

# Bulletin *of the*

CONNECTICUT ACADEMY OF SCIENCE AND ENGINEERING

Volume 18,1 / Spring 2003



## Activities of the Academy

Following is a list of the most recent major reports of the Academy. Reports are available for a nominal fee from the Academy office or web site; executive summaries of the most recent reports are available on the Academy web site at [www.ctcase.org](http://www.ctcase.org).

"A Study of Fuel Cell Systems" (2002)

"A Study of Bus Propulsion Technologies Applicable in Connecticut" (2001)

"Study of Radiation Exposure from the Connecticut Yankee Nuclear Power Plant" (2000)

"Efficacy of the Connecticut Motor Vehicle Emissions Testing Program" (2000)

"Indoor Air Quality in Connecticut Schools" (2000)

"Efficacy of MTBE Use in Connecticut" (1999)

"Radon in Connecticut: Quantitative Perspectives about Effects on Public Health" (1998)

"Building Agricultural Biotechnology in Connecticut" (1997)

"Status of Connecticut Critical Technologies" (1997)

"Evaluation of Critical Technology Centers" (1996)

"Science and Technology Policy: Lessons from Six American States" (1994)

"A State Science and Technology Policy" (1992)

"Electromagnetic Field Health Effects" (1992)

## Powering the Future: Fuel Cells Promise Clean, Reliable Power

Fuel cells, which use hydrogen and oxygen to produce electricity through electrochemical reactions, form the heart of fuel cell power generation systems. They have the potential to create much more reliable power, with lower levels of undesirable emissions and noise and higher overall efficiency than more traditional power generation systems. With existing and projected applications ranging from spacecraft to private automobiles, large stationary power generation systems to small electronic devices, fuel cells are poised to play an increasingly critical role in meeting the world's growing demand for clean, reliable power.

Connecticut is currently home to a number of companies and research centers on the cutting edge of fuel cell research and development. These include United Technologies Corporation's UTC Fuel Cells (formerly International Fuel Cells) in South Windsor, which has supplied NASA with fuel cells for manned space flight since the early Apollo missions and has long been considered a world leader in fuel cell technology; Fuel Cell Energy in Danbury and Torrington, the largest manufacturer of molten carbonate fuel cells in the world; and Proton Energy Systems in Wallingford, a leader in the field of medium-sized hydrogen generating systems. New, but important, players in the state's fuel cell industry are Southbury-based GenCell, rapidly becoming known for innovative approaches to fuel cell design, manufacture and system reliability; and the Connecticut Global Fuel Cell Center, a center for research and development established at the University of Connecticut's Storrs campus in 2001. The Center's mandate includes advancing research and development of advanced fuel cell technologies and associated technologies, educating "students

(See Fuel Cells, page 2)

## News from the National Academies

The following is excerpted from press releases of the National Academies and from *Infocus Magazine*, a news resource of the National Academies, which can be found at [www.infocusmagazine.org](http://www.infocusmagazine.org)

### ◆ Climate Change Plan Falls Short

A newly released report by the National Research Council concludes that a draft strategic plan developed by the federal Climate Change Science Program (CCSP) includes important new initiatives, which provide a "solid foundation for future research," but lacks a "clear guiding vision" and will require significant revision in order to adequately meet the needs of decision-makers who must deal with the effects of climate change on the federal, state and local levels.

CCSP is a federal program formed a year ago in an effort to facilitate research in climate change across 13 different federal agencies.

The committee that wrote the report, chaired by Academy member Thomas E. Graedel, professor of industrial ecology at Yale's School of Forestry and Environmental Studies, also noted that the president's fiscal year 2004 budget request appears to leave funding for CCSP relatively unchanged, despite new initiatives called for in the plan.

"While past climate-change science has focused on how climate is changing and affecting other natural systems, future science must also focus on more applied research that can directly support decision-making," said Graedel. "Research is especially needed to improve our understanding of the possible impacts of climate change on ecosystems and human society, as well as options for responding to — and reducing — these effects."

[See [www.nap.edu/books/0309088658/html/](http://www.nap.edu/books/0309088658/html/)]

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## Our Thanks to Academy Sponsors

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## Fuel Cells (continued from page one)

of all ages," commercializing fuel cell technology, and serving as the "principal center" for demonstrating innovative and critical applications of fuel cell technology.

The presence of some of the world's largest fuel cell manufacturers, along with a number of smaller companies engaged in innovative research and development and a world-class center of excellence, makes Connecticut a leader in the field of fuel cell technology.

