CASE REPORTS

HIGHLIGHTS OF SCIENCE AND TECHNOLOGY IN CONNECTICUT
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A Commitment to Excellence

Connecticut's Bioscience Sector Invests $2 Billion in New Facilities Construction

Winston Churchill once said, "We shape our buildings, and afterwards they shape us." A wave of new science construction is helping to shape the future of Connecticut. Buoyed by several factors, including the recent good economy and funding availability from several quarters, the bioscience sector, including academics, pharmaceuticals, and biotechnology, has committed itself to the expansion and renewal of its infrastructure. The recent and planned spending on new construction and renovations exceeds $2 billion. Although the new buildings have been designed with different purposes in mind, they will all contribute to Connecticut's emerging leadership in Bioscience.

Pharmaceuticals—Designing for Productivity

The watchwords in new science construction are flexibility and collegiality. These concepts are nowhere more evident than in the pharmaceutical industry, where there are enough financial resources to create the buildings that dreams, and productivity, are made of.

One of the best examples of this vision is Pfizer Inc.'s Building 220, their new Drug Discovery Facility in Groton, which opened on June 26, 2000. Billed as the largest building for drug discovery in the world, the 585,000-square-foot structure was designed in extensive collaboration with the end users.

"We believe our buildings provide Pfizer with a competitive edge, in that we design functionality and productivity into them," says Michael Mirabito, Manager of Project Engineering. "We ask scientists what makes a building good, not just from a productivity standpoint, but also from a recruitment and retainment standpoint, and we cast a far net to get the end users in the process so that they can get the building they want."

Indeed, Pfizer went to extraordinary lengths to take the end users' views into account in creating building 220. Charged with designing a building that optimized research collaboration and interaction, the architects, from CUH2A of Princeton, NJ, interviewed more than 250 researchers before beginning the design. A 10,000-square-foot mockup was then created, and the scientists' comments were again solicited to tweak the final design. Of the final product, says Mirabito, "The response from people in the building is very positive."

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Environmental Science at UConn
Second in a two-part series
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FROM THE EDITOR

This issue of *CASE REPORTS* marks the end of my Editorship, which began exactly ten years ago. Through full-length articles and "In Briefs," my goal has been to convey to our readers a sense of the strength and vitality of science and engineering in Connecticut, and the positive impact these activities have on the economy of the state and the well-being of its citizens. As I talked with scientists and engineers across the state I came away with a sense of their excitement concerning their research, and I have tried to convey some of that sense to our readers.

The production of *CASE REPORTS* has been a partnership between myself and our Managing Editor, Martha ("Marty") Sherman. To the extent that *CASE REPORTS* has been beautifully managed, composed, written and edited, the lion's share of the credit goes to Marty. I thank her, and I also thank our Advisory Board, for making my job a pleasure.

I wish my successor well, and hope that he or she finds the task of editing *CASE REPORTS* as rewarding as I did.

Edward A. Adelberg
Yale University
February, 2001

FROM THE ACADEMY

Above and Beyond the Call: A Fond Farewell with Gratitude for a Job Well Done

On the front page of this edition, Ed Adelberg bids farewell as *CASE Reports* Editor after ten years of service "above and beyond the call." On behalf of the full Governance and Membership communities of the Academy, I want to take this opportunity to express our sincere thanks for a job exceptionally well done.

Ed's work speaks for itself. It is welcomed and read thoroughly by the readership. Due to his very active leadership, guidance and personal involvement, *CASE Reports* has established a consistent level of high quality, integrity and relevance we will strive to maintain. Some of you may have had the pleasure of being a subject of one of his interviews, which he conducted from border to border in Connecticut. He has put a public face on the Academy that is recognized and appreciated. Fortunately for us, he was recently elected to the Academy's Governing Council and thus will be available to guide us during the transition period to a new editorship.

We again thank him, and wish him the very, very best.

John Cagnetta
President

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Science Facilities *(from page 1)*

One of the most innovative features of the new building is that scientists from different disciplines who are working on the same project are housed in adjacent research areas. This contrasts with a more-typical arrangement, where the different disciplines are segregated according to logistical needs—for instance, chemistry is often found on the top floor because of ventilation requirements. In the new building, biologists and chemists share floors. "The design of the building fosters open communication," says Mirabito, "They have to talk to each other—they share the same coffee pot."

Pfizer is currently engaged in several other construction projects, as part of a major expansion. According to Mirabito, "Pfizer is working on a package of capital improvement projects, spending about $100 million annually. Projects include laboratory renovations, construction and expansion of major laboratory buildings, central utilities buildings, parking structures, and day-care facilities." The most massive of these projects is the new Global Development Facility (GDF) in New London. Nearly a third larger than the Drug Discovery Facility, the GDF will house Pfizer's world headquarters, was well as scientists and clinicians who will collect data from clinical trials—nearly 2000 people.

Bayer Corp., another of Connecticut's pharmaceutical giants, is also in the midst of a major, $80-million expansion in Connecticut, and has recently opened new research laboratories in Woodbridge and a High Technology Center in West Haven, where it is also building a new $53 million chemistry research building.

Robotics for Screening, Storage, and Retrieval of New Compounds

"Like every other major pharma, Boehringer Ingelheim discovered that high throughput screening [HTS] was a major tool for drug discovery," says Carol Ann Homon, Associate Director for Biomolecular Screening at Boehringer Ingelheim's Ridgefield site.

"The field is very competitive. We need to screen compounds quickly because the first company with a drug captures the lion's share of the market. There really is a race to the finish."

Homon's words reflect the tenor of the times: since 1998, three of the major pharmaceutical companies in Connecticut—Bristol-Myers Squibb (BMS), Bayer, and Boehringer Ingelheim (BI)—have begun or completed the development of state-of-the-art systems for compound storage and retrieval and HTS. Although these systems are tended by humans, they are manned by robots, and have vastly accelerated the rate that companies can screen compounds.

At BI, where the new Lead Discovery Technologies Building is being completed, the robots are already at work. One robotic system is their new "REMP" automated storage and retrieval system, which was developed by REMP AG in Oberdiessbach, Switzerland. On the day *CASE Reports* visited the facility, the new system was going though its "site acceptance" test, according to Dispensary Manager Marie Coscia, who was putting the robots through their paces.

Through small windows set into the wall between the 4°C. walk-in space and the –5°C., low-humidity freezer where the compounds are stored, the robots could be seen scurrying along banks of frozen liquid compounds. They can retrieve compounds in tubes or plates, as ordered, and place them in chambers that connect with the 4°C. space, to be retrieved by scientists. "The robots can even pass compounds to one another, when necessary," says Michael Girardi, President of REMP USA, who was on hand for the site test.

The systems that perform HTS hold sway in the middle of the "robotic core," a large open area devoted to robotics. The Allegro HTS system, built by Zymark in Hopkinton, MA, was designed in an unusual collaboration between scientists from a competing company and Homon, working as a consortium with Zymark, and is the heart of the rapid compound-screening. Unlike the REMP robots, whose mobility and dexterity suggest human qualities, the Allegro is distinctly mechanical, much like an industrial conveyer system, housed in modular units. Compounds are put in on one end, mixed with reagents to run various tests, with results coming out the other end. The automation of all of these steps means a huge acceleration in drug-screening capability.

