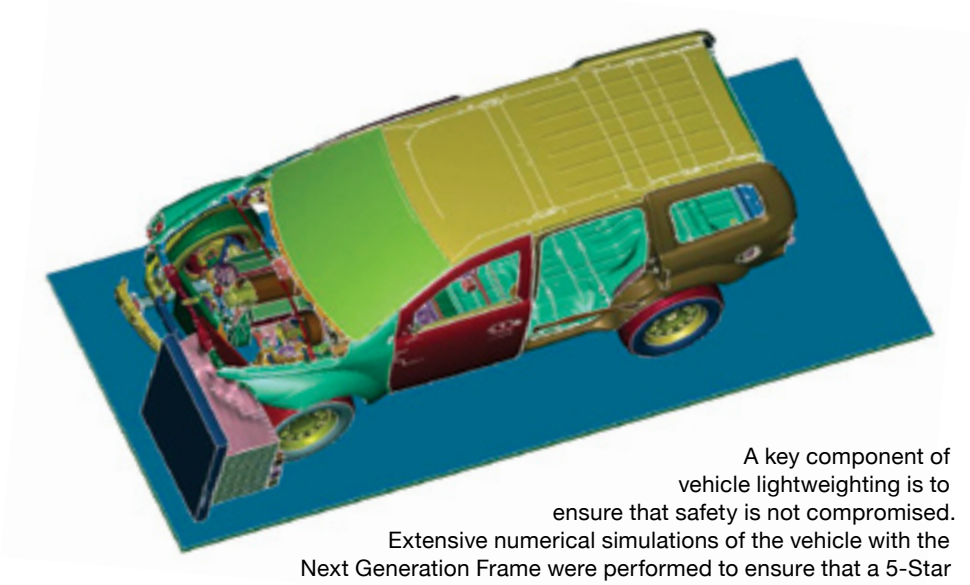
Because the purification and control of impurity levels in kraft-based lignin are the keys to reliable carbon fiber, MeadWestvaco is developing the concept for a cost-effective purification process. The proposed process has the potential to be low-cost, efficient, environmentally friendly and compatible with existing paper plant layout.

Researchers at PNNL are also continuing work in other areas to reduce manufacturing costs and develop new lightweight materials that are economical for manufacturers. PNNL in partnership with DaimlerChrysler; DOE's Office of Heavy Vehicle Technologies; and Alcoa, the world's largest aluminum producer; completed a project that involved developing three prototype lightweight vehicle frames. The prototypes, which are steel and aluminum hybrids, were tested on the chassis of a 2002 Dodge Durango earlier this year.

"The test results exceeded everyone's expectations, successful to the point that we have initiated a more challenging follow-on program called the Next Generation Frame," Smith said.

The Next Generation Frame prototype abandoned the steel portion of the frame, focusing entirely on an aluminum frame. The aluminum frame resulted in a weight savings exceeding 40 percent, and is now being tested on the latest model of the Dodge Durango.

Finally, PNNL is continuing to work with Northwest heavy-duty truck manufacturers to reduce the weight of tractor-trailer combinations by 20 percent. "We are working on a variety of projects addressing this goal including new materials and manufacturing for a lightweight door with PACCAR, and the production of lightweight hybrid composites for body applications with Freightliner," Smith said. ●



A key component of vehicle lightweighting is to ensure that safety is not compromised. Extensive numerical simulations of the vehicle with the Next Generation Frame were performed to ensure that a 5-Star Rating—the government's highest rating—would be achieved.
Photo courtesy of DaimlerChrysler.

NOTABLE Achievements

PNNL welcomes four new Lab Fellows

At the Pacific Northwest National Laboratory, one of the highest levels of scientific and technical achievement and recognition is being named Laboratory Fellow. These individuals consistently demonstrate creativity and leadership in their respective fields of research. PNNL is pleased to announce that Yong Wang, Fabrizio Petrini, Thomas Squier and TP Straatsma were bestowed the honor of Laboratory Fellow.


Wang

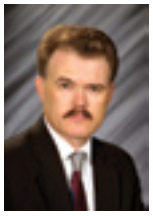
Yong Wang focuses on the areas of catalysis and reaction engineering. He is noted for his discoveries in microchannel reaction technology, specifically, highly active catalysts for microchannel reactor applications. His success in linking catalysis science and reaction engineering are breaking new ground in the way conventional chemical processes are operated and enabling process intensification in important energy areas.


Petrini

Fabrizio Petrini is an internationally recognized expert in high-performance networks, job scheduling algorithms, scalable system software design for large-scale parallel computers, and predictive performance modeling of scientific parallel applications. He is currently working on Buffered Coscheduling to design scalable operating systems for supercomputers.

Tom Squier has an established background in the field of calcium homeostasis and transport in biological systems. He has expanded this research emphasis to participate in the growth of multidisciplinary biological research at the Laboratory, making major contributions to staff, program, and business development.


Squier


Straatsma

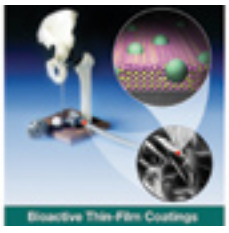
TP Straatsma has more than 25 years experience in the development, efficient implementation, and application of advanced modeling and simulation methods as key scientific tools in the computational study of chemical and biological systems. He is an internationally recognized scientist with an extensive background in quantum mechanics and classical mechanics approaches. ●

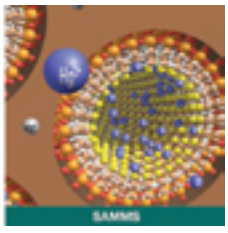
PNNL wins four technology transfer awards

Pacific Northwest National Laboratory has received four 2006 Excellence in Technology Transfer Awards from the Federal Laboratory Consortium—the maximum number of awards allowed in a given year. PNNL was recognized for transferring technologies that treat and cure cancer, uniquely analyze massive sets of data, increase surgical implant success rates, and neutralize toxic chemicals from the environment.