In April 2002, the Connecticut Academy of Science and Engineering was asked to conduct a study of the fuel cell industry, to include a description of the most current fuel cell technology, a description of current applications for fuel cells, an examination and summary of potential future applications for fuel cells, and an assessment of the leading fuel cell technologies and their development status and application time frames, with particular focus on Connecticut fuel cell producers. That study, requested by the Connecticut Department of Economic and Community Development (DECD) and the Connecticut Economic Resource Center (CERC) was released in December of 2002.

Entitled "A Study of Fuel Cell Systems," the study identifies five different kinds of fuel cell technologies that have been developed for varying applications. These are

1. **Alkaline Fuel Cells**, which can be very small, and have been used in NASA's space shuttle and in other applications where pure gases can be used as fuel;
2. **Molten Carbonate Fuel Cells** (MCFC), designed for large, stationary systems;
3. **Phosphoric Acid Fuel Cells** (PAFC), the only kind of fuel cells that are currently in widespread use in commercial or relatively large stationary applications;
4. **Polymer Electrolyte Membrane Fuel Cells** (PEMFC), expected to be the system of choice for vehicular power applications, but also being developed for stationary power applications; and
5. **Solid Oxide Fuel Cells** (SOFC), a prime candidate for relatively large, stationary systems.

The most important advantages (cited for all fuel cell technologies) are "very low levels of unwanted emissions" and "low noise," according to the study, while the most significant challenges to the development of fuel cell power systems include cost (system and life cycle), lack of demonstrated reliability for most types, lack of infrastructure for some types, and the need to identify and develop markets.

The report notes that Connecticut is already considered a world leader in the application of fuel cell systems for stationary power applications (for instance, UTC Fuel Cells already has over 250 PAFC-based units installed worldwide) and is the only state that can claim "substantial system experience in any fuel cell power application." However, the authors also note that

(See Fuel Cells, page 8)

# IN BRIEF

## Science and Engineering Notes from Around Connecticut



### Communication

**ESKIMO TALK.** Yupik, an Eskimo-Aleut language that is unique because it is the common language of a native group whose members live on both sides of the Bering Strait, is among the endangered languages receiving support from the **Endangered Language Fund (ELF)** of **Yale University**. The Yupik language is spoken both in Siberia and on St. Lawrence Island in the United States. However, the language was suppressed in Russia under the Soviets, making it harder for Soviet Yupiks to understand their native tongue. Yupik is one of twelve indigenous languages that have received support this year from ELF, which is dedicated to studying and maintaining languages that are in danger of extinction.

**A LITTLE BIT WIRELESS.** A new wireless technology under development by New Haven-based **DSL.net** allows laptops to hook up to the Internet without first being connected to a cellular phone. The technology, known as WiFi, also offers upload and download speeds that are far faster than those found on current wireless services. The company hopes that WiFi, which was tested in a coffee shop in Rhode Island in September, could eventually provide high-speed wireless access to small and mid-sized business customers, according to spokesman **Joe Tomkowicz**. The technology, though, is tied to specific sites: during its September test, WiFi could be used only within a 75-yard radius of the coffee shop.

**POISON PROTECTION.** Through its link with the Toxic Exposure Surveillance System, the **Connecticut Poison Control Center** at the **University of Connecticut Health Center** in Farmington is part of an early warning system that could identify a biological or biochemical warfare attack within the United States. The surveillance system is a nationwide database that contains detailed toxicological information on more than 24 million poison exposures reported to US poison centers, says **Marc Bayer**, medical director for the Center. "When we get a call about an exposure, we enter the case into the database in real time, so it's immediately available to experts who can screen for exposure patterns across the entire country."



### Education & Cognition

**SCIENCE MAJORS.** With a grant from the National Science Foundation, **Naugatuck Valley Community College**, in Waterbury, will develop and evaluate strategies to encourage students to earn degrees in the science, technology, engineering, and mathematics (STEM) fields. The three-year project, **Partners to Attract and Sustain Adult Learners**, will engage area businesses as supporters of the program, and will help students through mentoring, tutoring, scholarships, internships, academic advising, and web-based virtual tours of STEM industry work sites. The college is one of only 14 colleges and universities nationwide to receive funding for the program this year.

**READING READINESS.** In a **New Haven** pilot study last year, the **Breakthrough To Literacy** reading program increased the reading readiness of children in poor neighborhoods to the same level as that of youngsters from more affluent areas. This year, the program, which relies on a combination of phonics, reading comprehension, teacher training and technology, has been implemented in all New Haven kindergartens. As part of Breakthrough, the youngsters do some of their lessons on a computer, which records all their answers, creating a report that teachers can easily view. While other literacy programs

have targeted youngsters in second and third grades, this is the first aimed at kindergartners.