"In 1985 we discovered a hit, leading to the drug Viramune, by screening 10,000 compounds in a year," says Homon. "Now our entire library of compounds is screened in one month or less, and the library is growing all the time… We want to do the whole library in one month even as it grows, and we'd like to do dozens of screens a year at this site. We are only one of three BI sites with screening capabilities."

The growth of the compound library is largely due to the work carried out by Combinatorial Chemistry, which will be housed on the second floor of the new building.

Pfizer's Building 220 was designed to support movement and connection. Architects CUH2A, Inc. used natural light, curved paths, and multi-story vertical elements to create a network of connections for research activities.

(Photo courtesy of CUH2A, Inc.)

According to Homon, the new building has been built with two primary goals: to provide flexibility, so that the facility can be rearranged to adapt to innovations, and to provide "an excellent working environment."

"People work a lot better when they are exposed to natural light," she says. "This building was built to allow the maximum light in spaces where people work. It's people who make these things successful. We need to think about them and provide a working space that's bright and cheerful."

The HTS and compound retrieval systems built by Bayer and BMS have slightly different capabilities, but were designed for the same purpose. The Bayer High Technology Center is a single-story structure that is intended to screen 200,000 compounds per day per target. Like the BI facility, it was designed with an open floor plan and a focus on flexible technologies.

BMS's automated compound storage and retrieval system, called "The Haystack," was completed in 1998 and is housed in a four-story addition to their Pharmaceutical Research Institute facility in Wallingford. The building also houses an HTS system and drug discovery laboratories. BMS's Haystack, built by Britain's Automation Partnership, is billed as the world's largest robotic system for automating a sample library.

At the Universities: Playing Catch-up and Then Some

Where the pharmaceuticals are breaking new ground, the universities are, at least to some extent, playing catch-up. Victims of deferred maintenance for decades, and originally built according to now-defunct codes, many research buildings at the University of Connecticut and Yale are no longer sufficient to house basic research. The new buildings, however, go far

(see Science Facilities page 10)

IN BRIEF

Communication

LIFELONG LEARNING. **Yale** has joined with three other universities in a distance-learning venture that will provide its alumni with online courses, interactive seminars, multi-media programs, live coverage of campus speakers, and lectures on tape. Yale, Princeton, Stanford, and Oxford will each contribute $3 million to the nonprofit **University Alliance for Life-Long Learning**, which will solicit faculty proposals for programs, subcontract with the universities to produce the projects, and arrange for distribution. While initially the Alliance offerings will be offered only to alumni of the four universities, officials have stated that they eventually plan to make these opportunities available more widely.

POLICE RADIO. After months of testing, the new statewide digital police communications system went online last fall. The Motorola system, which replaces an antiquated and inadequate 60-year-old radio system, provides coverage across 98% of the state. It eliminates most dead spots, allows troopers to communicate car to car, and includes portable radios, which allow troopers to remain in contact even if they leave their cruisers. The system includes CAD (Computer Aided Dispatch) software to aid dispatchers in assigning troopers to calls, and will use global positioning system satellite technology to track troopers' movements.

HEALTHNET. Through its **Healthnet** service, the **University of Connecticut Health Center** now helps consumers negotiate the maze of health information on the Internet. Originally started in 1985 for librarians, but now available directly to state residents, Healthnet evaluates online databases and Internet resources, as well as providing other services. "There is so much information available to consumers that people run the risk of missing the most relevant information, or, worse yet, reading the wrong information," says **Alberta Richetelle**, Healthnet program director. Recently, through funding provided by the National Medical Library, Healthnet has started training self-help groups on ways to access current and authoritative resources on the Internet. The Healthnet website can be found at library.uchc.edu/departm/hnet.

VIDEO VIEW. A plug-and-play system developed by Wallingford-based **VBrick Systems** allows users to easily send video pictures through a computer network. To use the device, the consumer simply plugs a video source, like a TV camera or VCR, into one jack, and any standard computer network connector into another. The video stream can then be viewed through any computer on the network. With more than one VBrick in a system, video conferencing becomes possible. VBricks have been used for security monitoring, distance learning, and even, in West Virginia, to conduct a statewide town meeting. The device, which is intended primarily for use on corporate networks, sells for $5000. The company plans to release a higher quality VBrick, and is also considering the development of a consumer-grade product.

DOCUMENT DELIVERY. With the **University of Connecticut's** new electronic document delivery service, members of the university community can order and access interlibrary loan journal articles right through their home computer. Users submit requests via email. If the article is already online, or is owned by one of the roughly 600 libraries with appropriate scanning software, the order can often be filled within hours; the average turn-around time is two to three days. Once the University Libraries receive the item, it's posted to library's server, and the user is notified of its arrival via e-mail. The new system, which replaces trips to the library to photocopy articles, has been received enthusiastically by users.

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 CASE at (860) 527-2161, write the editors at 179 Allyn St., Suite 512, Hartford, CT 06103-1422, or e-mail us at acad@ix.netcom.com

Education & Cognition

HIGH-TECH CHECKOUT. **Manchester** schools have joined school districts in **West Hartford, Coventry** and **Enfield** in offering students a computerized debit checkout system for the lunchroom. The Manchester system, which uses a $120,000 software program known as Cafe Terminal, allows parents to prepay their children's meals; at the cash register, the children punch in their personal identification number and the cost of the food is deducted from their account. When the account drops below $5, the student is automatically notified. The computerized system speeds up cafeteria lines, so the students have more time to eat. It also tracks all transactions, making it possible, for example, to provide parents with records of what their children eat.

VISUAL PROCESSING. Visual processing requires activity in several areas of the brain, according to research recently done at the **University of Connecticut**. Psychology professor **Brett Steinberg** has used fMRI, or functional neuro-imaging, to study neurological functioning and age-related changes in the brain. The non-invasive technique can identify which parts of the brain are involved in performing a specific activity by detecting changes in the oxygen level of the blood, according to Steinberg. He and his colleagues are using fMRI to study face and object processing; they recently completed a study that observed men aged 20 to 30 years in the process of determining whether drawings in the lower half of their visual field could be matched to objects in the upper half. They are also reviewing follow-up data from men aged 70 to 85. "People do worse on a variety of cognitive tasks as they age," said Steinberg. "I hope to find out why."

ENGINEERING BOON. A $4 million contribution from **United Technologies Corporation** to the **University of Connecticut (UConn) School of Engineering** is both the largest gift ever given to the school and the largest corporate gift ever given to a public school of engineering. The money, which will be matched by $2 million from the state, will be used to endow three chair professorships in research; sponsor four junior faculty positions; provide a $1 million endowment for undergraduate scholarships; and establish an Advanced Technology Clinic for joint research between engineering faculty and UTC. Although enrollment in engineering programs is declining nationwide, UConn's School of Engineering has seen a 60% enrollment increase over the past three years.

COGNITION STUDY. Research conducted at **Yale** has shown that the brains of children born prematurely are much smaller than the brains of those born full-term. "The differences in brain volume on average were dramatic in all regions, with reductions ranging from 11% to 35%," said **Bradley Peterson**, professor in diagnostic radiology and the study's lead author. The study found that "the magnitudes of abnormalities were directly proportional to how early the children were born; the abnormalities were strongly associated with IQ of the children at age eight years." The study was the first to relate cognitive ability to brain abnormalities caused by premature birth. Its findings can be used to help identify children at risk, in order to provide treatment as early as possible.