Brachytherapy Cancer Treatment


Starlight Information Visualization


Bioactive Thin-Film Coatings


SAMMS

Through collaboration with PNNL researchers and access to facilities at PNNL, IsoRay Medical, Inc., expanded its brachytherapy technology for treating prostate and other cancers. The medical isotope "seed" products are available at more than 17 implant centers nationwide. More than 40 organizations, including Fortune 500 companies, are using the Starlight information visualization software to mine and interpret massive amounts of data.

Bacterin International licensed bioactive thin-film coatings, which reduce infection rates associated with surgical implants. Self-Assembled Monolayers on Mesoporous Silica (SAMMS), a process for removing mercury and other toxic chemicals from the environment, was licensed to Steward Advanced Materials for use in coal-fired power plants, municipal incinerators, and other plants.

The Federal Laboratory Consortium is a nationwide network of more than 700 major federal laboratories and centers as well as their parent departments and agencies that provides a forum to develop strategies and opportunities for linking technology with the research mission and the marketplace.

The FLC presents its Awards for Excellence in Technology Transfer to federal laboratory employees who have done outstanding work in transferring U.S. government-sponsored technologies to the public and private sectors. Since 1984, when the awards program was established, PNNL has earned 62 of these awards, more than any other national laboratory. ●

Science of doing business

Technology demonstration thwarts fictitious terrorist attack

The pace was intense as data flowed in from sources across the world—a spike in radiation from a ground-based indicator in Pakistan, an unexplained outbreak of plague in India, and a disturbing convergence of travel plans among suspected terrorists. Information Analysis Center analysts agreed the evidence indicated a well planned terrorist attack was imminent in downtown Seattle. Local law enforcement was quickly dispatched, capturing the suspected terrorists as they attempted to smuggle a chemical and radiation dispersing bomb into the city.

If you think you've just read the next plot line from the hit television series *24*, you'd be wrong. This scenario was all part of a "techno-drama" demonstrated by real scientists and engineers from the U.S. Department of Energy's Pacific Northwest National Laboratory, showing the power of information and technology integration during two live demonstrations in December at PNNL's downtown Seattle office.

The mock scenario known as *Threat Alert 2005* covered six days but was compressed into a 75-minute, fast-paced drama played out in a fictitious Integrated Analysis Center following a series of seemingly unrelated events that evolved into a full terrorist threat. It provided a realistic platform for illustrating the application of detection and information analysis technologies that may be used to combat terrorism worldwide.

A handheld biotoxin detector, developed by PNNL researchers for the Air Force, was used in the scenario to rapidly identify a fictitious Seattle terrorist "hot spot." This technology is used to process samples of biological agents in a matter of minutes to determine if they are harmful.

"These demonstrations brought together technologies in sensor measurement and information analysis, addressing the important challenge of early warning and prevention of acts of terrorism," said Doug Lemon, lead for PNNL's Homeland Security initiative. He added the dramatization is the culmination of three years of research and the next step in moving technology out of the research and development phase and into user implementation.

During the mock scenario, PNNL drew on technologies it has developed to identify, understand, and respond to a series of seemingly unrelated events underlying an incipient terrorist attack. The tools included information analysis and visualization technologies coupled with detection and forensic methods for chemical, biological, radiological, nuclear, and explosives threat materials.

"We received input from the Seattle first-responder community early on," comments Lemon on the success of the demonstration. "We tried to mimic reality as much as we could." It was good to use real staff, Lemon said, because they knew the technology was working. "We wanted a realistic drama, with the technology as the star."

A technology demonstration of this size and complexity was a pioneering event for PNNL. Fueled by the post-911 demand for counterterrorism technologies, Lemon and his team created a plan early on to integrate technology development with a goal to demonstrate the results. They aligned development with client and market needs, such as portable and quick detection of potential threats, and then set out to invent the tools with a goal to demonstrate the application.

The techno-drama played to a full house at the PNNL Seattle office. Audience members included representatives from the Department of Energy, Department of Defense, local emergency responders and the local media. Former Department of Homeland Security Undersecretary for Science and Technology Dr. Charles McQueary and key staff were among the guests. It was the beginning of a three-day visit McQueary took to Seattle during December to meet with PNNL staff and local area emergency responders. ●

Fish-friendly solutions

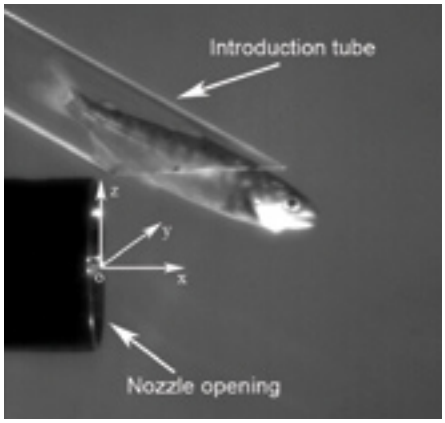
Although turbines have generated power at hydroelectric dams for many years, not much is known about how water flowing through the turbines may harm fish. In efforts to design more "fish-friendly" turbines, Pacific Northwest National Laboratory researchers conducted laboratory experiments to examine the relationship between water velocities within the turbine chambers and injuries to fish.