**FAST FOOD.** In **Tolland**, schoolchildren have been fingerprinted—but it's just so they can get through the lunch line. To speed up the often slow process of paying for food, the school system has purchased a biometric scanning system which allows youngsters to purchase their snacks simply by putting their index finger on a small scanner. The device identifies each youngster by creating an algorithm that plots 12 key points at the intersections of the child's fingerprint arcs and swirls; these 12 points are then matched to patterns already stored in the computer, and the child's purchase is charged to his or her account. While the system shows much promise, it does take some getting used to. "We've had to train the kids not to eat their lunch while they're standing in line," said food services director **Jackie Schipke**. Greasy fingers, it turns out, can prevent the scanner from working.

**TALK NOW, READ LATER.** Low-income youngsters improve their vocabulary and language skills much more quickly when they attend preschool with more affluent children, according to research conducted by **Carlota Schechter**, an education professor at **St. Joseph's College** in West Hartford. The study compared two preschools that served only low-income youngsters with five that handled children from a variety of economic backgrounds. Schechter found that, after six months, not only did the low-income youngsters attending mixed preschools increase their vocabularies six times faster than their more isolated peers, they have also caught up with their affluent classmates.

**TOWN-GOWN TOGETHER.** **Yale** has been awarded a four-year, \$2.1 million grant from the Howard Hughes Medical Institute to enhance science education at Yale, and to fund science outreach programs for **New Haven** public schools. The money will be used to support a variety of projects, including a summer residential program for high school students that introduces them to science research and clinical medical care at Yale; the DEMOS program, in which Yale students volunteer in science programs in local schools; and the STARS program, which encourages ethnic minority students aiming for science degrees and biomedical careers.



### Energy

**LITE LIGHTS.** The town of **Hamden** currently pays about \$3.5 million annually for utilities, but municipal officials believe they can cut those costs by 30% to 50%. Last fall, the town hired national energy conservation company Vestar to perform a townwide energy audit. The company will survey municipal and school buildings, pumping stations, street lights, and sewer lines for a three- to four-month period, looking for ways that the town can improve its use of energy. Its recommendations may include upgrading heating and ventilation systems, replacing boiler plants, and redesigning interior lighting. Should the town hire it to make improvements, Vestar guarantees the results.

*Items that appear in the In Brief section are compiled from previously published sources including newspaper accounts and press releases. For more information about any In Brief item, please call the Academy at (860) 527-2161, write the editors at 179 Allyn St., Suite 512, Hartford, CT 06103-1422, or email us at acad@ix.netcom.com*

# IN BRIEF

## Science and Engineering Notes from Around Connecticut

**POWER ON ITS OWN.** Hartford-based **United Technologies Corporation (UTC)** is expanding its power production business by partnering with a California microturbine company. The alliance with Capstone Turbine Corp. allows UTC to offer a low-emission microturbine system, which extends the company's line of stand-alone power generators. Like the fuel cells that the company already produces, the microturbines allow power to be produced on site. The generators are intended for commercial, industrial, and municipal facilities, according to Capstone. Based on a technology similar to that used in a jet engine, they're about the size of a refrigerator. Each one can generate about 30 kilowatts of electricity, and sells for about \$25,000 to \$55,000.



### Environment

**RIVER RESTORATION.** The lower **Hop River**, in **Coventry** and **Columbia**, has been reconfigured as part of a **Department of Environmental Protection (DEP)** project intended to restore the stream to a more natural state. During a 1970s highway construction project, the Hop River had been straightened and relocated; this change ultimately increased erosion in the river and degraded fish habitat. The restoration was intended to correct that. The DEP used living plants, and other materials including coconut fiber rolls, and erosion control fabric to stabilize the stream beds, and tree-root structures to deflect water flow from stream banks and provide refuges for fish.

**BETTER QUALITY.** With the help of student volunteers from **Norwalk** and **Westport**, the water-quality monitoring organization **HarborWatch/RiverWatch** keeps track of the small rivers that flow into **Long Island Sound**. Based at the **Nature Center** in Westport, the organization has been testing water since 1985, focusing on the smaller streams that the **Department of Environmental Protection (DEP)** often doesn't pay attention to. The volunteers, supervised by **Dick Harris**, the group's director of water resources, have detected problems that range from an ammonia spill to leaking septic tanks. Data collected by the group is used by the DEP and by Westport town officials to enforce conservation compliance.