IN BRIEF

HIGH-TECH HIGH. The first high school in the state devoted to training youngsters in information technology opened last fall in Stamford. The Academy of Information Technology will offer instruction in computer graphics, web design, programming, and database and network administration; it will also help students obtain internships at local high-tech businesses. The school currently has 225 enrolled 225, out of the 300 who applied. Next year, it hopes to be able to accommodate even more, and eventually, according to Christine Casey, assistant superintendent of Stamford schools, to be able to open the academy to the public. "There is a huge need to provide adult education to the public," said Casey.

Energy

CALIFORNIA CLEANIN'. With a kit that replaces components of the combustion system on their older power-producing turbines, **Pratt & Whitney Power Systems** has developed a way to reduce turbine-caused air pollution. The environmental upgrade kits will significantly cut the amount of nitrogen oxide and carbon monoxide produced by gas turbines. Five of the kits were purchased by a California utility, which will install the components on five Pratt industrial gas turbines. The modifications allow the turbines to meet California's rigid air quality requirements.

FUEL-ISH. With the help of $15 million in investment from two larger energy corporations, **FuelCell Energy Inc**, of Danbury, has moved towards its goal of developing fuel cell power plant products. FuelCell uses carbonate technology to produce stationary power plants that can provide as much as 3 megawatts of electricity. This field is considered a growth opportunity, as states open up retail electrical markets and as they seek new energy sources to meet increasing demand. FuelCell plans to move into its new manufacturing facility this winter, and to begin taking orders in the second half of the year, according to a company spokeswoman.

NUCLEAR WASTE STORAGE. With the federal Department of Energy unable to accept nuclear waste from decommissioned power plants for at least another ten years, **Connecticut Yankee** has opted to store its 1,300 pounds of spent fuel in dry casks on the site of its nuclear power plant in Haddam. The company proposes to move its 1,019 fuel assemblies into stainless steel canisters, which would be encased in steel-lined concrete casks 21 inches thick. These would then be moved to a fenced, concrete slab 50 feet above sea level, which would be guarded by radiation and temperature monitors and by a round-the-clock security force. Dry cask storage, which was first used in 1986, is the method of choice at 15 commercial nuclear sites around the country.

HOT WIRE. Construction is scheduled to begin this year on the 23-mile-long, high-voltage undersea electrical cable that will link Connecticut with Long Island. The **Cross-Sound Transmission Cable**, which will run between **New Haven** and Brookhaven, NY, is intended to bring additional power to New England; an insufficient number of high voltage transmission wires coming into the region has been cited as one of the area's critical energy problems. The cable will provide a 600-megawatt capacity; one megawatt can power 200 to 300 homes for 6 peak-usage hours. The cable is expected to go into service in late spring of 2002.

SUN SCREEN. A solar generator developed by **Solar Dynamics Inc**, of Simsbury, could provide power to places that lack electricity. The portable photovoltaic generator, basically a battery charged by an attached solar panel, is able to run equipment like hand tools, radios, computers, and small appliances. The startup company has received $100,000 in financing from the **Connecticut Clean Energy Fund**, a state-sponsored venture capital fund with the goal of providing Connecticut with renewable energy sources. The goal of the Fund, which is financed by consumers through a monthly surcharge on their electric bills, is to help Connecticut derive 10% of its electricity from renewable resources by 2020.

Environment

AMPHIBIAN STUDY. With a $2.1 million grant from the National Institutes of Health, researchers at **Yale** and Pennsylvania State University will investigate the causes of deformities in amphibians. The study will focus on four states: Connecticut and Pennsylvania, which have lower than average rates of deformities, and New York and Vermont, which show higher than average incidences. The researchers are interested in whether the problems may be caused by trematodes, a group of parasites known to cause fatal diseases in humans. Trematodes must be carried by snails as hosts before they can affect amphibians, and, according to Yale ecology professor **David Skelly**, who was among the researchers awarded the grant, snails may be proliferating. "People may be doing things to wetlands that inadvertently turn wetlands into snail farms—such as making wetlands deep, introducing nutrients, or cutting trees to let in more light," he said.

BROOK RESTORATION. **Connecticut Department of Environmental Protection** fisheries biologist **Brian Murphy** is managing an effort to restore the natural flow of **Railroad Brook** in **Bolton**; the stream's original path was destroyed by railroad construction. The restoration involves using a backhoe to excavate a new channel through nearby wetlands. The new channel is lined with rocks that range in size from gravel to boulder; the rocks are intended to provide habitat for aquatic plants and animals. Strategically placed logs and boulders should create bank undercuts, bends, and curves that will, if necessary, dissipate the brook's energy and prevent floods. The design should allow deep pools to form, in which the stunted native brook trout and black-nosed dace that now populate the stream can grow to normal size.

WHAT A GAS. A new state-of-the-art system for managing the 65-acre landfill near the **Manchester-East Hartford** border offers major environmental benefits, according to town officials. The system consists of a series of 30 collecting wells, which feed the gas generated by the landfill into a network of pipes; eventually, the gas is burned off. The system also collects leachate, which is pumped to a separate system and sent to a wastewater treatment plant. This reduces the amount of liquid that leaves the landfill. The landfill stopped accepting garbage in January, 2000; the town now sends its waste to the Hartford-based **Connecticut Resources Recovery Authority** for incineration.

INVASION OF THE PHRAGMITES. The state **Department of Environmental Protection** (DEP) is collaborating with the **Nature Conservancy** in an experimental program to eliminate phragmites, a reed grass that is choking out many other native species along the **Connecticut River**. The project, at **Lord's Cove**, a rare brackish tidal marsh, is an emergency measure to stem the invasive plant, and requires the unusual step of spraying the area with the non-selective herbicide Rodeo. Since the state prohibits aerial spraying of pesticides, the work must be done from the ground, using amphibious vehicles to spray the pesticide in 50-foot swaths. Lord's Cove provides habitat for several bird species, including the bald eagle. Currently, phragmites grow on 200 of the cove's 1,100 acres; the plant is spreading at a rate of 30 acres a year.

IN BRIEF

WEST NILE VIRUS OUTBREAK. The federal General Accounting Office's (GAO) September 2000 report about the outbreak of West Nile virus recapitulates the timeline of the 1999 invasion. It begins "Tuesday, 6/1/99. (Approx date) **Connecticut Agricultural Experiment Station** begins annual mosquito surveillance." The last page of the timeline documents the 12/17/99 report of isolation of the virus from a Cooper's by the Connecticut team led by The Experiment Station.

Food & Agriculture

GREEN MEDICINE. Through her "greenhouse pharmacy," **University of Connecticut** professor **Usha Palaniswamy** hopes to find better ways to raise plants that can be used to treat diabetes. The 52 species of Asian medicinal plants in her collection contain phytochemicals that can prevent the occurrence and progression of major diseases, she explains. Palaniswamy hopes to identify the environmental conditions that will produce the highest phytochemical concentrations in plants; her previous work has shown that plant nutritional balance, temperature, and light intensity all affect phytochemical level. Currently, her studies focus on *Gymnema sylvestris* and *Phyllanthus amarus*, two plants that have been used to lower blood sugar levels in diabetics.

