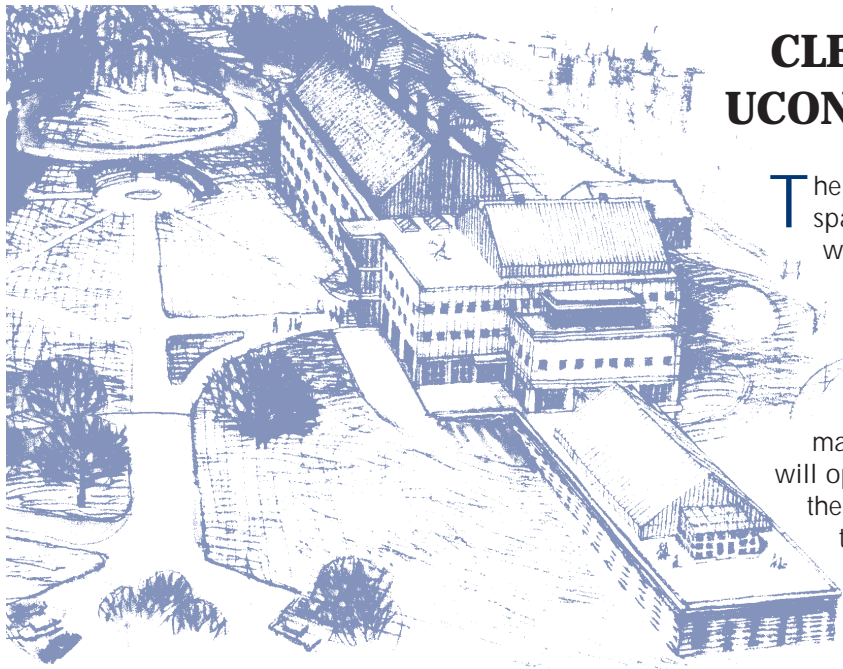

HIGHLIGHTS OF SCIENCE AND TECHNOLOGY IN CONNECTICUT

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CLEAR SAILING AHEAD FOR UCONN'S AVERY POINT CAMPUS

The view of Long Island Sound is stunning. The sun sparkles off the water, and light floods the room, which is entirely fronted by floor-to-ceiling windows. Outside, a deck skirts the meeting area. It's like the view from a ship's bridge, but it's the executive conference room on the third floor of the Avery Point Marine Sciences building, and this is only one (albeit the grandest) of many startling views from the new building, which will open this winter. This new flagship facility is part of the general renaissance of the Avery Point campus of the University of Connecticut (UConn).

The Avery Point campus is the site of intensive, high-quality marine research. The principal aca-

An artist's rendition of UConn's new Avery Point campus. (Graphic: MSTC/UConn)

(see *Avery Point*, page 10)

The Science of Environmental Pollution: A Multi-Disciplinary Approach

If you're an animal, you can throw your garbage anywhere you like. Shell from a nut, half-eaten carcass, outgrown carapace—just drop it, and go. It's fine. That's because in nature's tight-linked system, the leavings of one organism quickly become the raw material on which another organism thrives.

CASE member Dr. Thomas Graedel, Director of Yale's Center for Industrial Ecology and a pioneer in the field of industrial ecology (IE), believes that the industrial world created over the last

(see *Environmental*, page 2)

Editor's Preface

Our environment—the world around us—includes our physical environment (earth, water, atmosphere), our biological environment (plants, animals, microbes), and our fellow human beings. Environmental studies thus encompass a variety of disciplines, from geology and oceanography to ecology and sociology. In each case, such studies must deal with many different aspects, from understanding how the environment has evolved and how it functions, to the direct and indirect ways in which we interact with it.

Given the above definition, hundreds of scientists at the major institutions in Connecticut are engaged in environmental studies from the standpoint of every conceivable discipline: far too many to be dealt with in this two-part series. We will therefore select, as an example, just one aspect of environmental science and engineering: namely, the study of those human activities which adversely affect the environment, and the attempts being made to prevent or remediate them. Specifically, we will focus on the pollution of the environment, and show how this problem is being approached from a variety of perspectives, including biology, chemistry, engineering, economics, and law.

The first of this series, which follows, reports on environmental science and engineering at Yale. The second of this series will report on environmental science and engineering at the University of Connecticut at Storrs.

FROM THE ACADEMY

Connecticut's High-Tech Workforce Pipeline

On October 17, 2000, the Academy presented an invited paper entitled "Connecticut's High-Tech Workforce Pipeline" at the Connecticut Summit on Science, Engineering and Information Technology Workforce held at Central Connecticut State University (CCSU). A full version of the paper is available at the CT Academy's web site: www.ctcase.org.

As a member of a five-person panel representing industry, government and academia, Mike Werle, executive director of the Academy, made the presentation on behalf of his two Academy co-authors, John Cagnetta and Tom Malone. The presentation addressed the fact that the demand for high-tech employees by Connecticut's high-tech industries significantly exceeds the available domestic supply. It posed and addressed three questions:

Is the issue real or possibly an aberration that will pass soon?
How did it come about?
Can we and should we do anything about it?

Concluding that the problem is indeed a real one that shows little sign of abating due to several international and national events impacting Connecticut's economic underpinnings, the presentation focused on the educational system pipeline for bringing new talent to the state's high-tech industries. Evidence was presented that 1) the inflow to the pipeline is relatively low; 2) there seems to be a break in the pipeline at the critical early high school level; and 3) there is little state institutional attention being given this issue. A variety of recommended solutions were presented. The Academy's overall position is that the state has before it the opportunity to cause a meaningful increase in

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The purpose of the Academy is to "provide guidance to the people and the government of the State of Connecticut, upon request, in the application of science and engineering to the economic and social welfare."

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Environmental (from page 1)

century must look to that model. Cars, flashlights, washing machines—they must be viewed not as individual pieces, but as an interconnected system, as flows of material that interact with, and affect, each other.

The concept of industrial ecology implies more. It holds that the industrial ecosystem and the biological ecosystem are inextricably intertwined, and that industry must be viewed through its place in the natural world.

This idea, different and important enough that some label it a paradigm shift, is, says Graedel, becoming increasingly common. It's more than just a phrase; businesses, for example, are using it. "Electronics is very active in this, the auto industry, the pharmaceutical industry." Connecticut companies, Graedel says, are among the leaders: Pratt and Whitney, Pfizer, United Technologies and General Electric all follow IE approaches.

But what, exactly, does that mean?