**RETURN OF THE NATIVE CAT.** Mountain lions, long vanished from Connecticut, may be returning to the state. Once native to the region, the big cats were driven out by hunters, and by the growing human population. Now, they're believed to live largely in the western United States, and in some parts of Florida. But some Connecticut enthusiasts believe that at least a few of the animals have moved back. There have been unconfirmed sightings, including one in **Farmington** and a cluster in **Somers**. Cougar fans are also encouraged by the state's changing landscape. The state is now far more wooded than it was a century ago — two-thirds, as opposed to one-fifth.

**UNNATURAL WORLDS.** For the past twenty years, scientists have often used mesocosms, or artificial ecosystems, to study such issues as drinking water standards, the effects of global climate change, and endangered species. But this technique may not give accurate results, according to a study done by **Yale Forestry and Environmental Studies** professor **David Skelly**. To evaluate the accuracy of this method, Skelly conducted identical experiments on tadpoles in mesocosms (250-gallon tanks) and in enclosures placed

in a pond. He found that the animals behaved differently in each environment, and that the mesocosms did not accurately predict the way animals would behave in the wild.



### Food & Agriculture

**BIRD WATCH.** With a \$50,000 federal grant, the state **Department of Environmental Protection (DEP)** plans to develop a coastline birding trail that will include about 50 birdwatching sites. The trail should be in place next summer, with detailed information about each site posted on the web, according to DEP supervising wildlife biologist **Jenny Dickson**. Sites expected to be included are the **Coastal Center** in Milford, **Hammonasset Beach State Park** in Madison, and **Audubon Greenwich**. Other sites can be nominated by going to [www.ctbirdingtrails.org](http://www.ctbirdingtrails.org).

**SELF-HEALERS.** With a \$3.4 million National Science Foundation grant, **Yale** researchers hope to find ways to control plant diseases by tapping into the plants' own protective abilities. The team, led by **S.P. Dinesh-Kumar**, plans to focus on the plants' hypersensitive response (HR), in which cells at the infection site undergo rapid death. This reaction, explains Dinesh-Kumar, can save the plant by depriving the pathogens of nutrients, thus limiting their ability to survive. The researchers will develop functional genomics and proteomics techniques to identify the genes involved in disease resistance and susceptibility, and to explore the molecular mechanisms by which infectious viruses thwart the plant's defenses. Infectious crop diseases result in multi-billion dollar crop losses annually, says Dinesh-Kumar.

**SAFE CIDER.** At the **Beardsley Cider Mill and Orchard**, in Shelton, **Dan Beardsley** relies on the latest technology to keep his farm going. His state-of-the-art cider mill, which visitors can observe in action, processes apples at the speed of one bushel per minute. And, even more importantly, Beardsley, an environmental scientist-turned-farm entrepreneur, has devised his own way to keep cider safe. Beardsley has developed a pasteurization machine that relies on ultraviolet light to knock out bacteria. The \$3,500 machine enables Beardsley to run a cost-effective operation, and unlike heat pasteurization, the ultraviolet process does not affect the cider's taste. Beardsley plans to patent the device, which is undergoing testing.



### Health

**TUMOR TISSUE.** To aid researchers in the fight against cancer, the **University of Connecticut Health Center** plans to establish a 'tumor bank,' which will store a sample of every cancer tumor removed at the Center's hospital. After hospital pathologists have studied the tumor to determine the best way to treat it, excess tissue will be saved. It will be cataloged by its type and stage, flash-frozen to -188° C., and stored in a freezer tank cooled by liquid nitrogen, where it can be retrieved by researchers looking for a particular type of cancer. Researchers can use the tissue to determine the tumor's genetic characteristics; they can also use it to test potential treatments.

**STAY STRONG.** Elderly people may be able to stay independent longer if they participate in strength training and balance exercises, according to a **Yale** study. The researchers followed a group of 188 people who were 75 or older, providing half of them with physical

# IN BRIEF

## Science and Engineering Notes from Around Connecticut



### High Technology

therapy and the other half with educational materials. The subjects were scored on their ability to perform tasks essential to independent living, like walking, bathing, dressing, and eating. "We found that the physical therapy intervention was effective in preventing functional decline, while the control group showed a steady decline over the year," says Yale professor **Thomas M. Gill**, the study's principal investigator. The elderly who received physical therapy were less likely to spend time in nursing homes, and had fewer fall related injuries. The exercise program consisted of daily balance exercises lasting 10 to 15 minutes, and muscle training with elastic resistance bands three times a week.