In the experiments, Chinook salmon were individually launched through a tube into a fiberglass testing pool. They were then introduced to high velocities of water pumped out of an underwater jet nozzle. Fish response to the water jet was digitally recorded through viewing windows located on the side and bottom of the testing pool.

Within a few seconds following each individual experiment, the pump was turned off and fish were captured using nets. Each fish was examined to assess the type and severity of external injuries. Injuries typically result from the rapid change of velocity over a small distance, also know as shear. Common shear-induced injuries include eye damage, gill damage, scale tearing, split fins, and bruising.

Video images of exposed fish were captured using high-speed, high-resolution digital cameras and 3-D motion analysis to measure the velocity, acceleration, jerk, bending angle, and bulk force of the fish. Recording these parameters helped scientists understand the injury process and dynamics.

With this study, researchers will be able to draw conclusions about how fish are injured during exposure to severe water forces. These data contribute to the development of improved engineering design tools and a promising new generation of turbines—resulting in increased fish survival rates. ●



A close-up image shows a young salmon being introduced to the testing pool close to the jet nozzle. The high-velocity stream helped scientists understand why fish are commonly injured by hydroelectric dam turbines.

PERSONALITY PROFILE

Portrait of a legend—mathematician Benoit Mandlebrot

Mandlebrot

At 81, Benoit Mandelbrot takes on new challenges in advanced mathematics for computational science.

One of the world's most influential mathematicians, Benoit Mandelbrot has joined the Department of Energy's Pacific Northwest National Laboratory.

Mandelbrot is recognized as the mathematician principally responsible for originating fractal geometry and applying it to science and engineering research. Examples of fractals range from natural objects with self-similar patterns, such as clouds and plants, to unique computer-generated graphical art forms created using mathematical formulas. The best known of these is called the Mandelbrot Set. Researchers use fractals to model and measure irregular patterns and structures, such as the rough coastline that cannot be represented by classical geometry.

Today, it is common to find fractals applied to many fields, including economics, linguistics, meteorology, demography, and fine arts. The financial bestseller, *The Misbehavior of Markets: A Fractal View of Risk, Ruin, and Reward*, which Mandelbrot wrote with former *Wall Street Journal* editor Richard Hudson, applies fractal geometry to the stock market.

Mandelbrot was born in Poland in 1924 but moved to France in 1936. Because his family is Jewish, he was forced to spend much of World War II hiding in the countryside rather than in school. During that time, he studied on his own, developing a free-thinking and independent attitude that never left him. He completed his undergraduate studies at Ecole Polytechnique in Paris, earned a master's degree in aeronautics from the California Institute of Technology, and his doctorate in mathematics at the University of Paris. Mandelbrot is now a member of the National Academy of Sciences and France's Legion of Honor. He is Sterling Professor of Mathematics Emeritus, at Yale University and Fellow Emeritus of IBM's Watson Research Center, where he developed some of the first computer programs to print graphics.

According to George Michaels, associate laboratory director for PNNL's Computational and Information Sciences Directorate, Mandelbrot's "unique ability to think freely and unconventionally" lends itself to creating new methods for solving the kinds of computational conundrums that science is currently confronting. Among these challenges are managing, measuring, and making sense of vast amounts of data generated by proteomic research, information analytics, and cyber security. ●

Introducing PNNL:

The **who**, **what**, **when**, **where**, and **why** of a national laboratory

When a company knocks on the door at Pacific Northwest National Laboratory seeking a research or technology partner, a bit of identity confusion is typical. Who will I be working with, the company asks—a private company, a government agency or some combination? Even more important, companies ask, how will this identity affect contracting ease, access to people and equipment, and rights to intellectual property?

Simply put, companies work with Battelle to obtain research and development services and intellectual property rights. The work is delivered through people and facilities at Pacific Northwest National Laboratory.

Battelle, one of the world's largest independent research and development organizations, operates PNNL for the U.S. Department of Energy's Office of Science. Through a unique contracting mechanism between Battelle and DOE, companies can access 4,200 staff and more than 2 million square feet of facilities at the PNNL locations in Richland, Seattle and Sequim, Wash.; Portland, Ore. and Washington, D.C. Battelle has 14,000 staff in more than 100 locations worldwide.

Commercial clients seeking research or technology at PNNL may contract directly with Battelle—legally, Battelle Memorial Institute Pacific Northwest Division—without DOE's direct involvement. Each year, about 130 companies use this streamlined, flexible contracting process. Before a research project begins, companies typically negotiate rights to any intellectual property that may be generated. Firms also can license intellectual property from previously funded government research. About 30 license agreements are signed annually, 70 percent of them with commercial companies.

This model of sharing government and Battelle resources at a consolidated laboratory has proven effective on many levels. Companies tap into a world-class source of innovation to enhance their industrial competitiveness. DOE increases the value of technologies and research generated from its national laboratory. And consumers get new products that improve their lives.

Out of the lab and into the park

Connecting world-class science with industry and community

Battelle has managed the Pacific Northwest National Laboratory for the U.S. Department of Energy for more than four decades with the mandate that discoveries in the Laboratory find useful application for the greater common good. And while commercialization has been a way of life at PNNL for many years, last year management reorganized the business arm of the company to become a single-purpose group called the Commercial Partnerships Directorate (CPD).

Director Mike Schwenk captains the team toward stronger partnerships with industry that result in returns to the Laboratory, taxpayers, and the community at large. Since October 2005, Mike has assembled a business development team to meet the challenge of finding big industry problems and then solving them with world-class scientific capabilities using the commercial business tools at PNNL's disposal. Over a cup of coffee, Mike discussed his vision for commercial victory.


Mike Schwenk
CPD Director

Why did the Lab create a separate directorate for commercial business?