At a fundamental level, IE is a way of thinking. "It helps you realize," says Graedel, "that some of the boundaries we take for granted should not be regarded quite so much as boundaries." Increasingly, he says, "we're finding people that think through the whole life cycle, and say, 'well, if I buy copper, that implies I've asked somebody to dig it out of the ground, I've asked somebody to go through the smelting and refining step, and, eventually, I'm asking someone to recycle this.'" These people, he says, become concerned with optimizing the entire cycle, rather than just their own piece of it.

But IE is more than a way of looking at the world. It's a set of tools to help achieve sustainability. These tools could be as thorough as "life cycle assessment," tracking the effects of a product from inception through dis-

posal, or as simple as a list of guidelines, that explain, for example, that when you design a machine, you should use standard fasteners, so that if the machine breaks, it's easier to take it apart and repair it than to throw it away. IE is a cluster of factories designed to use each other's wastes. It's a project to track all the copper used in the last century, so that if people choose to recycle it, they'll know where it is.

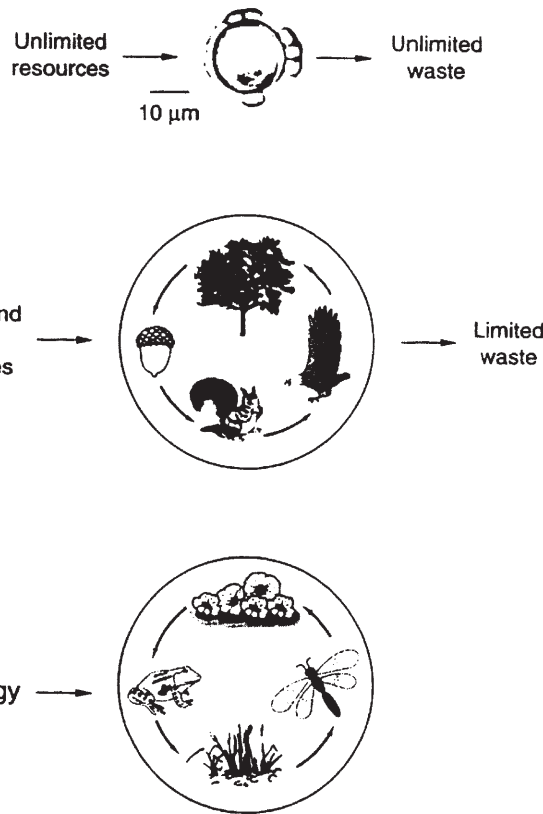
This kind of thinking represents a major shift: in the current environment, technological and industrial flows are often handled as if they are part of a linear system, in which a resource is used once, and then leaves the process forever. The goal of IE is to change that, to help industry evolve toward a more mature, sustainable system, in which all it uses is contained within it, and is recycled, over and over again.

**Dr. William Smith:
How Much Does It Hurt?**

If Graedel's work provides a plan for the future, Dr. William H. Smith, Yale Professor of Forest Biology, looks at damage that may already have been done.

For the past 35 years, Smith has tracked the effects of air pollution on forests, focusing on the Hubbard Brook Experimental Forest, in New Hampshire's White Mountains. It's a significant area, explains Smith, because air mass movements across the United States tend to converge over northern New England.

Smith and his colleagues have followed an array of air pollutants: heavy metals, ozone, and acid depositions. They monitor precipitation. "In the summer, you place a funnel out, and you collect the rain. In the winter, we place a plastic barrel out



Industrial ecology represents a major shift in thinking, from a linear model (top) in which a resource is used once, then leaves the process entirely, to a cyclic model (bottom) in which everything is contained within the system and is recycled over and over again.

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and collect the snow." The project, he says, provides the longest continuous record of precipitation chemistry in the United States and, in the 1960s, did much to alert the country about the prevalence of acid rain.

"The pH of the rain [at Hubbard Brook] was showing up to be in the low 4's, about 4.1, 4.2. You'd have individual rain events that could be as low as 3.5, 3.5." That's very acidic, he explains—perhaps a hundred times the normal acidity of precipitation.

The relationship between acid deposition and forests is subtle. After sulfur dioxide and nitrogen oxides are released by, say, a power plant or car, rain and dry deposition transfer the acid from the atmosphere into the soil, where it takes the form of negatively charged ions. The nutrients that trees require, like calcium, magnesium, and potassium, carry a

positive charge, and can be combined with the negatively charged ions. So, instead of the calcium being taken up by the tree roots, it combines with sulfate, forming CaSO_4 , a mobile compound that may be quickly leached away. In other words, the acidity harms forests by reducing the nutrients in the soil and diminishing, in the long run, the ability of the soil to support growth. A casual observer might label the trees on such sites as fine. But their growth might be stunted, their health made more fragile.

Long-term monitoring like that at Hubbard Brook allows researchers to catch these problems. Decade-long studies are far from the norm; three to five years is the typical maximum for most federally funded research, says Smith. But, he adds, long-term research can be absolutely necessary, "especially for long-lived ecosystems like forests." Such ecosystems, explains Smith, respond subtly and sluggishly to low level

exposures to heavy metals and acid deposition. If you want to anticipate potential problems, he says, you have to keep monitoring and testing hypotheses.

**Dr. Roger Ely:
Microbes Solve The Problem**

Some problems are more obvious, with more urgent consequences. Take TCE, or trichlorethylene. This manmade compound is a widely used industrial solvent and a suspected carcinogen. It moves through the earth, making water undrinkable. It's ubiquitous: chlorinated solvents like TCE form the most common ground water contaminant at the nation's hazardous waste sites.

TCE has proven a formidable pollutant. Historically, TCE contamination has been handled by pumping the contaminated ground water to the surface, removing the TCE, and

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returning the treated water into the earth. However, this process is expensive, time consuming, and, often, inadequate. Ely, an environmental engineer in Yale's Chemical Engineering Department, has been exploring a more effective tool: bacteria.

Some naturally occurring microbes are able, under some conditions, explains Ely, to break down and detoxify TCE. Working with a graduate student at a government site in Idaho, Ely has developed ways to encourage this behavior. The Idaho land had been used as a disposal site: the operators of the facility had tried to get rid of wastes by injecting them into the earth. "They put spent solvents in there, they put in metal wastes, radioactive wastes, sewage sludge... There was a contaminated plume [of TCE] that was about two miles long and about half a mile wide."

The cleanup had become a huge project: just researching ways to do it cost more than \$4.5 million. The original questions, Ely explains, were: if we don't do anything about this, in a hundred years is it going to migrate off site, and, if we have to do something, what can we do?

"Our part of it was small," he says. "We were just looking at some of the biological aspects." He was, he explains, "just trying to create conditions that were favorable for the bacteria to do what we wanted them to do."

The bacteria he studies need a supply of electrons to do their job. They take electrons from a compound, usually an organic compound, and transfer those electrons to the TCE, detoxifying it by pulling off its chlorine atoms, one by one.