**AT UCONN, A MOUTHFUL.** At the **Dental Prosthetic Lab** at the **University of Connecticut**, technicians make perfectly fitting caps, crowns, bridges, and implants using CAD-CAM (computer aided design-computer aided manufacturing). Using an impression sent by the dentists, the laboratory technicians begin by making individual dies of the teeth. The die is mounted on a computerized rotating platform, and traced by a highly accurate stylus. A computer digitizes the tracing and converts it into a 3-dimensional model, which is used as the basis for the new prosthetic which is manufactured elsewhere. "Ten years ago, if someone told me CAD-CAM would be this accurate, I would have doubted it," says **Gary Karlsrud**, director of the laboratory.

**CRITICAL PROTEINS.** A new technology to diagnose and treat cancer has been developed by researchers at the **Yale School of Medicine**. The scientists use microarrays to determine the kinds and amounts of proteins that are expressed at particular points in a cell. "This is a breakthrough for new bio-specific drug discovery since it allows the measurement of proteins that will determine if the patient is likely to respond to therapy," says lead researcher and pathology professor **David L. Rimm**. Currently, pathologists diagnose cancer by looking at cell morphology. Checking the proteins associated with that cancer could allow greater precision, both in identifying the cancer, and in predicting the course of the disease.

**HEART ATTACK.** A drug commonly used to treat heart failure seems to increase the risk of death in women, according to research done at the **Yale School of Medicine**. While the medication, digoxin, did not affect mortality in men, it increased the risk of death in women by 23%. "These data suggest that digoxin acts differently in men and in women," said **Harlan Krumholz**, director of the **Yale-New Haven Hospital Center for Outcomes Research and Evaluation**, and the study's senior author. Digoxin, also sold as Lanoxin, is one of the commonly prescribed medications in the country. However, for patients suffering only from heart failure, the drug's only benefit is a small reduction in hospitalizations. "Women with heart failure who are taking digoxin should talk with their physicians about whether they should continue with this drug," said Krumholz.

**HEALING TOUCH.** A \$1.8 million grant from the National Institutes of Health will be used to establish an **Exploratory Center for Frontier Medicine** at the **University of Connecticut Health Center**. "Our studies will focus on energy medicine—therapeutic touch, healing touch, and reiki," says **Karen Prestwood**, a professor at the **UConn Center for Aging** and principal investigator for the new Center. She plans to apply rigorous scientific standards to these studies, which will look at the effects of therapeutic touch on bone metabolism, bone formation, and on the healing of wounds.

**WORKOUT.** The computer-controlled exercise bike that helped quadriplegic actor Christopher Reeve regain some function in his paralyzed limbs is now available to some Connecticut patients. The bikes, donated by the **Connecticut Chapter of the National Spinal Cord Injury Association**, help those unable to move on their own to maintain good physical condition by moving their body for them. The stationary bikes, or Functional Electrical Stimulation machines, use electrodes to stimulate the patient's nerves. This activates the leg muscles, causing the patient's legs to move, and providing vigorous aerobic exercise. The bikes, which cost at least \$15,000, have been donated to the **Valley-Shore YMCA** in Westbrook, the **University of Connecticut** in Storrs, the **New Horizons Center** in Farmington, and the **West Haven Community Resources Center**.

**WITHOUT BIOPSIES.** A device that combines ultrasound and near-infrared optical capabilities could help diagnose whether a breast lump is a harmless cyst or a malignant tumor. The sensitive, hand-held imager, developed and patented by **University of Connecticut** physicist **Quing Zhu**, contains an infrared light component that is able to distinguish between benign and cancerous solid lumps, and an ultrasound component, which emits high-frequency sound waves that bounce off tissue, and can pinpoint the tumor's precise location. The imager, which could help eliminate some biopsies, shows promise in detecting small cancers, which are often the more aggressive types. The imager could also be used to monitor the progress of cancer therapy, by checking whether or not a cancer is shrinking in response to treatment. The device, which is still undergoing clinical trials, is being developed with the help of a four-year \$800,000 grant from the National Institutes of Health.

**QUANTUM LEAP.** With a \$1.2 million grant from the W.M. Keck Foundation, **Yale** researchers hope to find out whether it's possible to build a quantum computer. This device, unlike a conventional computer, would have 'bits' able to be both on and off at the same time. Studies suggest that a quantum computer would be far more powerful than the ones in use today. "The question we will address in this project is whether or not quantum information can be stored and processed in solid-state and molecular systems," said Yale physics professor **Robert Schoelkopf**, one of the project's principal investigators. The grant, which establishes the **W.M.Keck Foundation Center for Quantum Information Physics** at Yale, will help fund the purchase of a field-emission scanning electron microscope system, as well as other equipment. The project's total budget is more than \$4.8 million.