CLONING CONCERNS. According to a new study by **University of Connecticut** professor **Jerry Yang,** cells in cloned calves seem to be the same age as cells in animals reproduced by conventional means. Yang's laboratory studied the length of telomeres on ten calves cloned from a 13-year old cow. Typically, telomeres, which are needed for cells to divide, become shorter as an animal ages, eventually becoming too small to allow the cells to function properly. Yang's results alleviate fears that cloned animals might inherit the cellular age of their genetic donor, causing them to age prematurely, and means that cloned cells from human donors could be used for transplants without the risk that they will age too quickly.

YALE-PEKING CENTER. A joint center for research and training in plant biology has been established by **Yale** and China's Peking University to encourage collaborative research among the universities' scientists. Research at the **Peking-Yale Joint Center for Plant Molecular Genetics and Agribiotechnology** will focus on the field of basic biology in model plant systems and on the application of this work to crop improvement. The center will also encourage student and faculty exchanges.

BALI STUDY. Appropriate fertilizer use holds the key to successful rice paddy farming and coral reef preservation on the island of Bali, says **University of Connecticut** marine scientist and coastal systems ecologist **James Kremer**, who has been studying Bali's collapsing coral reefs. The problem, his research suggests, was initiated when the Indonesian government, in an ultimately unsuccessful attempt to increase crop yields, mandated that local rice farmers use nutrients that turned out to have excessive levels of phosphorus and potassium. The unused nutrients washed out to sea, ultimately disrupting the coastal ecology and damaging corals.

Health

SOUND DIAGNOSTICS. Strokes can be prevented in youngsters with sickle cell anemia by a technique known as Transcranial Doppler Ultrasonography, which is offered both at **Yale-New Haven Hospital**, and at **St. Francis Hospital** in Hartford. The treatment, used to detect the possibility of strokes in time to give the youngsters preventative transfusions, uses changes in the apparent frequency of sound waves to determine how fast a child's blood is flowing. If it's fast in one area, that could indicate a blockage in a nearby blood vessel, which could close down and cause a stroke. One in ten sickle-cell victims suffers a stroke by their twentieth birthday, according to **Lee M. Pachter**, director of the **Sickle Cell Anemia Service** at St. Francis.

AGING STEREOTYPES. A study conducted at **Yale** has shown that beliefs about aging can directly and quickly affect an individual's health. Researchers exposed a group of elderly participants to both positive and negative stereotypes of the elderly by flashing words like "wisdom," "creative," "senile," and "dying" before them on computer screens for fractions of a second. The study found that those treated to positive stereotypes showed a significant decrease in both systolic and diastolic blood pressure, while those given negative stereotypes showed an increase in those measures. The study also found that those exposed to positive aging stereotypes demonstrated higher self-confidence and higher mathematical ability than the other group. Yale professor **Becca Levy** was the study's lead author.

SILENT KILLER. **Yale** will serve as the lead test site in a $3.2 million national study to identify diabetics suffering from silent, or asymptomatic, heart disease. Designed by Yale professor **Frans J. Th. Wackers**, the study will include a total of 1,000 subjects at seven sites. Participants will be given a stress test, and a radioactive tracer will be used to monitor the heart's ability to increase muscle blood flow, indicating the possible presence of heart disease. "We want to see how often we can detect coronary heart disease that is not yet clinically evident," said Wackers. Of the 16 million diabetics in the United States, 20% have already been diagnosed with heart disease, said Wackers. But, within one year, 12% of asymptomatic diabetics will either die, suffer a heart attack, or be diagnosed with advanced coronary heart disease.

EMPHYSEMA. Using transgenic mice, a team of researchers led by **Jack Elias** of the **Yale School of Medicine**, have determined that pulmonary emphysema is caused by two genes, Interleuken-13 (IL13) and gamma-interferon. These genes were already known to cause inflammation, and IL-13 is also thought to contribute to asthma, indicating that common causes may underlie these two disorders. The researchers showed that the genes triggered increases in two classes of proteases, a type of protein that degrades lung tissue. Further, the team was able to block the IL-13-induced emphysema by giving the animals drugs to inhibit the proteases. "Pulmonary inflammation is a characteristic of patients with [emphysema]," said Elias. "However, the way that inflammation causes emphysema has not been defined until now." This work provides researchers with target molecules for drug development.

AIDS PROTECTION. The HIV virus remains alive on syringes at least 42 days when stored in near-freezing temperatures, but has a much smaller chance of surviving when stored above room temperature, according to results of **Yale** study. "The practical implications of these findings are that when people do not have access to clean syringes, storing used syringes in warmer temperatures decreases the likelihood of HIV transmission," said **Robert Heimer**, professor of epidemiology at the **Yale School of Medicine**. The study found that at temperatures above 27° C, less than 1% of the syringes contained viable HIV after one week.

High Technology

STARRY SKIES. An agreement between **Yale** and the University of Chile allows the institutions joint access to prime viewing time on

powerful telescopes in Chile. With little air turbulence and few clouds, Chile is considered the best observational site in the Southern Hemisphere, and it hosts a multitude of powerful telescopes, including four eight-meter telescopes known as VLTs (very large telescopes), two 6.5-meter Magellan telescopes, and a very large, extremely sensitive radio telescope. In return for access to the devices, Yale will help train Chilean students in astronomy and astrophysics. The two universities will also collaborate on a variety of research projects.

GETTING A CHARGE. Researchers at **Yale** have developed an improved way to screen drugs that act on ion channels, which permit signals to pass through cell membranes. Traditionally, ion channels are studied via a patch clamp technique in which an electrode held against a cell's plasma membrane measures the current flowing through the channel. Yale's innovation speeds up this unwieldy process. Invented by postdoctoral student **Kathryn Klemic**, and professors **Frederick Sigworth, James Klemic**, and **Mark Reed**, the new method involves microfabrication of integrated planar electrode and amplifier arrays which makes possible multiple, simultaneous, single-cell electrical recordings.

ELECTRON MICROSCOPE. A National Science Foundation grant of $620,000 will help provide scientists at the **University of Connecticut** with an automated digital transmission electron microscope. The instrument will have a resolving power of less than a 100-millionth of an inch, allowing for atomic resolution digital images. It will also have an X-ray spectrometer and an electron energy filter, allowing researchers to gather information about the location and concentration of the component elements in a material, and even to observe the electronic structure of the elements themselves. The microscope will be used to investigate such materials as high temperature aircraft alloys, tough ceramics, and molecular sieves.

INSIDE VIEW. **Yale** physician **Stephen Palter** has performed what is believed to be the first endoscopic surgery using high definition television (HTDV). An endoscope is an instrument that can be used to send pictures of the interior of a bodily canal or hollow organ, like the colon or bladder, to a monitor, in order to guide a doctor during surgery. Typically, HDTV cameras, whose 3-dimensional effect provides even more information than traditional video devices, have been too large for endoscopic procedures. However, Palter substituted a specially designed, miniaturized HDTV camera system, along with high definition upgrades in the accompanying processing and projection systems. "

Industry

HELP WANTED. Using the largest disability study ever conducted, **Yale** researchers have examined the prevalence and impact of mental and physical disability in the United States. They found that one-quarter of all disabled workers reported disability-based job discrimination in the past five years. They also found that one-third of those reporting disabilities said that a mental disorder contributed to the problem. The research team examined data from a 1994-1995 government survey, which interviewed 106,573 Americans about limitations in participating in major life activities. The scientists found that social and economic barriers hampered individuals with all forms of disabilities.