The question was, what kind of electron donor would the bacteria prefer? "We did lab studies to look at different electron donor combinations. We

looked at potential interferences from other electron acceptors." Eventually, they settled on a donor. It was something simple: an ingredient in milk.

"In November of 1998, we started pumping lactate into the ground, and did lots and lots of monitoring... it was tremendously effective." Within a month or two, TCE had dropped to such low levels that, in some cases, none at all could be found.

Bacteria, Ely believes, can do more than just clean up wastes. They are sensitive enough, he thinks, to serve as a bellwether for a variety of problems—for example, to reveal imbalances in wastewater treatment plants. To test this idea, Ely is currently using genetic analysis to pinpoint how bacteria respond to stress. "For example, if they are stressed by exposure to cyanide, or TCE, are they able to recognize those are two different things?"

Ely believes that it's possible that bacteria, with their rapid generation times, may be evolving abilities to deal with the compounds that humans have created. "I think," he says, "that there's a fair amount of impetus for that to happen."

Robert Mendelsohn: 2050 Is The Year That Counts

But once you've identified a problem, and found a solution, a question remains: Is it worth fixing? For environmental issues, the answer is rarely obvious: it's hard to understand the damage a problem may cause. Dr. Robert Mendelsohn, a professor of environmental economics at Yale, conducts impact analysis, which answers this type of question. Right now, his focus is global warming.

The initial climate change impact studies, says Mendelsohn, predicted disaster: houses flooded, farms ruined, ecosystems collapsing. But though such scenarios usefully caught the public attention, they

were not completely accurate. They were based on the assumptions that human behavior would not change: that even as floodwaters rose around them, humans would try to remain in the same spot.

But humans can adapt. And Mendelsohn's models reflect that. Using scenarios that assume that both humans and ecosystems will adjust to change, Mendelsohn's models predict that as long as global warming remains mild—less than 2.5° c.—climate change may not be too much of a problem.

"Change," says Mendelsohn, "is not necessarily bad." Take recreation. While it's true that in a warmer climate, winter sports like skiing would be hurt, swimming, boating, hiking, camping would all increase. Since most outdoor activity occurs in warm weather, the recreation industry as a whole would thrive.

In fact, if Mendelsohn's models are correct, mild warming will probably benefit the United States as a whole. In particular, a warmer climate and the fact that CO₂ acts as a fertilizer, means that "the gains we're going to get in agriculture and forestry are going to be larger than the damages that we will suffer in the other market sectors—from sea level rise, in energy, and in water."

But there are two caveats. First, if the temperature rises more than 2.5° c., benefits disappear. Second, even a mild global warming helps only the colder, northern regions. "As you go towards the low latitude countries, these countries are going to be hurt." It's the third world countries, the least developed countries, that will be damaged by global warming, which, explains Mendelsohn, makes for an uncomfortable paradox. "If you look at it from a global perspective, what you see is that the OECD [the Organization of Economic Cooperation and Development]

(see Environmental, page 9)



Communication

BETTER WEBSITE. An effort to develop a national prototype for a state website is being headed by the **University of Connecticut (UConn)**, according to UConn economist **Fred V. Carstensen**, a co-organizer of the recently held second annual state data conference. Carstensen feels that such a website is sorely needed in Connecticut. Right now, he says, data about the state are scattered among so many agencies that the information is nearly impossible to find. But a state data center could correct that problem. Making information more easily available to the public "translates into vastly improved discussions about public policy" said Carstensen.

FIBER OPTICS EXPANDS. Fiber optic lines may soon cover the state, with more than a dozen companies now vying to lay the lines. "There are places where there are two or three companies working on the same road," said one company spokeswoman. Fiber optic lines allow for broadband transmission, carrying computer data, voice, and video. They can transmit information at a rate of a trillion bits of data per second—a rate about 200 times faster than what is available now.

OF MICE AND MEN. Researchers have long believed that humans communicate through pheromones, and, finally, they have found physical evidence that this may be so. Researchers at **Yale** and Rockefeller University have, for the first time, isolated a gene that can potentially be linked to pheromones. The gene, **V1RL1**, is believed to encode for a pheromone receptor in the mucous lining of the nose. However, it is not yet known whether the gene is active in humans, or to which behavior it might be linked. In many mammals, behavior is heavily regulated by pheromones; mice, for example, have more than 100 functioning genes in the **V1R** family. However, in humans, **V1RL1** may be the sole remaining functional gene in that group.

EASY LISTENING. With a palm-size radio device that clips onto the side of a breathing mask, firefighters will be able to talk to each other in the midst of fires without yelling through the muffling effects of the mask. Developed by Connecticut fireman **John Bieback**, **TeamTalk** is activated by pressing a single large button on its side; it allows for wireless, hands-free communication. The device is not expected to hit the market until later this year, but fire departments around the nation, many of whom tested prototypes of the device, are already interested in buying it.



Education & Cognition

WATER, WATER EVERYWHERE. As part of an after-school program, a group of 9-year-old to 11-year-old **New Haven** girls will have the opportunity to learn about water—especially New Haven water. The youngsters will collect local samples to examine under a microscope to determine whether the water is safe to drink. They'll look at the behaviors of different kinds of filters, such as sand, clay, and activated carbon, and explore the effects that hard and soft water have on soap. Designed and run by **Yale** environmental engineering professor **Roger Ely** and Yale student **Regina Sieber**, the lessons are intended to help the kids become more aware of environmental issues, to give them an opportunity for hands-on learning, and to stimulate reflective thought. The classes are part of the New Haven's **LEAP** program, which offers learning opportunities to kids from high-poverty urban backgrounds.

PLAYING AROUND. Teaching low-income parents to play make-believe with their preschoolers can help the youngsters succeed

academically, according to a study by **Dorothy** and **Jerome Singer**, directors of the **Yale Family Television Research and Consultation Center**. "After training parents and caregivers for just two weeks, the children showed measurable gains in key school-readiness skills ranging from enhanced vocabulary and language usage to counting, fine motor control and social/emotional growth," said Jerome Singer. Play, he explains, helps children reduce the world to understandable dimensions, manipulate it, and begin to understand how it works. "The activities that are the easiest, cheapest, and most fun to do, such as singing, playing games, reading, story-telling, and just talking and listening, are also the best for child development," he notes.

OCEAN VIEW. Started nearly 30 year ago as a way to bring kids and the ocean together, **Project Oceanology** moved this fall from its original home in a run-down boathouse to a new state-of-the-art building on the **University of Connecticut's Avery Point Campus**. The program's new home includes seven laboratories for studying marine biology, geology, chemistry, seawater, and plankton, and a 56-bed hostel that will enable visiting school groups to stay overnight. The new facility will allow for other programs, too, according to director and founder **Howard Weiss**. He looks forward to adding workshops aimed at teachers and retirees, and possibly a summer camp. Project Oceanology is owned and operated by a non-profit association of 25 institutions throughout Connecticut, Massachusetts, Rhode Island, and New York.