**PATIENT CARE.** To coordinate its 37 operating rooms and up to 100 surgeries a day, **Yale-New Haven Hospital** has installed a computerized management system called NaviCare. Replacing a cumbersome paper-based tracking system, it allows hospital staff to easily keep track of, and adjust to, the constantly changing flow of activity. Work stations let hospital staff update information, while display boards show information like the start time of each surgery, the stage of the operation, and estimated time of completion. The system allows hospital staff to more easily manage the constant scheduling changes, so that, for example, if an operation runs longer than expected, a simple keystroke can identify idle operating rooms that can be tapped for the procedures that have been displaced.

# IN BRIEF

## Science and Engineering Notes from Around Connecticut

**JUST THE GOOD ONES.** A new technology that can screen potential drugs for toxicity even before the compounds are tested in mammals has been developed by scientists at New Haven-based **Curagen**, and **Bayer Corp.**, with offices in West Haven. Toxicity, especially liver toxicity, is one of the primary reasons that drug compounds fail in development, so the ability to predict toxicity so early should help to make the drug development process more efficient and less costly. Bayer plans to use the Predictive Toxicogenomics Screen to evaluate a variety of compounds under development, said Curagen officials; the process is expected to be licensed to other pharmaceutical companies.



### Industry & Business

**MONEY FOR BIOTECHS.** Biotech startups will have a new advantage in Connecticut, thanks to the advent of the state's new **Bioscience Machinery and Equipment Financing Program**. The program, part of the Office of BioScience in the Department of Economic and Community Development, is designed to make it easier for the companies to obtain the financing they need for capital investment. It will provide banks with a 30% loan guarantee for small biotech. The state plans to make \$11 million available over the next two years, and this program will be marketed to companies in other states as a way of drawing them to Connecticut.

**LOCATION, LOCATION, LOCATION.** **University of Connecticut** population geographer **Alex Vias** has found that micropolitan areas, also known as emerging metropolitan areas, have been among the fastest growing regions in the country over the past 30 years. Micropolitan regions are defined as county-level units with a population of more than 40,000 and a central city with a population of over 15,000. There are 219 of these regions scattered around the country, and they are of special interest because they reflect the changes occurring in the country as a whole. By studying population and employment data, Vias and his colleagues found that since 1970, the number of micropolitan regions with mining centers dropped from 14 to five, while the number of regions with agricultural centers dropped from 20 to five. The number of those with manufacturing, service, and trade centers remained fairly constant.

**CNS RESEARCH.** **Pfizer Inc.**, with a research facility in Groton, plans to invest \$5 billion over the next five years to develop new medications to treat neurological and psychiatric disorders. This means that Pfizer will dedicate, in total, about \$2 billion a year to studying central nervous system (CNS) disorders. Approximately 1.5 billion people worldwide suffer from a medical or neurological disorder, according to Pfizer, with many going underdiagnosed or untreated. It takes about twelve years and an average of \$800 million to bring a drug from the initial discovery phase to market, said **Stephen Lederer**, director of media relations for research and development. The company spends about \$5.3 billion on research annually.

**NO HANDS.** A plastics manufacturing plant in Vernon runs by itself every night—and that's the wave of the future. At the plant, owned by **ABA-PGT**, fourteen injection-molding machines work without human supervision, producing the gears used in lawn sprinklers and computer printers, and then depositing the parts in boxes on conveyor belts. Such "lights-out" manufacturing is increasingly popular throughout the country as companies look for ways

to compete with low-cost overseas operations, like those in China. This new technique is made possible by improvements in robotics, which allow the machines to make reliably consistent parts on their own, and by computer technologies that link plant equipment to the Internet, so that a single supervisor can oversee operations at many plants, at any time and from any place.



### Transportation

**CLEANING THE AIR.** Connecticut has joined other states in a suit to force the US Environmental Protection Agency to promulgate stalled 2001 diesel truck and bus exhaust standards. These standards could reduce diesel emission by 90%, preventing about 8,300 deaths a year. In Connecticut, residents face a 1 in 1,736 risk of cancer from diesel exhaust — a risk that is 576 times higher than the federal benchmark of 1 in 1 million. Construction equipment produces 57% of the state's diesel pollution, with the rest coming from cars and buses.