STORAGE ONLINE. **FleetBoston Financial Corp**, parent of Connecticut's largest bank, will be the first major US bank to offer customers a virtual safe deposit box, or "cybervault" for the storage of electronic documents. The service, known as fileTrust, will be aimed at small businesses that cannot afford their own electronic back-up systems. Customers will be given a password, but will also be able to give others access to documents. The service would include 128-bit encryption, currently the most effective way to protect a transaction from hackers. According to safedepositbox.com, which is working with banks to develop the electronic boxes, the service is expected to evolve into a way for businesses to exchange confidential and critical information.

WINNING WEBSITE. Since its inception one year ago, the Wallingford-based entertainment website **eUniverse** has managed to achieve at least two of the holy grails of webdom. It has traffic: 11.3 million individuals in a single month, making it the eleventh most visited site in the world. Just as important, its sites are 'sticky': users stay at the site once they've found it, an important measure for advertisers. According to one Net measurement firm, eUniverse is one of the web's stickiest sites, with an average visit lasting 13 minutes and 56 seconds. This results from the site's development strategy, says eUniverse co-president **Brett Brewer**: the company grew by acquiring already existing websites that were attracting desirable demographics.

IMPROVED SERVERS. With a $200,000 National Science Foundation grant, **University of Connecticut** computer science and engineering professor **Alexander Shvartsman** plans to develop the more complicated distributed systems that will be increasingly demanded in computer applications. Currently, says Shvartsman, most distributed systems involve a simple application, with interaction limited to one client and one server at a time. Such systems include the World Wide Web, e-mail, and bank ATMs. However, many emerging applications demand more complex systems. For example, distributed banking requires supplying accurate information to many different parties. Shvartzman plans to explore both theory and implementation of distributed systems.

Transportation

TRAINING GROUND. As of November, Amtrak's Acela Express, the nation's first high-speed train, began carrying travelers between Washington and Boston. Amtrak officials believe that the Acela, which can reach speeds of 150 miles per hour, will compete for passengers with airline shuttles. Able to travel from New York to Boston in three and a half hours, the train currently stops at **New Haven**; stops at **Stamford** and **New London** will be added. Eventually, Amtrak will offer 19 daily round-trips, weekdays, between New York and Washington, and 10 round-trips between New York and Boston. Revenue from the high-speed train is necessary to help Amtrak, which must operate without federal subsidies by the end of the 2002 fiscal year. A business-class Acela ticket from New Haven to New York costs $60, compared to a MetroNorth fare of $14.

FIRE FLIGHTERS. **Sikorsky Aircraft** has sold two of its S-70 Firehawk helicopters to Los Angeles County. Each firefighting whirlybird contains a 1,000-gallon water tank, extended landing gear, rescue hoists, and a customized interior for emergency medical service use. The Firehawk is designed with special modifications that allow it to refill its tank more easily than other firefighting helicopters, enabling it to deliver more gallons per hour, according to Sikorsky officials. The aircraft is able to fill its tank through a snorkel hose while hovering over a water source; it can also land next to a source and have the water pumped in through a connector on the tank. Los Angeles County officials have allocated $25 million to buy the Firehawks, said a Sikorsky spokesman.

—Compiled and edited by Karen Miller

Summary of New Science Facilities Planned, Under

Organization type	Name	Facility	Completion date	Approx. total gross square feet	Approx. tot cost ($ millio
Pharmaceutical	**Bayer Corp**	Chemistry Research Building	2001	125,000	53
		High Technology Center	2000	12,000	NA
	Boehringer Ingelheim	Lead Discovery Technologies Building	Jan. 2001	27,000	NA
	Bristol-Myers Squibb	Haystack	1998	120,000	NA
	Pfizer Inc	Drug Discovery Facility	Jun-00	585,000	250
		Global Development Facility	2001	800,000	270
		Bioprocess Lab Building	Fall 2001	60,000	$20
Academic (Undergraduate/graduate)	**CT State University, Eastern**	Science Building	2003	114,000	42
	CT State University, Western	Science Building	Fall 2003	110,000	46
	UConn (Avery Point)	Marine Science & Technology Center	2001	136,000	31
	UConn (Storrs)	Pharmacy/Biology	2003	185,000	47
		Engineering	Spring 2003	120,000	26
		Agriculture/Biotech Phase I	Dec. 1999	46,000	14
		Advanced Technologies Institute Building (Agriculture/Biotech Phase II)	Spring 2002	26,000	7.3
		Chemistry	Nov. 1998	199,000	56.7
		Biology/Physics	2002	133,000	41
	Yale University	Environmental Sciences	Dec. 2001	100,000	42
		Forestry and Environmental Studies	TBD	TBD	TBD
		Molecular Biology	TBD	TBD	TBD
		Chemistry	TBD	TBD	TBD
		Engineering	TBD	TBD	TBD
Medical School/Graduate Education	**Uconn Health Center**	Academic Research Facility	Jan. 1999	170,000	38
	Yale University School of Medicine	Biomedical Research and Teaching Building	2003	452,000	176
		B-Wing extension	Spring 2002	26,000	NA

Construction, or Recently Completed in Connecticut

al ns)	Activities	Architect
	Drug-discovery research	NA
	High-throughput screening	NA
	High-throughput screening, compound storage and retrieval, combinatorial chemistry	Kling Lindquist, Philadelphia, PA
	High-throughput screening, compound storage and retrieval, drug discovery laboratories	NA
	Drug discovery: 120 labs, 815 scientists	CUH2A, Inc., Princeton, NJ
	Collection and analysis of clinical trial data. Also Pfizer Global R&D headquarters. Up to 2000 people.	CUH2A, Inc., Princeton, NJ
	Storage, staging of equipment and materials	S/L/A/M Collaborative, Glastonbury
	Classrooms, research and teaching laboratories, office space, lecture halls, instructional support areas, and computer facilities. Adjacent greenhouse.	S/L/A/M Collaborative, Glastonbury
	Faculty offices, teaching and research labs, storage/prep/work-rooms, ancillary space for Chemistry, Physics, Astronomy, Meteorology, and Weather Center	Fletcher Thompson with Mitchell Giurgola Architects, NY
	Research laboratories, classrooms, faculty offices, administrative space	S/L/A/M Collaborative, Glastonbury
	Research laboratories for the Pharmacy School and Biology; classrooms, Pharmacy teaching laboratories, offices, library	Davis Brody Bond, LLP Architect and Planners, New York, NY
	Laboratories for computer science and engineering, offices, auditorium, seminar rooms	Burt, Hill, Kosar, Rittleman Associates, Washington DC, in association with Preiss Breismeister, Stamford, CT.
	Labs, conference rooms, faculty offices and carrels, lab support services, administrative offices, plant biotechnology facility	Svigals Associates, New Haven, CT
	Research and industrial incubator space, greenhouses	Svigals Associates, New Haven, CT
	Undergraduate classrooms, research labs, administration, building support, resource and learning center	Centerbrook, Essex, CT
	Evolutionary biology, electron microscopy, biotechnology, labs, offices, support space; physics accelerator and laser technology	Allan Dehar Associates, New Haven, CT
	Interdisciplinary research, storage of museum research specimens	David M. Schwarz Architectural Services, Inc., Washington DC, with Gilberti Spittler International, Inc., Cleveland, OH
	Teaching and research in environmental sciences, policy, and management	TBD
	Research in biological sciences	TBD
	Research, including NMR, organometallic chemistry, and bio-organic chemistry	Bohlin Cywinski Jackson, Pittsburgh, PA, and Cannon Design, Boston, MA
	Research in engineering sciences	TBD
	Basic research, clinical research, dental science, and other biomedical centers	S/L/A/M Collaborative, Glastonbury
	Wet-bench and teaching laboratories, MR research center, transgenic and gross anatomy facilities	Payette Associates, Boston, MA, with Venturi Scott Brown, Philadelphia, PA
	NA	NA