URBAN HABITAT. Thirteen incoming **Trinity College** freshmen spent a month last summer researching, designing, and building an urban wildlife habitat on the grounds of a Hartford restaurant. As part of the **Challenge Program**, an intensive summer college-orientation program, the students dug up concrete slabs, shoveled and raked 60 cubic yards of compost and mulch, installed a 2,500-piece brick sidewalk and underground irrigation system, and planted nearly 100 types of trees, bushes and flowers. The habitat, which is designed to attract birds and butterflies, is supported by a grant from Trinity's 1634 Fund, which aids college-community programs that better the lives of children living near campus.

LEARNING THE SYMPTOMS. The symptoms of Attention Deficit Disorder (ADD) include more than just hyperactivity, according to **Thomas E. Brown**, associate director of the **Yale Clinic for Attention and Related Disorders**. Brown cites issues such as: difficulty getting started on projects; difficulty staying focused on some, but not all, activities; problems staying alert; problems caused by letting emotions get in the way; and problems with short-term memory. Brown, who devised the **Brown ADD Scales** to discern and rate these symptoms, suspects that ADD results from an abnormality in the executive functions of the brain, which integrate and manage brain activity. "In ADD, the 'musicians' are OK," he said. "The problem is the 'conductor.'"

TREATING ADHD. Neurofeedback, a form of biofeedback that has been successfully used to treat patients with epilepsy and traumatic brain injury, may also be valuable in treating attention deficit/hyperactivity disorder (ADHD). Offered at **Connecticut Educational Services**, a Middletown clinic, the treatment is not fully accepted because it has never been tested in a standard double-blind study. However, experts say that the idea behind it is a

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valid one. Neurofeedback attempts to help children improve their concentration by training them to better use the brain waves that control attention. The youngsters are hooked up to sensors that track brain waves from the frontal lobe, the part of the brain that controls attention. "We believe that ADHD, learning disabilities, behavior disorders, all these disorders have a neurological basis," says clinic director **Robert F. Reynolds**.



Energy

SOME LIKE IT HOT. Through an innovative system of "smart" thermostats, **Connecticut Light and Power (CL&P)** hopes to reduce electricity use during peak use hours. The technology, which was tested this summer in homes in the Farmington and Stamford areas, allows CL&P to control thermostats in individual homes via the Internet. The utility can use the system to adjust temperature settings in order to lower electricity use if demand becomes overwhelming. The goal is to help utilities avoid system overload. The system does allow homeowners to override CL&P's temperature settings, using either the thermostat or the Internet.

MICROTURBINES. With a grant of more \$8.6 million from the federal Department of Energy, researchers at **United Technologies Corp. (UTC)** are at work on the development of environmentally friendly microturbines. These small gas engines are used by electric companies to produce power, and to perform other functions involved in generating electricity. The improved version is expected to increase power production while reducing pollution and boosting energy efficiency. The work will be performed at the company's East Hartford research center; UTC is one of six companies involved in the \$40 million federal initiative to develop the machines.

CONSERVING ENERGY. Connecticut residents use energy far more efficiently than the average American, according to economist **Steven P. Lanza**, whose work was recently published in *The Connecticut Economy*. Lanza found that during the 1990s, state energy prices for oil, gas, and electricity exceeded the US average by 41%. However, in 1997, Connecticut residents paid only 4.7% above the national average. State residents spent \$2,218 per person on energy, \$99 over the national average of \$2,119. The state, says Lanza, is about 30% more efficient in its energy use than the rest of the country, and this trend toward improving energy efficiency is continuing. He found that while nationwide, energy efficiency rose by about 4.4% a year between 1981 and 1997, in the state it grew by 5.3% a year during the same period.

GO WITH THE FLOW. The **Connecticut Department of Environmental Protection** approved water quality certification for five hydroelectric plants on the **Housatonic River**; the certification requires that the facilities modify their procedures in ways that will improve the river's ecological health. The plants, run by the **Northeast Generation Company**, must restore natural flow to 27 miles of river habitat by shifting from a "pond-and-release" operation to one that uses run-of-river flow. The certification also requires that fish be given access to stretches of the river from which they've been excluded for nearly a century, and that a dissolved oxygen problem caused by releases from the **Shepaug Dam** be corrected.



Environment

FROG HEAVEN. This year's rainy, cool summer, which disappointed so many humans, has proved a reproductive bonanza to frogs, according to **Yale** scientist **David K. Skelly**. The wet season

ensured an abundance of the vernal pools in which amphibians breed, making it easier for the creatures to grow from egg to tadpole to young frog. Skelly, who does research at the **Yale-Myers Forest** in **Ashford, Eastford, Union, and Woodstock**, studies 16 vernal pools. In an average year, wood frogs emerge from only one, two, or three of the pools. "This year, we batted a thousand," said Skelly. This kind of boom or bust reproductive pattern is typical of amphibians, he explains. However, he adds, habitat loss—the greatest problem for amphibians—remains a critical issue, and one bountiful year will not reverse amphibian decline over time.

FAULT LINE. A long dormant fault in northwestern Connecticut may have been reactivated last June, when the strongest earthquake to hit the area in 25 years occurred. The 3.3 magnitude quake, with an epicenter about 12 miles north of **Granby**, lasted about five minutes. New England averages about six quakes a year, but it's rare to find quakes centered near western Connecticut, according to **John Ebel**, director of New England's quake-monitoring center. The fault lines in that area are at least 200 million years old, and it may be that the June quake marked a reactivation of a fault. There is, said Ebel, a strong possibility that a larger quake could hit in the future. However, he noted, that follow-up quake could occur anytime from tomorrow to 3,000 years from now.

ANTHRAX DRUG. The United States could be better protected against biological attacks, with a Food and Drug Administration (FDA) recommendation to approve a treatment for people who have inhaled spores of anthrax. Made by **Bayer Corp.**, of West Haven, the drug—ciprofloxacin—has been available commercially for about 13 years under the name of Cipro. Approved for a variety of infections, it's used by about 250 million patients around the world. But it is the first drug formally approved to prevent anthrax, which is considered a likely biological weapon because it is deadly and easily distributed over wide areas. The FDA recommendation is part of a federal effort to prepare the nation for biological attack; the Centers for Disease Prevention and Control (CDC) is prepared to stockpile the drug once the FDA recommendation is approved.