**AIRPORT SECURITY.** A state-of-the-art digital fingerprint scanner is helping to enhance security at **Bradley International Airport**. As part of a post-9/11 effort to thwart terrorist infiltration, the \$35,000 machine has recorded the fingerprints of all of the more than 4,000 airport and airline employees with access to secure areas. The scanning device, known as the ID 1000 Live Scan System, provides a detailed, magnified picture of a finger's unique markings, providing a resolution of up to 1,000 dots per square inch. The machine generates a format that can be scanned by the FBI. About 80 of the devices have been sold to 65 US airports during the past year.

**CHOO-CHOO.** After nearly two years of work, archivists at the **University of Connecticut** have created an extensive online collection of material documenting the **New Haven Railroad**. This digitized collection includes nearly 500 photographs of steam and electric locomotives. The site also includes a catalog of material in the collection that has not been posted online. In addition to photos, the collection includes administrative and payroll files, maps, and blueprints. Putting the collection online makes it one of the country's most accessible railroad collections. Users can reach the site at <http://railroads.uconn.edu>.

**FLYING HIGH.** When engineers design a new plane, they figure out how much stress it can handle by building a full-scale model and then breaking off one of the wings. With a \$715,000 grant from the National Science Foundation, **University of Connecticut (UConn)** professor **Thomas Peters** hopes to find a way to eliminate that final, very expensive step. Peters, a computer scientist and engineer, studies geometric intersections: for example, the joint where a wing connects to a fuselage. Right now, he explains, wing-breaking is necessary because engineers generate designs using computer algorithms that cannot accurately predict the "complex surface interactions" found in modern planes. Peters hopes to develop a more efficient way to design the algorithms. He will head a team of researchers from UConn, Purdue, MIT and Boeing; their success could save the aerospace and automotive industries more than a billion dollars a year.

— Compiled and edited by Karen Miller

## News from the National Academies (continued from page 1)

### ◆ The Promise of Nanotechnology

Nanotechnology is the science of manipulating matter at the atomic, molecular, and macromolecular levels — a scale of less than 1/100,000th the width of a human hair. Operating at these most basic levels, scientists are able to create materials, devices, and systems with fundamentally new properties and functions. Industry and academia hope to use nanotechnology to design products that are faster, cheaper, lighter, and stronger.

Science and engineering on this scale will have a dramatic impact on fields such as computing, telecommunications, and medicine. For nanotechnology to fulfill its promise, however, the government-funded National Nanotechnology Initiative — which has received almost \$1 billion in funding since 2001 — must increase its support of long-term research and promote more interdisciplinary efforts, according to a new report from the National Research Council. Investment in the development of tools that allow scientists to view, model, and manipulate nanoscale objects must continue, and a “new breed of scientist” must emerge — one who is well-grounded in a specific discipline but able to work across multiple fields. Nanotechnology centers in the United States currently encourage collaboration, but creation of a more widespread interdisciplinary culture is crucial to stimulating growth in the field.

Federal leaders of the initiative need to develop a broad strategic plan that outlines goals and objectives. In addition, an independent advisory board composed of leaders from industry and academia should be established, the report recommends.

[See <http://www.nap.edu/books/0309084547/html/>]

### ◆ Too Much Oil in the Sea

Although double-hulled tankers and tougher international standards have led to a significant drop in the amount of oil spilled by ships since 1989, some 29 million gallons of oil still winds up in North American ocean waters each year as a result of human activity, according to a new report from the National Research Council. Most of this oil can be attributed to land-based runoff, polluted rivers, jet skis, and airplanes that jettison fuel over the water, with only about 10% coming from tanker and pipeline spills, or the oil-drilling process.

Oil runoff from cars and trucks is a particular problem in coastal regions where more roads and parking lots are being built to accommodate dramatic population growth. Oil that is in wastewater or that has been improperly disposed of also finds its way to the ocean. Two-stroke engines manufactured before 1998 discharge significant amounts of unburned fuel and can still be found on many recreational boats and jet skis; bigger ships may release oil from their engines while in port or at sea.

Scientists studying the aftermath of the Exxon Valdez spill discovered that the environmental devastation caused by an oil spill of that magnitude lasts much longer than previously thought, and that even a small spill in an ecologically sensitive area can have long-term effects. There is growing evidence that toxic compounds found in oil can adversely affect marine species even at very low concentrations.

While scientists now better understand the damage caused by an acute oil spill, less is known about how the ocean ecosystem is affected by chronic releases from land-based sources or boat engines. To learn more, the report recommends that the federal

government launch a major research effort. The report also urges federal and state agencies to collaborate on a new system for documenting sources of runoff, and recommends that the US Environmental Protection Agency continue efforts to phase out older two-stroke engines.