beyond replacing these antiquated facilities—they are technologically sophisticated structures that meet the most exacting standards for basic research and higher education.

UConn at Storrs: Getting Ahead of the Eight-ball

"I have never been on a campus that is spending this much money this fast," says Regina Smith, Executive Director of the Office for Sponsored Programs at UConn at Storrs. UConn 2000, the legislature's 10-year, $1 billion capital project, is remodeling the Storrs campus.

The new structures and landscaping are being fashioned according to a carefully thought-out Master Plan, intended to make the revitalized campus not only more functional, but also more attractive and collegial. According to Tom Trutter, a Senior Project Manager for UConn's Architectural and Engineering Services, the university has settled on a unifying architectural appearance that emphasizes "traditional window openings and a brick facade. The new buildings are a blend of contemporary architectural styles."

A substantial portion of UConn 2000's budget is devoted to improving the university's science resources. Five new science buildings for Chemistry, Engineering, Agricultural Biotechnology, Pharmacy/Biology, and Biology/Physics are either completed or in the works, as are cutting-edge facilities to house transgenic technologies. A sixth large science building is nearing completion at the Avery Point campus (see *CASE Reports*, 15,4). UConn 2000 is being implemented in three phases. Buildings designated as "Phase I" are largely complete; the Phase II buildings are still being designed or are just breaking ground.

The renovation and new construction projects are critical steps toward maintaining UConn as an important center for science education and research. Many of the older buildings, which were built according to specifications that are not sufficient to support modern energy-intensive technologies, are difficult to work in. Several researchers remarked that prior to UConn 2000, heating, air-conditioning, electrical power, and even distilled water had not been reliably available. "There had been an historic lack of funding to maintain and renovate buildings," says Karen Grava, Manager of Media Communications. Moreover, says Grava, "before UConn 2000, buildings were strictly low bids, so they didn't really last." Now contractors must be vetted before bids can be submitted to make certain they have the experience and financial security to successfully complete these demanding, high-tech projects.

Given the long-term frustrations of working in suboptimal quarters, the science faculty is both delighted with the renovations and new buildings and wary about the future. Gary Epling, Professor and Head of the Chemistry Department, is "delighted" with the new Chemistry Building that opened last fall and is "one of the most sophisticated in the nation." Says Epling, "I consider this to have been a major positive commitment the university has made to chemistry. It maximizes the chance for us to move onward with teaching and with research, and provides the facilities that allow the faculty to be competitive with their colleagues who are also working out of modern facilities." Nonetheless, he notes that in just two years, the chemistry department will have expanded into all the available space in the new building.

Some special features of the new buildings include the privately funded "Pharmacy Care Center," to be housed in the Pharmacy/Biology building. It will be a simulated pharmacy that "will allow students to learn in an environment similar to that in which they will be working," according to Michael Gerald, Dean of the School of Pharmacy. He adds, "We're replacing facilities that are 40-50 years old. These antiquated facilities do not enhance our efforts to recruit students or faculty. By contrast, the new facility will have state-of-the-art classrooms and laboratories."

The Information Technology Engineering building "will be state-of-the-art in promoting information technology," says School of Engineering Associate Dean Tom Anderson, adding "Wireless connections and fiber optic cable will run throughout the building." Anderson is also excited about the "new labs for fiber optics and computer engineering and teaching labs for new ideas and directions in computer science. Students will get the best there is in terms of a learning environment." The new building will be situated between the Homer Babbidge Library and the new School of Business building, and will be the focal point for Information Technology on campus. Attached to the building will be a 350-seat auditorium which will be available to the university community at large.

UConn is also breaking new ground as a provider of biotech incubator space with its Advanced Technologies Institute Building, a phase II complement to the Agriculture Biotechnology Laboratory. The incubator space will be built adjacent to the graceful main building completed during Phase I, which is "a multidisciplinary structure that includes members of the departments of Plant Science, Animal Science, and Nutritional Science," says Louis Pierro, professor emeritus and on-site manager of the building. It provides ready access to the facilities needed by the scientists working in the building, including a plant biotechnology facility, which is a shared space.

In the Phase II building, flexible laboratory space for industrial tenants will be provided on the second floor. A fully equipped plant tissue culture and micropropagation laboratory will be available for shared use on the first floor. Says Pierro, "We're going to have to look for tenants with interests similar to those of our more active biotechnology labs on campus. Prospective tenants will probably be interested in all aspects of biotechnology. The number of tenants will depend on the need for wet lab vs. office space with computer access." Pierro adds, "My hope is that at least some tenants will be spin-offs building on UConn-developed and owned technology."

Making Maintenance a Priority

Paul Betts, head of Biology Central Services, and the liaison between the Building Committee and the three biology departments of the College of Liberal Arts and Sciences, explains that although the biology faculty is very happy to be getting space in the Pharmacy/Biology and the Biology/Physics buildings, there was a lot of disappointment when the original amount of planned space was scaled back because of funding concerns. The result was that the biology faculty will remain scattered across campus, some in long-term "temporary" housing.

Betts also expresses a concern shared by other members of the faculty: that no appropriations have yet been made for the maintenance of the new buildings. "The standards for maintenance of these new structures with their sophisticated air handling and controls systems are much higher, and additional manpower—especially manpower that is appropriately trained in assessing and correcting faults in these sophisticated systems—is needed to take care of them," he points out. And, although he feels that Connecticut and the university are making progress, "we're behind the eight-ball to start with, and it will take a long time to catch up," he says.

Physics professor Ed Eyler, who has been involved with designing the physics space in the Biology/Physics building, agrees with Betts' concern about maintenance, "I hope that the commitment to capital improvement is matched by a similar commitment to operational resources." Nonetheless, he stresses that "it is good to see it happening. Not very many public universities are undergoing this sort of expansion and implied commitment to research."

UConn Health Center: Building Momentum

At the UConn Health Center at Farmington, a new research building means expansion and revitalization. "The new building has been a tool for advancement," says Richard Berlin, Associate Dean for Research Planning and Coordination. "It has facilitated the recruitment of excellent faculty and provided an environment that emphasizes collaborative and original research."