MERCURIAL MEASURES. One of the first states to place limits on the mercury content of batteries, Connecticut is now committed to reducing mercury emissions 50% by 2003. The metal, which environmental experts consider worse than lead, attacks the central nervous system, damaging vision, producing mental symptoms, and, in some cases, causing death. It's released into the environment when oil and coal are burned, and when mercury-containing debris like batteries and thermometers are incinerated at municipal waste sites; about 12,000 pounds of mercury is deposited in the Northeast annually. The proposed legislation would ban mercury from schools, require labels on mercury-containing products, eliminate mercury from the waste stream, and require proper disposal.



Food & Agriculture

RESIDUAL EFFECTS. The insecticide chlordane, which was banned in the United States in 1988, lingers in the ground, and can be absorbed by vegetables long after its use has ceased, according to researchers at **The Connecticut Agricultural Experiment Station** in New Haven. The scientists grew vegetables on land that had been treated with the pesticide in 1960. They found chlordane in root crops like carrots, beets, and potatoes, and in the edible parts of vegetables like spinach, lettuce, and zucchini. They did not find the chemical in the edible parts of tomatoes, corn, or peppers. Only small amounts of the chemical were found in the plants, according to the researchers. Chlordane, which accumulates in animal tissue, can lead to nervous and digestive system disorders.

VALUABLE TIMBER. The white oak—*Quercus alba*—grows straight, hard, and clear-grained. It resists water and rot, and in the northwest corner of Connecticut, it's "good and slow-growing and especially free of dead knots," according to specialty logger **Charles Besozzi**, of Collinsville. Besozzi supplies Connecticut white oak to wooden boat builders, and has provided major portions of the sterns, stems, gunwales, planking and decking in numerous restoration projects. Connecticut's remaining stands of prime hardwoods, including cherry, red and white oak, ash, and sugar maple, are valued throughout the world, and the state's 570 licensed loggers harvest about 70 million board feet of timber a year, adding about \$414 million to the state's economy.

DEER-BORNE DISEASE. Scientists at **The Connecticut Agricultural Experiment Station** confirmed that deer can harbor *Escherichia coli* O157:H7, the same strain of E.coli that can poison people. Microbiologist **Douglas W. Dingman** and his colleagues were able to match the bacteria found in a deer shot in Vermont with that in a Connecticut child who had eaten meat from the animal. This research, which supports a 1997 Oregon study that found E. coli in elk and deer meat, suggests that the bacteria may be widespread in venison, and raises concerns about safe preparation of wild game. The deer in the Connecticut case had been stored for two days without refrigeration or butchering, in temperatures that rose as high as 55° F., ample warmth, according to Dingman, for the bacteria to survive.

DIFFERING PERCEPTIONS. A Yale study has found evidence that one predictor of eating disorders may be a discrepancy between what parents report about their own attitudes toward food, and what children perceive their parents' attitudes to be. The research, conducted by **Christina Baker**, a Yale graduate student at the time of the study, examined parental attitudes and behaviors from the perspective of both parents and children. "A lot of people are concerned about blame [for eating disorders] being placed on parents," said Baker. "This study points out that children's perceptions are more important."



Health

ASPIRIN AND ALZHEIMER'S. People who regularly take non-steroidal anti-inflammatory drugs (NSAIDs) such as aspirin have been shown to have a 50% lower risk of developing Alzheimer's Disease. Now, the **Yale School of Medicine** is participating in the first large-scale clinical trial to determine whether the reduced risk of Alzheimer's actually results from the drugs, or whether it's merely a coincidence. NSAIDs may halt or slow Alzheimer's by blocking the swelling of the brain that accompanies the disease; they work by interfering with a hormone-like substance that regulates many systems of the body, including inflammation. About 4 million Americans now suffer from Alzheimer's; within the next 25 years, that number is expected to increase to approximately 14 million.

NIT-PICKING. A shampoo developed by Yale pediatrician **Sydney Spiesel** makes it easier to get rid of lice by staining the nits (eggs) with a fluorescent dye that makes them easily visible under ultraviolet lights. Spiesel developed the shampoo after assisting with a lice epidemic at a New Haven day care center. The shampoo, he says, is not a treatment, but a disclosing agent that helps parents find nits and lice so they can be easily and thoroughly removed.

STRONG HEARTS. In some heart transplants, it may be better to attach the new heart to healthy parts of the old heart, rather than tossing out the old heart altogether. The technique, currently being explored by two surgeons at the **Yale School of Medicine**, helps to compensate for the fact that in problem hearts, it's often just the

left side that is severely damaged. The right side, in fact, grows stronger under these conditions, because it's been compensating for problems caused by the weaker side. When a new heart is transplanted into this maladjusted system, its right side tends to fail, because the patient's body has been transformed in a way that requires that side to work extra hard. The solution, according to Yale surgeon **John A. Elefteriades**, is to hook up the new, donor heart to the strong right side of the old heart. This leaves the patient with two right sides, which work together. The method has been successful in dogs, and could be tried on humans within six months, says Elefteriades.

LIVER SOURCE. By examining liver samples from female leukemia patients who had received bone marrow transplants from a male donor, a team of researchers from **Yale** and New York University discovered that mature liver cells in humans are generated from bone-marrow-derived stem cells. "This is an exciting finding, and incredibly surprising because the bone marrow has never been considered a source of liver cells," said **Diane Krause**, a professor at the **Yale School of Medicine** and senior author of the study. Traditionally, bone marrow was considered to produce blood cells, while liver cells were thought to come from the liver. More recently, though, it has been found that bone marrow stem cells can transform themselves into many types of tissue, including brain and muscle tissue. Such stem cells could potentially be used to provide a source for liver transplants, as a pool of cells for the development of an artificial liver, or, through gene therapy, as a way to treat liver or other disorders.



High Technology

READING READINESS. In a rapidly expanding series of trial programs, libraries across the state have begun to offer electronic books to patrons. **Hartford Public Library**, for example, offers a website through which users can download e-books to their home computers. The books can be read either through the Internet, or after being downloaded; either way, encryption software automatically "returns" the book by switching it off. The program is available to the public at www.hartfordpl.lib.ct.us. Other libraries, including those in **Newington** and **Enfield**, have begun to circulate the Rocket ebook, a hand-held electronic reading device. The paperback-sized gadget weighs 22 ounces and is able to store about 10 novels. It is proving immensely popular with readers.

SCREEN TEST. Lasers are the key to a "tough technology" laptop computer screen invented by **Essex** businessman **Douglas Nagan**, which can continue to function even if someone shoots a bullet through it. Rather than relying on today's liquid crystal displays, Nagan's flat-screen system generates images by using laser beams to project light through a clear polymer resin. When a beam strikes the dye contained in the resin, a glowing particle appears on the screen; the beams are controlled by switches. Nagan believes that his rugged screen could be very successful, estimating that the military market alone could exceed \$4 billion by 2005.