PNNL is a $700 million taxpayer-financed research and development institution. With that kind of investment, people naturally want to know how this benefits the nation. One of the best ways to show return back to the taxpayer is when our research finds its way into the commercial marketplace as a product or service. CPD was created to think about that every day. We consider how government research can be leveraged by other companies who create products and services. By creating

this directorate, we now have a group of folks who are totally focused on making this happen.

What kinds of goals have been set forth for the CPD?

There are financial goals that we have that are important to the Laboratory because the returns that we are able to generate in our commercial business go right back into the Laboratory to refresh equipment, mature our technology and help hire strategic staff. It's basically about how we sustain a world-class national laboratory.

We also have what I call anecdotal goals that are basically great stories about how our research got put into use in everyday life. One of the best examples from PNNL is one that people are so familiar with—the compact disc technology.

There are economic development goals as well. Like other businesses, we are concerned about the business climate and quality of life in our community. It is a business imperative that we think about our neighbors and take an active role in making our community strong, healthy and technology-oriented so we can thrive in it. That means looking at the commercial business that we do and using it to help the local economy.

Why "Commercial Partnerships" and not "Commercial Business" or some other name?

We aspire to have long-term strategic partnerships with our industrial clients, not a one-off business transaction. That's the short answer. But there's a little more to it. In a partnership, both sides bring something to the table and both sides get something in return. Together we're stronger, which is what makes it a partnership. That accurately reflects the client relationships we want to have.

The other thing about partnerships has to do with our economic development agenda. We partner with a lot of groups interested in bettering the environment within which we operate and live. They may be economic development councils, state government or other nonprofits. Together we create jobs and wealth for our neighbors. So that's part of this partnership theme, too.

What do you mean by client contributions?

Our clients bring several things to the table. Obviously, if they're going to work with us, they become the financial source for the R&D we're going to do. But also we recognize that typically they have their own first-class people who have been working on the problem. And so generally when we go into a relationship, the work is happening in both places—their lab and ours. We recognize and respect that it's a team effort to solve the problem. So they have a financial contribution but there's also an intellectual asset contribution that they are making along with ours. The third thing they bring to the table is their connection to the marketplace. We don't have that. To the degree that there will ultimately be a great outcome and returns to both parties, that can only occur if they are successful in the marketplace. And they bring that to the partnership.

Why would an industrial client come to PNNL?

It all begins with the client's problems. If they have a problem they can't solve with their internal R&D resources, they look around for existing capabilities that they don't have—be it intellectual property, facilities and equipment, expertise, or a combination of all three. Our client set tends to be industrial companies engaged with problems that relate to the work we do on a national level: energy, environment, and national security. An example could be an energy company looking at alternative energy technologies. Since they seek ways to be competitive, they watch to see who is working on new developments. In that market space, a lot of those technologies have been created at the national labs. So that makes for an easy partnership. We have it. They want to put it into practice.

If you could summarize what PNNL has to offer industry in a couple of sentences, what would you say?

What industry needs to know is that PNNL has enormous capability that we can tap to solve big problems. At this laboratory there is great deal of depth in three core fields: energy, environment, and national security. That research takes advantage of some best-in-class capabilities in computational sciences, unique instrumentation and equipment, and a systems science approach to chemistry, biology, life sciences and physics.

It's one thing to work on a small project here or there, but that doesn't fully utilize this taxpayer-financed resource called PNNL. We work on huge national problems such as securing our nation's borders, and we aspire to solve similar-scale problems for industry. So if you're from industry and you have a big problem needing high-value research, we should be talking.

What does success look like for CPD?

I think ideally success would have three big elements. We have the ability to do contract research. We generate IP and we can license it. We're interested in industrial competitiveness and economic development that can come from those activities. So for us, success is when those three activities align and maximize the effect of each other. A home run is when all three overlap.

I can imagine in the near future a scenario where we provide the foundational intellectual property for a research project with industry and together we generate new IP. We conduct the research project on a national-scale problem and solve the problem with a new product or process. The pilot-scale testing and demonstration of that new product or process is located across the street in our research park. So the problem is grand in scale and significant beyond our community. And yet the solution is being developed in our community. Now there you've got a grand slam for commercial partnerships.

National laboratory science & technology:

What's in it for industry?

PNNL has been transferring innovative technologies to industry and the marketplace since 1965. PNNL pioneered optical digital recording, the critical design element for compact discs and disc players. We also developed a material still sold at most hardware and garden stores that prevents roots and vegetation from invading septic tanks, sidewalks, and buried pipes, saving millions of dollars in maintenance costs. And our researchers invented and commercialized radio frequency tags, which can be used to track and monitor a wide range of items.

PNNL maintains an active intellectual property licensing program for technology transfer to industry. Our intellectual property portfolio of products, technologies, and processes reflects the Laboratory's current research areas in biotechnology, biobased products and waste cleanup, chemical and materials processing, new catalysts, advanced computation modeling, information analytics and cyber security, sensors and detection systems, energy generation/transmission/distribution systems, and transportation emissions reduction. Industry can also tap into PNNL's leading-edge research capabilities, research staff expertise, and some of our unique facilities and equipment.

Doing business with PNNL—which method is right for your company?

Whether you're a small business needing expert technology advice, a university researcher wanting access to specialized scientific facilities, or a large business looking for a capability or new technology to augment your in-house research or products, Pacific Northwest National Laboratory offers several ways to partner that can enable your business strategy.

The U.S. Department of Energy provides guidelines for private companies, state and local governments, and universities to gain access. The guidelines are common to all national laboratories. However, Battelle, as the operator of PNNL, also can partner with companies, governments, and universities directly in its private capacity.