[See <http://www.nap.edu/books/0309084385/html/>]

### ◆ Meeting the ‘Call to Duty’

The National Academies have met “the call to duty” posed by the September 11 attacks in a variety of ways, including convening groups of experts to identify and examine technical approaches to countering or mitigating the most dangerous threats facing the United States. More than 100 scientists, engineers, physicians, and national-security specialists were enlisted in the task, which resulted in a 440-page report entitled *Making the Nation Safer: The Role of Science and Technology in Countering Terrorism*.

Although the report is the centerpiece of the Academies’ counterterrorism activities, they have undertaken other studies and held workshops to seek ways to make the nation safer. A new Academies web site at [www.nap.edu/firstresponders](http://www.nap.edu/firstresponders) provides firefighters, EMTs, and other rescue personnel with links to credible information resources on chemical and biological terrorism. The Transportation Research Board and the National Materials Advisory Board have been advising the new Transportation Security Administration on explosives-detection technologies. Yet another study focused on how well the Internet performed on Sept. 11. Last fall the Academies released *Countering Agricultural Bioterrorism*. The study, which was initiated before Sept. 11, warns that the country remains vulnerable to a bioterrorism attack on its crops and livestock and needs a more comprehensive plan to defend against it.

[See <http://www.nap.edu/terror/>]

### ◆ Easing Rules on Big Rigs

The federal government should authorize states to permit trucks that exceed present federal size limits to operate on interstate highways, provided that impacts on safety and road-maintenance costs are monitored, according to a new report from the Transportation Research Board.

The standard tractor-trailer has five axles, and the current federal limit is 80,000 pounds. The report recommends that states be allowed to issue permits for the operation of six-axle tractor-trailers weighing up to 90,000 pounds.

Noting that objective data collection and analysis is critical, the study committee recommends that Congress charter a new organization to oversee implementation of federal truck-size regulations and evaluate their results, carry out pilot studies and research to determine the impact of trucks on highways, and recommend new rules based on its findings. The proposed studies could provide industry and states with incentives to develop safety innovations.

Promising technologies, such as electronic braking systems, could improve truck safety but more research and monitoring is needed, the report says. The proposed pilot studies and permit program could provide incentives for industry and states to develop safety innovations.

[See <http://www.nap.edu/books/030907701X/html/>]

## Fuel Cells (continued from page 2)

other states, including Michigan, Ohio, California, and Texas, are actively engaged in developing fuel-cell-based industries which could pose “significant challenges” to Connecticut’s existing lead in the field of stationary power applications as well as its efforts to enter the market for transportation applications (automobiles and buses).

The study identifies a wide range of uses, or applications, for fuel cells — from commercial building heat and power to military applications to small electronic devices — and time frames for achieving market penetration that range, depending upon the application, from one to seven years.

“Large capacity stationary power” — defined as a system with an output power capability exceeding 100kW — is likely to be the “first significant commercial market,” according to the Academy report. This market should see immediate growth (in 2003-2004) due to significant price level breakthroughs which were recently announced. This market includes Stationary Reliable Power (applications in which reliability is vital, such as rapid response financial systems, on-line commerce, hospitals, etc.); Commercial Building Power (small, commercial buildings or strip malls, where the heat generated by the system often is also used, resulting in a combined usage called “Combined heat and power” or CHP); and Distributed Power (applications that serve several customers or a small substation, usually as part of the overall power grid). Two Connecticut companies, UTC Fuel Cells and Fuel Cell Energy, are nationally competitive in this market, with even greater

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An expanded version of this article is available online at [www.ctcase.org/bulletin/fuelcells.html](http://www.ctcase.org/bulletin/fuelcells.html)

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market penetration anticipated as production volume increases and prices drop.

Transportation markets, which include transit buses, other fleet-type commercial vehicles, and automobiles, will be more difficult to penetrate, according to the study, because of the relatively low cost of existing piston-engine power plants. Although the potential market is large, costs must be reduced sufficiently to make fuel cells an economically competitive alternative.

Very low power (~1-5 kW) fuel cells for electronic applications offer a promising market, and one which no Connecticut company is currently targeting, according to the study.

Finally, the use of fuel-cell-like devices to make pressurized hydrogen gas is expected to be a small but growing “niche” market, competing with the pressurized bottled gas industry.

The study concludes that, while there are still major obstacles to large-scale fuel cell commercialization, including cost and reliability issues, there are also many opportunities for “rewarding investments” aimed at lowering the manufacturing costs, improving long-term reliability, and increasing market penetration. — **Martha Sherman, Connecticut Academy of Science and Engineering**

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