According to Berlin, the UConn medical school opened in 1967 and the main building was built in 1972. While not completely modern, the building is not outdated, and the medical school doesn't have the infrastructure problems of the Storrs campus. It does, however, share a space problem. Says Berlin, "Faculty recruitment [into the existing space] was complete by the early 1980s, but growth was limited by space." Supported by reviews from the Association of American Medical Colleges that indicated new space was needed, the school requested funding for a new building from the state around 1990.

Although a strategic plan for research and fundraising was developed in 1992, and monies were set aside in 1994 both for the facility and to hire new research faculty, the Rowland administration did not release the building funds until 1996.

Construction began in the spring in 1997 and went quickly.The new building was finished in May of 1999, although one and one-half floors were to remain shell space, as there was no funding to complete them for research uses. Says Berlin, "We decided to allocate the money to a larger footprint with a plan to fund the final part of the construction later. It has been rather painful finding the funds to finish it. It would be premature to say we've got it in the bag."

The eleven-story research building was built in register with the main Health Center building. Says Berlin, "We didn't want a freestanding building. This plan facilitates interactions among different groups." It also allowed people from the same department to be housed on contiguous floors of adjacent buildings, as the neuroscience department is. Built on a hill, with the seating spaces near the windows, the new building permits spectacular views of the surrounding countryside. As an important adjunct to a state-of-the-art research building, a transgenic animal facility is being completed at the basement level.

The most important part of the new building may be what it has allowed the Health Center to accomplish. "We can recruit more than 40 new research faculty," says Berlin, "We formed two new departments [the Genetics and Developmental Biology Department and the Department of Neuroscience], and established four research centers: Microbial Pathogenesis; Immunotherapy, Cancer and Infectious Disease; Vascular Biology; and Molecular Medicine."

"We wanted to reserve much of the building for new initiatives because it was a recruiting tool," says Berlin. "This has been a very exciting time here." With a smile, he adds, "We think we should be planning for a new building."

Connecticut State University System: New Research Opportunities

In the Connecticut State University System, the new science construction heralds not only a welcome change from outdated structures, but also a new emphasis on research. Although the primary mission of the state university system is still teaching, "research is required to get a bachelor degree in science," says Western Connecticut State University (WCSU) chemistry professor Paul Hines, who also chairs the Building Committee. In addition, new faculty are expected to conduct independent research. As a result, the new science buildings at both the Western and Eastern campuses will be outfitted with research laboratories, in addition to new teaching laboratories, classrooms, faculty offices, and administrative space.

At WCSU, "the state funding was originally geared for renovation," says Hines. But during the preplanning stage, Alan Dehar & Associates (the architectural firm who handled the preplanning assessment) recommended that the old science building be renovated for flexible classroom space and a new science building be built from scratch, as doing both would cost less than bringing the old science building up to code. "Some of the best money the state ever spent was on the preplanning," says Hines.

(see Science Facilities , page 12)

Science Facilities *(from page 11)*

At Eastern Connecticut State University (ESCU), Nancy Tinker, Director of Facility Management and Planning, is enthusiastic about the new science building, which she feels is one of several major advances at the campus. As at WCSU, the new building will provide faculty research space for the first time, and the former science building will be renovated for classroom space. Says Tinker, "The president [David Carter] has single-handedly changed this campus from a sleepy little teachers' college to an exciting dynamic place. It is a pleasure to work with a president who understands the connection between the success of an institution and its facilities."

Yale: A Greater Commitment to Excellence in Science

In January of 2000, Yale announced that it would invest $500 million to improve its science facilities, putting up four buildings on its Science Hill campus, building an engineering building on the central campus with the help of a $24 million gift from John Malone, and undertaking comprehensive renovations of many of its other science buildings.

According to CASE member Pierre Hohenberg, Deputy Provost for Science and Technology, although this plan is partially intended to address the consequences of two decades of deferred maintenance, "Yale is also determined to enhance the excellence of its science programs."

To make certain that the renovations at Yale are handled in a strategic, unified way, the improvements to the different geographic regions of the campus have been approached as "area plans." Hohenberg chaired the faculty task force that prepared the Science Hill area plan with the Hillier Group as architect/planners. "It was a culmination of five years of ups and downs," he says, "and attempts to reconcile academic aspirations and plans with physical conditions and fiscal realities. … Yale as an institution is very conscious of its buildings. They are important for defining Yale to itself and to the outside world."

According to Hohenberg, "there is a sense that Science Hill is far from town and not central to Yale College. We can't change the geography, but we want to change the message to say that science is central to education, especially undergraduate education."

The plan is intended to "make Science Hill a place where students want to be. Attention will be paid to social interactions." As a result, besides the four new buildings that will be added to Science Hill, and the extensive renovations to existing buildings, the landscaping, paths, and architectural environment will be designed to enhance congeniality and foster communication. In addition, some facilities will be relocated; for instance, the dining hall will be in a more central, ground floor location, in an attempt to bring people together.

Another plan to help undergraduates feel more engaged in science is to "bring the mountain to Mohammed for large enrollment courses," says Hohenberg. To do so, new lecture halls for introductory science courses will be built on the central campus.

The Science Hill area plan calls for the campus to be divided into two major groupings. The southern portion will have an environmental focus, and will include the Yale School of Forestry & Environmental Studies, the departments of Ecology & Evolutionary Biology, Geology & Geophysics, and the Peabody Museum. A new Environmental Sciences facility is currently under construction next to the Peabody museum, and will open in late 2001. A Forestry & Environmental Studies building is also planned for the southern campus.

The northern portion will have a molecular focus and include the departments of Chemistry, Molecular Cellular & Developmental Biology (MCDB); Molecular Biophysics & Biochemistry; Physics and Astronomy. Architects have been hired to design a new chemistry research building, and a new MCDB research building is also planned.

Yale School of Medicine: A Major Expansion

"This will be a signature building. Robert Venturi designed the exterior. It is in the neighborhood of buildings completed in the last decade by Cesar Peli and Frank Gehry." John Bollier, Director of Facilities Development and Operations at Yale University School of Medicine, is speaking about the massive new Biomedical Research and Teaching Building that is going up next to the medical school. "The new building will provide a 30% increase in existing laboratory space at the medical school," says Bollier. Considering that the medical school complex consists of many separate buildings all primarily devoted to research, a 30% increase means a large amount of laboratory space—136,000 square feet of it, to be exact. "Assignment to the research space will be program-based, rather than department-based," says Bollier. The building will also house the gross anatomy facility, a transgenic animal facility, teaching laboratories, and the Magnetic Resonance Research Center, with two new 4-Tesla magnets.

The new research building is part of a 10-year, $500 million capital improvement project that is being implemented at the medical school. The project will also involve renovation of the Sterling Hall of Medicine and some of the other older medical school buildings, to bring them up to current heating, ventilation, and air-conditioning standards.

According to Bollier, in the past 10 years, the standard has "moved to single-pass air"—technology that passes air through the building without recirculating it. "It is incredibly energy intensive, but considered safer," he says. The older buildings also need more steam and chilled water, and "the power requirements for labs have increased over the last 40 years," says Bollier, "so electrical upgrades need to be done." He adds that some of the older buildings are no longer suitable for wet lab use and will be decommissioned.