Through a unique contracting mechanism between Battelle and DOE known as a Use Permit, Battelle may use DOE facilities and equipment on a full cost-reimbursement basis for work for Battelle's account. Battelle can directly perform contract R&D at PNNL for federal, state and local governments and for private companies. Each project is negotiated and tailored to the needs and resources of the participating parties. The contracting approach is flexible and typically conducted on a fixed price, time and material, or cost-reimbursement basis.

A company with interest and capabilities in a specific research or technology area might consider partnering with PNNL using a Cooperative Research and Development Agreement (CRADA). A CRADA is a contractual agreement in which both parties collaborate, share costs, and pool the results of their research and development program. Your staff, facilities, equipment, and other resources are leveraged with those of PNNL,

and you gain access to PNNL's science and engineering expertise, results of recent research, and technical facilities. A CRADA provides the unique opportunity to use new technologies evolving from federal research programs in a collaborative way.

A small technology-based business needing short-term technology assistance might benefit from PNNL's Technology Assistance Program. Up to 40 hours of free technical help from PNNL scientists and engineers are available each year. Assistance can include testing and recommending product materials, creating new software/hardware applications, improving production and manufacturing processes, and resolving technical problems. Through this program, PNNL has helped more than 400 firms with 700 projects in the last 10 years.

An organization pursuing technology goals could arrange access to the national laboratory's resources through the Work for Others (WFO) program. Here, PNNL staff perform work using PNNL facilities and technical expertise. Standard terms of the agreement are established by DOE, but DOE does not fund the work. DOE has a mission to provide technical assistance to other federal agencies, commercial companies, local and state governments, and foreign governments, and any of these may use WFO to access PNNL's specialized research and development capabilities on a full cost-recovery basis (reimbursable agreements). Technologies may be transferred from the Laboratory to the marketplace for further development or commercialization.

Scientists researching energy, environmental, health, or national security issues can arrange access to specialized facilities through PNNL's User Facilities Agreement. User facilities include DOE's William R. Wiley Environmental Molecular Sciences Laboratory and the Applied Process Engineering Laboratory. Proprietary and nonproprietary agreements are possible, depending on the user's willingness to publish the results of the research.

License Agreements are another way to partner with the Laboratory. PNNL receives approximately 250 invention disclosures from its researchers yearly, and many are converted into patent applications and software copyrights available for license. More than 150 technologies are available for licensing organized by technology portfolio: analytical instrumentation, biomedical and biotechnology, chemistry, electrochemical, electronics, energy, environmental, information technology, materials, microsystems, nuclear, sensors, and ultrasonics.

PNNL welcomes the opportunity to partner with industry in support of DOE's mission to move science from the national laboratory to commercial use. For more information, contact the individuals listed in the table below.

Type of Agreement	Description	When to use this mechanism	Who to Contact
Cooperative Research and Development Agreement (CRADA)	Cost-shared collaboration with industry for R&D activities of mutual benefit	Works best when an organization has a research program related to existing government-funded work at PNNL. A CRADA would allow mutually beneficial collaboration to occur.	**Cheryl Cejka**, Director Technology Commercialization (509) 375-3700 cheryl.cejka@pnl.gov
Direct Contract with Battelle	Permits industry, government agencies, and nonprofits to directly fund and negotiate contract R&D work through a private contract with Battelle	Ideal for industry partners who want to leverage core Laboratory science and technology, but looking for application- or solution-specific development. Projects are client-funded; most flexible contract arrangement.	**Rich Chapas**, Director Industrial Collaboration (509) 375-2158 richard.chapas@pnl.gov
License Agreements	Granting of rights to practice Battelle intellectual property to enable client's business plan	Appropriate for companies interested in using Battelle's intellectual property for commercial use.	**Cheryl Cejka**, Director Technology Commercialization (509) 375-3700 cheryl.cejka@pnl.gov
Technology Assistance Program	Forty hours of PNNL staff time annually	Ideal for small technology-based companies who desire access to unique capabilities at PNNL.	**Gary Spanner**, Manager Economic Development Office (509) 372-4296 gary.spanner@pnl.gov
User Facilities Agreement	Provides access to certain dedicated DOE laboratory facilities	Provides access for non-PNNL researchers to use specialized equipment at PNNL.	**Bruce Simanton**, Manager Business Development and Analysis (509) 376-0161 bruce.simanton@pnl.gov
Work for Others (WFO)	Enables federal and non-federal agencies to access PNNL's capabilities on cost-recovery basis	Appropriate for situations where an agency wants direct access to PNNL capabilities under a cost-reimbursement arrangement through DOE operating contract.	**Marlene K. Meeks** WFO Onsite Specialist (509) 372-6258 marlene.meeks@pnl.gov

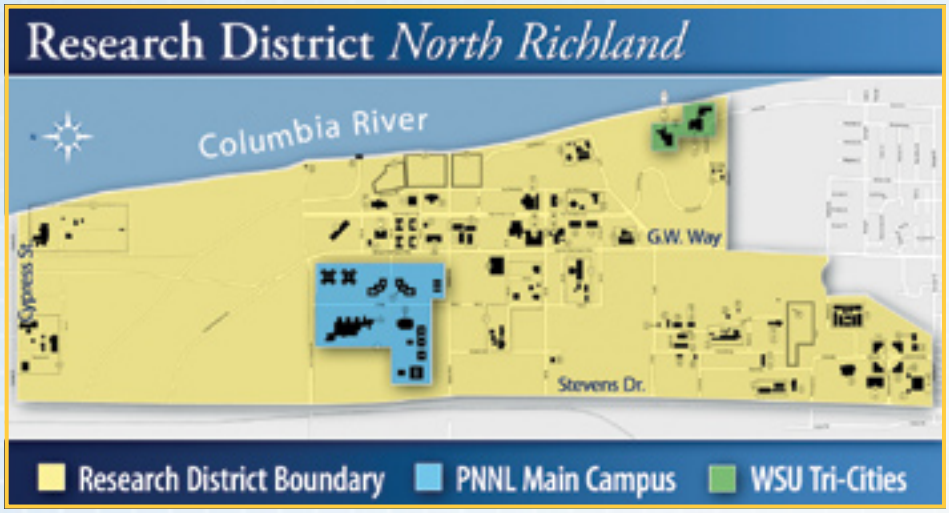
PNNL is strong asset for Research District