ATOMIC STRUCTURE. By using x-ray crystallography, a technique that shows the position of the individual atoms in a molecule, two **Yale** scientists have deciphered the atomic structure of the large subunit of the ribosome, a part of the cell that makes proteins. Understanding the structure of ribosomes could lead to the creation of better antibiotics. Often antibiotics work by inhibiting the ability of the ribosomes in bacteria to make new proteins. Understanding the structure of the ribosome "should enable pharmaceutical companies to devise new inhibitors of ribosome function that can be used to control bacteria diseases," said CASE mem-

IN BRIEF

IN BRIEF

ber and Yale professor **Peter Moore**. Similar methods of "structure-based drug design" have been used to develop AIDS medications.

PERFECT PRESCRIPTIONS. In **West Hartford's Suburban Pharmacy**, prescriptions are just as likely to be filled by a robot as by a person. The "robot pharmacist," which looks like a pair of glass-fronted beige refrigerators, is capable of dispensing any of 200 separate medications. The machine, says drugstore owner **Larry Ratner**, manages more than half the prescriptions that go through the store. It frees the human pharmacists from the time-consuming process of counting out pills into bottles, but, perhaps more important, it's safer. "The only way this machine can make a mistake," says Ratner, "is if you intentionally lie to it about what you're putting in."

A WALK IN THE PARK. With hand-held computers, custom-designed software and digital cameras, seven **Hartford High School** students and graduates conducted a high-tech survey of five city parks over the summer. Through the **CityScan** project, the students documented conditions in the parks, collecting data, analyzing it, and posting it to a web site (www.cpec.org.) The project is intended to provide citizens with information, and to offer city officials a resource for maintaining and improving public spaces. Managed by the **Connecticut Policy and Economic Council (CPEC)**, the CityScan project is considered a national model for citizen-based assessment of performance of municipal governments. It is financed largely by the Alfred P. Sloan Foundation.



Industry

HARTFORD OPPORTUNITY. An alliance of companies and universities hopes to bring together doctors, engineers, and business people to create a new medical technology zone in **Hartford**; this zone could serve as a prototype for similar areas across Connecticut. The alliance, which formed three years ago to foster biomedical engineering programs, hopes to stimulate a high-tech business base in the city by encouraging startups; the new companies are expected to focus on developing innovative mechanical and electronic medical devices. Increased interaction between doctors, engineers, and developers should shorten the time it takes to develop a new medical technology, according to a **Hartford Hospital** doctor.

WORLD-CLASS LABORATORY. The world's largest drug laboratory opened its doors this summer in **Groton**. **Pfizer's** new \$220 million, 585,000-square-foot facility will house about 700 scientists and provides 120 new laboratories. The building also includes such amenities as a three-story atrium with a built-in coffee bar. Pfizer has dozens of new drugs in its pipeline, including a form of inhaled insulin for diabetics, and treatments for migraine headaches, hypertension, cancer, incontinence, and psychosis. Research plans, according to company officials, include using the recently mapped human genome in drug development efforts.

SILVER BULLET. Manufacturers of toothbrushes, sneakers, air humidifiers, and even countertop coatings may soon be able to increase consumer safety by adding a newly developed, silver-based anti-microbial compound to their products. Produced by **HealthShield Technologies**, a company formed by Connecticut businessmen **Neil Friedman** and **Roger Freedman**, the compound works by slowly releasing silver ions, which can kill bacteria, mold, and fungi. According to **John Barry**, a company scientist, items coated with the HealthShield product will be protected against microbes for over 100 years. Silver, which can prevent infection when used on burn wounds and catheters, is known to

effectively fight microbes without harming human cells; unlike antibiotics such as penicillin, it does not destroy its own effectiveness by causing the evolution of silver-resistant bacteria. The product is expected to go on the market this year.

LET'S MAKE A DEAL. **University of Connecticut (UConn)** officials hope that the recent licensing of an environmental-cleanup technology developed by UConn professors will be just the first success in a fledgling technology transfer program that is expected to bring money into the school, and to create new companies and jobs for the state. Currently, UConn's income from licenses and royalties is \$500,000; by comparison, Yale, which aggressively commercializes its discoveries, received \$46.5 million in 1999. **Leslie Cutler** and **Michael Newborg**, of **UConn's Office of Science Technology Business Development**, believe that it will take three to five years for UConn to bring in the kind of revenue that Yale now enjoys. UConn expects to find licensing opportunities in academic areas like photonics, marine research, and biotechnology.



Transportation

GETTING THERE. Developing a way to link car, air, and train travel transportation may be crucial to sustaining Connecticut's economic success, says **Matthew A. Coogan**, a specialist in the field. Such "intermodal transportation," which is increasingly popular in other countries, could be used to provide state residents with easy access to the abundant international flights at Kennedy Airport. Made possible by computer technology, the system could allow passengers to check their baggage at the train station and buy a combination train and plane ticket before leaving for the airport. It tracks passenger movements and delivers information to travelers on monitors as they move from car to train to airport. "The focus is on information systems to make intermodal [transit] work," Coogan said. Airports in New York, Providence, and Boston are already working to develop connections with train service.

SAFETY FIRST. A team of professors at the **University of Connecticut (UConn)** is developing a new statistical approach to analyzing traffic data that could help prevent accidents. Currently, traffic researchers predict safety by comparing the number of cars traveling on a particular road with the number of accidents. The new measure would look at more specialized data. For example, instead of looking solely at the number of cars going through a particular intersection, it might analyze which of the intersecting roads has more traffic, at what hours, and under what conditions. "We hope this will make it easier to compare the safety record of different locations," said **John Ivan**, an associate professor of civil engineering at UConn, who is participating in the research. Other team members are associate professor of statistics **Nalini Ravishanker**, and retired psychology professor **Donald Tepas**. The work is being done under the auspices of the **Connecticut Transportation Institute** at UConn; it is being financed by a \$99,900 federal grant.

ALL EYES. The city of New Haven plans to replace the underground wires currently used to monitor traffic patterns and light signals with tubular detectors and movable cameras that will be mounted on traffic lights. The cameras, which will record 24 hours a day, will be used to provide evidence in accident claims and parking violations. Over the next seven years, the city will use a \$10 million federal grant to install 87 cameras; eventually, cameras will be placed at all of the city's approximately 300 intersections. There are about 7,000 traffic accidents annually in New Haven.

— *Compiled and edited by Karen Miller*

countries, the ones that are doing the emissions, are probably going to benefit. The low latitude countries, that would like to do emissions, but haven't done them yet, are going to be hurt."