Pacific Northwest National Laboratory has led a team of community partners in using a grant from the U.S. Small Business Administration to hire AngelouEconomics to develop marketing and land-use plans for the 1,600 acres of property in north Richland known as the Research District. Currently home to 5,000 employees and 85 businesses including PNNL and Washington State University Tri-Cities, community leaders are positioning the Research District to create the Tri-Cities as a regional technology center similar to the Research Triangle in North Carolina.

"PNNL has been the key driving force to moving this study forward in looking at the Research District and how it can benefit the economy of the region," said Carl Adrian, president and CEO of the Tri-Cities Industrial Development Council, TRIDEC. According to AngelouEconomics, "research conducted at PNNL greatly enhances the region's image in the technology community and as the area's largest employer, PNNL will positively impact the economy through the realization of its long-term growth plan."

Listed among the selling points of the Research District are the low cost of doing business, technical capabilities (citing the location of PNNL and WSUTC inside the Research District), land availability, and the highly educated workforce, including a very high number of PhDs per capita. Chris Engle, vice president of AngelouEconomics said "The primary draw for science and technology businesses to locate to the Research District will be the opportunity for collaboration with PNNL."

In a recent presentation during the rollout of AngelouEconomics plans, Len Peters said "We agree that the Research District, with its space availability and other features, is perfectly suited for locating dynamic new companies around PNNL." Laboratory management was excited about the work AngelouEconomics did and is on board to support efforts to bring more science and technology businesses to the Research District in Richland.



IR&D spells success for PNNL scientists

Webster's dictionary does not use I, R, or D when spelling the word success. However, some of PNNL's scientists are finding that IR&D can spell success for taking their research to industry.

The Independent Research and Development program requests proposals for projects that support the growth in the contract research business at the Laboratory. This program's annual budget allows scientists to request funding that will assist them to advance their research to a level that is commercially viable for industry. IR&D proposals will focus on support to PNNL's industrial business strategy to enhance the intellectual property base of the Laboratory. Projects are selected based on their overall technical merit and strength of the business case.

"This program is beneficial to industrial R&D programs that are looking for new technology to improve their business," said Rich Chapas, director of industrial partnerships for PNNL. "More and more companies are adopting an open innovation model when looking for new technology that they may not necessarily have the capabilities or time to develop."

One particular success story involves a group of Battelle scientists working with Hewlett Packard. They applied for IR&D funds to provide them with the opportunity to discover exactly the right niche in their research that solved problems important to HP. The funding the scientists received closed the gap with HP and allowed their research to reach a point that the company could offer them a contract of $250,000 per year for up to five years with a potential for up to $1.2 million to continue developing their research for industry.

Unique partnership brings new cancer treatment to life

IsoRay is a company that started as a good idea and, in less than a decade, has grown into a publicly traded corporation. "IsoRay literally started in Lane Bray's basement, with about three employees," said Larry Greenwood, the Pacific Northwest National Laboratory technical lead for the IsoRay project.

IsoRay Medical, Inc., produces cesium-131 radiochemical brachytherapy "seeds" used to treat prostate and other cancers. The cesium-131 seed offers a significantly shorter half-life than the two other isotopes commonly used for brachytherapy. A shorter half-life means faster delivery of therapeutic radiation to the prostate gland and lower probability of cancer cell survival.

IsoRay's partnership with PNNL began almost as informally as the company did. In 1998, Bray, a PNNL retiree and internationally recognized expert in medical isotopes, and Don Segna, a retired engineer formerly with the U.S. Department of Energy, met with Larry Greenwood to discuss technical issues related to the fledgling company. This meeting led IsoRay to PNNL's Economic Development Office and access to PNNL expertise in the form of a Laboratory Technnology Assistance Program project.

Five additional TAP projects, several research contracts, and seven years later, IsoRay was producing and marketing its cesium-131 seeds to hospitals across the nation.

As a small start-up company, IsoRay did not have the physical or financial resources to conduct extensive testing in a radioactive environment. The company began by performing nonradioactive testing in a technology incubator facility before conducting the radioactive work at PNNL.

"It would have been nearly impossible to start this company without a laboratory like PNNL available to us," said Don Segna, now IsoRay's vice president of strategic planning. "The advantage of having a place like PNNL where we could do the radioactive work at a relatively low price meant that we didn't have to go public right away. We could still determine the company's direction."

In addition to providing a radiological lab and expertise, PNNL offered its regulatory experience. "We are used to the oversight involved in working with radioactive materials so we know the ins and outs of quality control and the documentation needed to make it happen," Greenwood said. "We also have DOE support for our work with small companies."

"We got our feet wet at PNNL, learned what kind of equipment we needed and how the regulatory process worked," said Bray, who is now chief scientist at IsoRay. "We still rely on Larry's group for analytical services and look forward to working with them in the future."

IsoRay's brachytherapy seeds use cesium-131, which emits a low-energy x-ray that effectively provides a cancer-killing dose to a tumor in a short period of time.