With mild warming, the harm may only be slight. But, even so, his results mean that negotiations to reduce greenhouse gases are going to get much more complicated. "To find out that [climate change] is bad in this particular way, where polluters actually benefit and the people who are not polluting will be damaged—that's a very bad result politically. It means that the people who really ought to be pushing Kyoto are the developing countries who have nothing to do with it, and the people who should probably be dragging their feet are the OECD countries, who are pushing it."

His work means that it's less likely that countries will band together to decrease greenhouse gases now. But it means something else, too. It means that may be okay.

If, as Mendelsohn's models predict, mild warming has only a mild impact, it may not be critical to decrease CO₂ emissions immediately. But, importantly, this grace period will not last long.

Mendelsohn sees the year 2050 as the turning point.

"In 2050," Mendelsohn says, "we run out of natural gas and oil. We have to shift to another energy source." If we don't do anything to interfere, he says, the market is likely to go to coal—a carbon-intensive, dirty fuel. "That's where most of the emissions are," says Mendelsohn. "Not in this economy, but in the next one."

Mendelsohn's work implies that policymakers should not focus their efforts on Kyoto-like projects today. Instead, they should be planning for the looming oil shortage. "We should be talking about what we're going to do in 2050. We should be researching, so that when 2050 rolls around, we have options." Alternatives exist: renewable resources, nuclear, a less carbon-intensive coal. But none of those technologies are ready to be implemented, Mendelsohn warns. For them to be viable possibilities in 2050, research must be done now.

"The real issue in climate change," says Mendelsohn, "is what we're going to do at that moment. It's from then on that you will either have enormous amounts of carbon coming into the system, or you'll cut it off. If you cut it off there, the temperatures will never get very high." And if that happens, he believes, the problem will go away.

Daniel Esty: A Global Solution

Climate change exemplifies a particularly intractable type of environmental problem: in cause and effect both, it spans the planet. Many issues such as ozone layer thinning and fisheries depletion occur on a global scale.

Dr. Daniel Esty, Director of the Yale Center for Environmental Law and Policy, believes that such worldwide problems cannot be resolved at a national

level. "We have," he says, "a hard

time dealing with environmen-

tal problems that are dispersed either geographi-

cally or temporally... it

makes it harder for politi-

cal leaders to understand

the benefits of taking action.

They fear that they're going to

impose costs on their own constituents, but that

the benefits will accrue to somebody else, either beyond the borders of their territory, or in the future."

Esty is developing a framework through which governments, industries, environmental groups, and citizens can work together to resolve environmental issues. "My starting point," he says, "is to step back and ask, 'what are the problems that we're addressing?' and from there, move to an analysis of what kind of institutions or structures we need to respond." He uses a technique he calls comparative institutional analysis. "One takes a problem, like the need to get collaboration in response to climate change, and asks: 'how is the system that we have in place doing? What are the features of that system? Are there comparable circumstances elsewhere, either within the international or national realm, through which we can understand alternative institutional approaches?'"

Esty believes that global-scale problems can best be dealt with through a GEO—a global environmental organization. He believes that a starting point in developing such a group could be to collect the multitude of already existing UN environmental groups into a more streamlined system. He'd like to see a tighter coordination among the existing multilateral environmental treaties. He points to treaties on hazardous waste, on endangered species, on ozone layer depletion. "One would like to have [these] much more carefully coordinated, so that you're getting some sense of priority setting, not only within each issue area, but across issue areas." Right now, he explains, these entities must compete with each other for the limited funding and energy available, which is wasteful and inefficient.

Coordinating these groups, he points out, would also allow opportunities for synergies that are not now exploit-

(see *Environmental*, page 12)

"We want to make sure we have a place to live."
— Daniel Esty, Director, Yale Center for Environmental Law and Policy

Avery Point (from page 1)

demographic component is the Department of Marine Sciences, whose faculty carries out research in a variety of disciplines in oceanography. The Sea Grant College Program office for Connecticut is located here. (Sea Grant is a federally funded program to promote wise use of the marine environment through education, research, and outreach, and UConn is a Sea Grant college.) The federal government also supports the National Undersea Research Center, one of only six in the nation, whose purpose is to provide the academic community with advanced underwater technology. Avery Point is also home to The Long Island Resource Center, a collaborative effort between UConn and the Connecticut Department of Environmental Protection, which collects information about the Sound for use by the public as well as researchers. Finally, Project Oceanology, a non-profit educational organization, conducts programs that bring thousands of high-school students, teachers, and parents to Avery Point every year. The activities of all of these groups are supported by the Marine Sciences and Technology Center (MSTC), which also runs a research vessel, the *R/V Connecticut*, for offshore research, instruction, and data collection.

Time for a Change

Despite its scientific quality, the campus has been managing for many years with an outdated infrastructure. Once an estate, Avery Point became a Coast Guard training facility during World War II, and most of the existing campus buildings were built at that time "as temporary structures," according to MSTC Director Dr. Richard Cooper.

Until recently, there have been no major upgrades in the facilities, but not because they weren't needed. The plumbing, electrical, heating, and telecommunications equipment had reached their limit. Basic services have been lacking: "We've never had hot water in our buildings except where we've installed small heating units," says Operations Manager Bob DeGoursey.

Many of the buildings were and are water damaged and decrepit. The converted army surplus transport boat (the *R/V UConn*) that served as the research vessel was also inadequate, a serious problem for scientists who rely on offshore data collection. By the late 1980s and early 1990s, Cooper and the current Head of the Department of Marine Sciences, Dr. Robert Whitlatch, were actively seeking ways to modernize and promote the Avery Point campus.

A New Research Vessel

The first item to be upgraded was the research vessel, thanks to a \$1.5 million grant from Connecticut Innovations, Inc. in 1996, and a loan of \$0.5 million from UConn. The new *R/V Connecticut* was launched in November of 1998, and represents "a significant increase in our ability to work offshore," according to Dr. W. Frank Bohlen, Professor of Marine Sciences.

"The new ship is larger and more versatile in terms of maneuvering and station keeping," says Bohlen. "She is much more adaptable and can be easily reconfigured to serve particular research programs. Tie downs [on the stern deck] can accommodate a variety of platforms, container labs, and living spaces. There are much more comfortable living conditions, and the boat is capable of extended periods at sea."

"She can also function as a 'mother ship' for a variety of deep sea diving equipment," adds Cooper.

Seen close up, the boat is surprisingly large. Tall and wide, she is crammed with equipment, including an articulated crane that can be extended across much of the afterdeck and a huge A-frame over the stern "that allows controllable lifting of large oceanographic equipment," says Captain Lawrence Burch, the Marine Operations Manager. On the main deck are a wet and dry laboratory and a galley, and below deck, berths for twelve. The galley in particular is spacious, with room for a number of people to relax and chat. "When the boat is on an extended mission, she carries a crew of five (including a cook)," says Burch, "and has room for seven scientists."