IsoRay's cesium-131 seeds are now being used in 36 medical centers and clinics around the United States. The cesium-131 seed has a half-life of 9.7 days, compared to 60 days for iodine-125 seeds and 17 days for palladium-103 seeds. Because of this shorter half-life, it delivers more than 90 percent of its total radiation dose in less than 33 days, attacking the cancer faster and reducing the incidence of common brachytherapy side effects.

"We now have a product that appears as if it could become the seed of choice for the treatment of prostate cancer," Segna said. "We've had some requests for using the cesium-131 for treating other cancers and are exploring those possibilities."

IsoRay developed all of the intellectual property and holds all of the patents for the separation and purification of cesium-131. IsoRay recently built its own radiological laboratory in Richland, Washington, and is now producing the seeds there. The cesium-131 seeds won a Federal Laboratory Consortium award in 2006 for the transfer of technology from a national laboratory to the public.

"Staff here really love working on the project, and we have great interaction with the IsoRay people," Greenwood said. "We also get a great deal of satisfaction from being involved with a project that may save someone's life."

IsoRay is based in Richland, Washington. More information about IsoRay is available at www.isoray.com.

Licensed to kill... metal contaminants

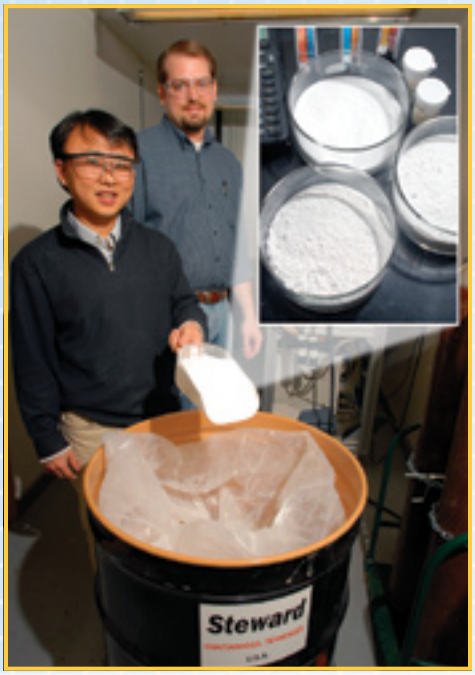
A nanomaterial designed to capture and remove mercury and other toxic substances from waste streams has been licensed for commercial use.

Battelle has licensed the SAMMS™ technology developed at Pacific Northwest National Laboratory to Steward Environmental Solutions, LLC, a manufacturer of advanced powders and nanomaterials.

SAMMS, or Self-Assembled Monolayers on Mesoporous Supports, is an advanced technology that can be tailored to selectively remove specific metal contaminants without creating hazardous waste or by-products.

Steward signed the first licensing agreement in November 2005 and intends to initially market SAMMS for treating gaseous emissions such as those from coal-fired power plants, municipal incinerators, and other similar plants where testing has begun. They have also begun testing on other complex aqueous and organic waste streams.

The original SAMMS application for mercury-removal from water and waste streams is being modified to work with Steward's proprietary powder technology for application to a broad category of waste streams. The two technologies are combined to remove mercury and other toxic metals from applications where it is difficult to use traditional physical filter technology. The combination of the two technologies reacts with mercury and removes it from the emissions stream prior to release into the atmosphere.



Steward Employees Xing Dong (left) and Ashley Mullins (right). Steward Environmental Solutions, LLC has signed two licensing agreements for the production of SAMMS. *Photo courtesy of Steward Environmental.*

The U.S. Environmental Protection Agency estimates that coal-fired power plants contribute about 48 tons of mercury to the U.S. environment each year. The Center for Disease Control and Prevention believes that roughly eight percent of American women of childbearing age have mercury concentration in their bodies that exceed safety limits. In March 2005, the EPA issued the first federal rule to permanently cap and reduce mercury emissions for coal-fired power plants, making the United States the first country in the world to regulate mercury emissions.

"The greatest benefit may be to the public," said Shas Mattigod, PNNL staff scientist. "By providing industry with simple, inexpensive and highly efficient methods to reduce or remove contamination to the environment, the impact to human health is significantly reduced."

In March 2006, Steward signed a second license agreement for the manufacture and sale of SAMMS for multiple fields of use. "SAMMS can be easily adapted to recover toxic substances from contaminated streams, lakes, and storm sewers," said PNNL SAMMS commercialization lead Rick Skaggs.

In the past, despite SAMMS' demonstrated advantages in treating heavy metals, the absence of a manufacturer left many companies with the impression that it is a research-level technology not applicable to solving real problems. "Now that SAMMS is commercially available from Steward, we anticipate even greater interest in using SAMMS to solve problems in many fields of use," Skaggs said.

Since the initial development of the technology, PNNL has continued to refine and test new applications that will broaden the range of contaminants effectively treated by SAMMS. Steward hopes to work with PNNL on the production of these applications. "We have received terrific support from several leading electric utilities, as they are truly committed to finding the best environmental technology," said Steward's vice president Bob Jones. "SAMMS earliest deployments appear to be in aqueous or organic solutions where a fast and economic solution is required such as municipalities, process industry, hospitals, and utilities."

Steward began producing SAMMS at an industrial scale in March 2006. "We are pleased with the comments about potential savings and performance advantages we have gotten from our first customers," Jones said. "We have planned a continuing increase in manufacturing capability so that we are able to meet demand."

Research investment in PNNL technology pays big for Chicago firm

A chance meeting in Vienna, Austria has led to one of the most successful relationships between Pacific Northwest National Laboratory and industry.