Funding for the *R/V Connecticut* comes from chartering fees. "She is totally self-sufficient financially," says Burch. She is often chartered by private industry or other academic institutions, as well as the faculty at Avery Point. For example, in 1999, the boat helped with a major whale release by the Mystic Aquarium.

Campus-wide Improvements

While plans to upgrade the boat were in progress, Cooper and others took steps to improve the rest of the campus. In the early 1990s, a coalition of scientists and business leaders headed by Cooper and Whitlatch, Elliott Finkel (former Director of the National Undersea Research Program), and Robert Wicklund (a former staffer for Governor Lowell Weicker) approached Governor Weicker with a request for funds to create a program development study for the improvement of Avery Point. According to Cooper, "We expected to meet with success because Elliott Finkel, Bob Wicklund, and I taught Weicker how to dive and certified him, so we knew he was a promoter of all things marine."

The \$170,000 made available by the Weicker administration was used to develop a Program Development Plan that has been the basis of the ongoing changes at Avery Point. It included provisions for a new building for Project Oceanology [see In Briefs, page 5], as well as for the new Marine Sciences and Technology Center. It also included the idea of an "Industrial Affiliate Program," whereby fledgling industries would form partnerships with the academic community to share expertise, and, eventually, profits.

Funding became available when the UConn 2000 plan was adopted by the state legislature in 1995, setting aside \$1 billion to improve the university over a ten-year period. Forty-five million dollars was allocated to the Avery Point Campus. Currently, all of the underground utilities including telecommunications and electricity are complete, and Project Oceanology has moved into its new seaside building, which includes laboratory spaces and a 56-bed hostel for groups attending multi-day educational programs.



The new research vessel *RV Connecticut*, pictured above, replaced the older *RV Uconn* and was the first major upgrade to the Avery Point facilities. The ship, made possible by a \$1.5 million grant from Connecticut Innovations and a \$.5 million loan from the University of Connecticut, was launched in 1998. Funded by chartering fees, she is often chartered by private industry or other academic institutions and is financially totally self-sufficient. (Photo: UConn/MSTC)

The Marine Sciences Building

The campus is now eagerly awaiting the opening of the new Marine Sciences and Technology building. The three-story building "is divided into three sections," says Bob DeGoursey, "for teaching, research, and administration, respectively."

The teaching section will contain "the first dedicated marine science teaching labs at Avery Point," says DeGoursey, which will free students and professors from having to adapt research laboratories into teaching environments. There are also two classrooms, and a seminar room for 100 people, furnished with state-of-the-art audio-visual equipment. The new teaching space is especially welcome because Avery Point is now conducting its first undergraduate degree program, in Coastal Studies. (Previously, only masters and doctorate programs had been offered.) Teaching will also be facilitated by the building's telecommunications capacity, which was designed with

the intention, according to Bohlen, of supporting distance learning, "first for students at Storrs, and later for general distance learning."

The administration section will consolidate most of the campus's marine resources, housing the MSTC offices, the National Undersea Research Center, the Sea Grant College Program, and the Long Island Sound Resource Center. "Space is also provided to support industrial collaborations," says Cooper.

The Marine Sciences faculty will trade their current spaces in the old infirmary, with makeshift laboratories and offices converted from patient suites, for state-of-the-art laboratories and sunlit offices with views of the Sound. Among the 24 new laboratories are ultraclean class 100 chemistry laboratories on the third floor and a fluid dynamics laboratory in the basement that is supplied with seawater. Eighteen of the laboratories will be complete when the building opens, with six more awaiting additional funding, according to DeGoursey.

A new set of colleagues will be joining the academic scientists in the facility. Through the Industrial Affiliate Program, fledgling industries will rent space in the new building, and work in collaboration with the academic researchers on joint projects. For example, according to Cooper, one interested company might "draw on local expertise in diving and robotics" to design small underwater robots that could do a variety of tasks, such as assessing water quality at oil-drilling and weapons-testing sites. "We think the international market for these robots is huge," he says.

Inside the new building, Bob DeGoursey indicates a wall where a sculpture will go up. Double panes of plexiglass a story high and etched with sea creatures will sandwich a sheet of flowing water. He shakes his head, savoring the anticipated change. "For thirty years, no hot water," he says, "and now this."
— *Grace E. Gray, Science Writer*

For more about the RV Connecticut and the Marine Sciences and Technology Center, go to www.mstc.uconn.edu/

Environmental (from page 9)

ed. Just in terms of physical synergies, he says, we know that the chlorofluorocarbons that deplete the ozone layer are also greenhouse gases. "One should be thinking about the response strategy with both of those difficulties in mind, not separately one or the other."

Esty believes that there is a growing interest in the formation of a GEO. He finds an increasing recognition that the current system is not working well. "I think the poor performance coming out of the system is increasingly a source of concern," he says, noting that in the past few years trade officials and political leaders in a range of countries—France, Germany, Singapore, South Africa,

From the Academy (from page 2)

the flow of its student citizens into the high-tech workforce through support of the extra curriculum programs surrounding its education pipeline. In the Academy's view, Connecticut needs to institutionalize support to such programs by creating a pro-active system that delivers leadership, role models and infrastructure support. Specific program elements to these ends are outlined in the full paper in three categories: General Actions, Short Term Actions and Longer Term Actions.

— *Michael Werle, Executive Director*

*The full presentation is available
on the Academy website at*

<http://www.ctcase.org/reports/educsummit.pdf>

Brazil—have all urged the creation of some kind of global environmental organization.

Esty labels himself a short-term pessimist and a long-term optimist. He believes that although progress on environmental problems may seem frustratingly slow, when the process is viewed over decades, it's clear that much progress has been made. "I guess I remain optimistic," he says, "that [in the next] 50 or 100-year time frame, we will make a huge move forward."

The Ending?

"I advise students," says Roger Ely, "who are trying to decide on different study options: do they want to work in medicine? do they want to work in environmental engineering? I tell them that to my way of thinking, it's very noble to want to ease human suffering and prolong human life." But if you look at the overall picture of the problems that the world is facing today, he says, then it seems clear that if we don't solve the environmental problems, none of the rest of it will matter. "We want," he says earnestly, "to make sure we have a place to live."

— *Karen Miller, science writer*

*Correction: Please note the correct spelling of
Dr. William Krinsky's name. Dr. Krinsky was the author of
"West Nile Virus: How Connecticut Scientists Helped Crack
the Case of An Exotic Arbovirus" in Vol. 15,3.*

Our apologies for the error.