Steve Miller, a staff scientist at PNNL, and Craig Yoder, senior vice president of Landauer, the world leader in providing personnel radiation monitoring services, met at a conference in Vienna in 1989. "I was giving a poster on my research in optically stimulated luminescence (OSL)," Miller remembers. "Craig showed an interest in the technology and later sent me a letter suggesting we develop a research project aimed toward commercializing the OSL technology." Yoder was a former Battelle employee and was familiar with PNNL's dosimetry technology research.

The OSL radiation detection technique is based on optical stimulation of sensitized metal oxides, alkali-halide and alkaline-earth halide crystals. Developed by Miller, the OSL technique has greatly improved the state of the art in gamma and beta radiation dosimetry. OSL is more sensitive than older technology, less expensive to manufacture, and faster to read out. The technology received an R&D 100 award from Research and Development Magazine for one of the top 100 new technologies and products of 1992, a Federal Laboratory Consortium Award for the Landauer technology transfer in 1994, and an R&D 100 award in 2000 for high-dose dosimetry.

Pacific Northwest National Laboratory staff scientist Steve Miller "holds up" the building blocks of improved ionizing radiation measurement known as optically stimulated luminescence.

Landauer began sponsoring research on the OSL technique in 1990 under PNNL's 1831 Industrial Research Contract. The Chicago-based company, highly respected for its expertise in accurate radiation dose assessments, has offices in the United States, Europe, China, Japan, and Brazil and generates $75 million in sales annually.

"In the early 90s, several market developments were occurring in providing radiation monitoring services that revealed a need for Landauer to establish a proprietary method as one way to differentiate it from its competitors," Yoder said.

Over the years, the relationship has paid off for both the company and PNNL. "When we first started, the technology was very immature," Miller said. "It took three to four years, with significant funding and technical contributions from Landauer, before we really got to the point where we had a product."

Both parties brought complementary strengths to the relationship. PNNL provided the underlying technology. "We had something that Landauer wanted," Miller said. Landauer provided the crucial funding as well as its manufacturing expertise, which enabled the development of a technology suitable for the marketplace.

As a result of the collaboration, OSL has become the method for personnel radiation monitoring service provided by Landauer. The company began the commercial use of OSL in 1997 and converted all of its films and thermoluminescent dosimetry methods to OSL. "Currently, OSL is used in 90 percent of our products and is the base technology that Landauer is using for its long-term strategic growth," Yoder said.

OSL gave Landauer a path toward international growth and has had a key impact in several foreign markets. In Japan, Nagase-Landauer (Landauer's joint venture in Japan since 1973) converted its film-based radiation monitoring service to OSL in 2000. "In response, our key competitor changed from film to glass dosimetry at the same time and, in 18 months, most of the Japanese market transitioned from film to photostimulable methods," Yoder said.

"We are having a similar impact in France where the advantages of OSL are creating pressures for our competitors to make their own technological changes. Now OSL is used in Japan, UK, Canada, France, Peru and Australia. We expect to add OSL to our subsidiaries in Brazil and China within the year, and we are in negotiations with laboratories in other countries."

As for PNNL, "The Landauer contract is the largest royalty producer for the Laboratory, bringing in $2 million in research funding and more than $3 million in royalty income thus far," Miller said.

"PNNL has been great at developing the technology, and our work with the Laboratory will continue," Yoder said. "OSL has been a successful story in personnel radiation monitoring, and we believe its applications will be equally successful in other radiation measurements as Landauer forms alliances with those who see OSL as a beneficial tool in new markets and applications."

PNNL staff members contributing to the OSL research were Mike Tinker and Paul Tomeraasen and former staff Joe McDonald and Bill Endres.

Catalysis: the science behind sustainable energy

About 60 percent of the things we wear or use are produced by processes that depend on catalysis. Catalysts are substances that modify chemical reaction rates and remain unchanged afterward.

Catalyst technologies affect nearly all areas of the chemical and petroleum industries with an economic impact estimated at more than $10 trillion per year worldwide. Now more than ever, innovative and improved catalyst technologies are in demand for new energy production processes to ease the United States' dependence on imported resources.

Pacific Northwest National Laboratory is a world leader in catalysis research with its Institute for Interfacial Catalysis. Established in 2005, the IIC is a centerpiece in the United States for work involving the control of chemical transformations for a secure energy future.

"So many new things are possible in the design and modeling of catalytic chemistry because of advances in nanotechnology and high-performance supercomputing, and PNNL has expertise in both of these areas," said Mike White, who manages the IIC in addition to continuing his position as Robert A. Welch Chair in Materials Chemistry at the University of Texas at Austin.

PNNL's catalysis research spans a broad area, including biomass conversion, environmental catalysis, and solid oxide fuel cells. In biomass, for example, PNNL scientists are developing catalyst materials and processes for producing value-added chemicals and fuels from biobased feedstocks. These types of advances result in new opportunities for grower associations, food processors, and chemical companies as well as federal agencies.

Solid oxide fuel cells are considered one of the most efficient and cleanest technologies for energy conversion, and catalysis plays a critical role in their development. At PNNL, researchers are conducting detailed studies of oxygen reduction kinetics in fuel cells. Results from these studies are being used to develop new catalytic materials for fuel cells.

No matter what the energy source is—oil, natural gas, coal, biomass, solar or nuclear—a clean, sustainable energy future will involve catalysis. PNNL expects to be on the forefront, developing catalysis processes and technologies to improve energy conversion efficiency, storage, and use options as well as reduce environmental impacts. ●

Researchers in PNNL's Engine Emissions Laboratory investigate catalysts, particulate traps, and other methods for reducing diesel engine emissions.

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Richland, Washington 99352

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