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UConn's Environmental Research Institute

From LIDAR to NEMO, Unique Storrs Facility Nurtures Critical Pollution Research

This is the second article in a two-part series on environmental science research at Connecticut's two largest universities. Part I, which appeared in Vol. 15,4 (Fall, 2000), highlighted research at Yale University.

Concentrations of less than one part per trillion? That's the equivalent of a single drop mixed into the water from a million swimming pools. It's not much. But in order to solve subtle and complex environmental problems such as, for example, the die-off of lobsters in Long Island Sound, environmental researchers must be able to detect contamination at those minute levels. And they can, at the University of Connecticut (UConn), with sophisticated analytical equipment available at UConn's Environmental Research Institute (ERI), and found nowhere else in the Northeast.

It's this type of capability, says ERI Director and CASE member George Hoag, that has attracted many faculty members to the university, and is in some measure responsible for the wide variety and high quality of environmental work done there.

Founded in 1987 to support and encourage environmental research at the university, ERI has grown to include about 40 professors. Last year, says Hoag, ERI did $6.5 million of externally funded research—a jump of 40% from the year before.

ERI has helped bring top-level professors to the university. "We work with department heads and deans when they have searches to communicate to them what areas of opportunities exist. If there is an outstanding faculty member, we financially help them attract that member."

Once a professor has come, ERI continues its assistance: hiring postdoctoral fellows, helping to write proposals, buying equipment. ERI provides office help to rescue researchers from housekeeping chores. "Our goal is to help faculty be more successful in their research," says Hoag. "If they're spending their time excessively dealing with personnel matters or purchasing, that takes away from the time they could be doing their scholarship."

ERI provides researchers with access to specialized equipment. To study real-life problems, instead of, for example, the way a single chemical behaves in a model system, a researcher may need to analyze "hundreds if not thousands of chemicals, often at very low concentrations." ERI offers that ability. "We can analyze any compound that a faculty would want—waste samples from an industrial landfill, sludge from river or marine sediments, air … We have the capability to analyze biological tissue for literally any organic or inorganic compound." There aren't many university-based facilities around the United States with as significant a capability, says Hoag.

The Institute sets few limits on the work it takes under its umbrella. "We just look for areas of promising research," says Hoag. ERI-supported projects range from bioengineering bacteria to cleaning up toxic chemicals to developing zero-valent iron filters to removing arsenic from potable water to researching ways to make fuel cells more efficient and less costly.

The organic laboratory at UConn's Environmental Research Institute. (Photo: John Collins, UConn/UCIMT)

Dr. David Miller, a micrometeorologist and atmospheric scientist, studies the movements of airborne particles, or aerosols. His work helps keep pesticides in their place.

It's not trivial to spray pesticides so that they end up where they belong: researchers have found that as much as 25% of all pesticides sprayed end up unaccounted for. Miller, who began by researching methods of quelling gypsy moth infestations in forests, has developed wind-field models for plant canopies which help predict where aerosols go.

To test his theories, Miller has developed a device, a LIDAR, with the ability to track moving droplets in mid-air. Miller describes the LIDAR, which he based on a similar instrument at Los Alamos National Laboratory, as similar to a laser radar. It consists of a laser and a telescope. He and his colleagues hire an airplane to release aerosols—usually water marked with a dye. The LIDAR emits laser beam pulses, which hit the aerosols, returning scattered light which is captured by the telescope and analyzed electronically. The device enables researchers to follow the plume in the air, observing how relative concentrations change over time and space. "At the moment," says Miller, "we're writing software to work out the graphics that show where the plume is going, and how it moves."

Miller's research shows that atmospheric stability is one key to aerosol movement. "During the day, the surface gets warm, the air rises, and we have convective, or unstable, conditions." At night, conditions are reversed. Because the ground surface is colder than the air above, aerosols stay near the ground. That doesn't mean, though, that it's necessarily better to spray at night. Aerosols, Miller explains, have to go somewhere. "So if you have a slope at all, the plume will move downhill, and if

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the droplets are small, they won't catch on anything, they'll stay in the air." The highest concentrations of aerosols in, say, downwind adjacent fields tend to occur during stable—nighttime—conditions.

Miller's work could also be used to track pollutants. Any time you have a spill of toxic material, some of those compounds enter the atmosphere, he explains, and LIDAR could monitor where the airborne material goes. His current LIDAR can be used to follow particles from smokestacks, the backs of cars, and even dust that blows up from fields. Understanding the movement of airborne particles could be important in military battlefield applications, forest fire smoke management, air pollution monitoring, and visibility improvement as well as pesticide drift.

"Once we learn how the aerosols move in the atmosphere," says Miller, "then we can figure out how to manage them." If you understand the process, he adds, controlling it turns into a matter of technology and money.

Hydrologist Fred Ogden also models movement—of water. Understanding runoff patterns is his concern. For the past eight years, Ogden has been developing a hydrologic model that is, he says, significantly different from the standard practice model. The standard model, he explains, treats a watershed as a black box, its internal workings indecipherable and therefore ignored. Instead of trying to understand an actual watershed, researchers rely on simple linear equations to predict the effects of rainfall. "If you put in one unit of rainfall, you get this amount of runoff. If you put in two units, you just double the response function." In some cases, Ogden explains, that's not a bad method.

But there are drawbacks. "Since the models lack physical basis, they tend to be 'lumped' over the whole watershed. They assume that the watershed is one unit, and they give no information about what's happening inside." They don't account, he explains, for the spatial variability of rainfall and watershed characteristics.

Ogden's model is exactly the opposite. CASC2D (CASCade of plane, 2-Dimensional) is a physically-based model that divides a watershed into a grid, and then collects specific data for each square: land surface elevation, amount of rainfall, soil texture, and land cover. This kind of detailed model is far more time-consuming to use. But it does offer the ability to track what happens inside a watershed.

This means that it can, for example, simulate more accurately the outcome of extreme events, like a flood. Ogden points to a 1997 flash flood in Fort Collins, Colorado, which killed five people and destroyed 200 homes. This flood was disastrous because the rainfall was concentrated at one end of the watershed, a situation CAS2D is designed to handle. A standard practice model, which averages total rainfall across an entire watershed, would predict a far smaller runoff event. CAS2D, which analyzed the Colorado flood after the fact, could eventually be used to give early warning of such disasters.

The model offers other capabilities. Because it can predict detailed runoff paths, it could eventually be used to track contaminants. It predicts soil moisture and erosion, which has led the Army Corps of Engineers to use it in managing army training grounds. "A lot of army lands are in fragile ecosystems, like deserts, or semi-arid areas, where a tank can do a lot of erosive damage." CAS2D can be used as a diagnostic tool, says Ogden, to answer questions such as: "If we keep training over here with the intensity that we are now, what will be the impact on erosion and runoff of sediments over the next five years?"

Among the processes simulated by runoff models is the infiltration rate: the speed with which soil absorbs water. In most of the country, the ground saturates from above; that is, rain collects on top of the soil faster than it sinks into the ground.

In Connecticut, the situation is different. Here in the Northeast, the soil tends to be shallow. When the glaciers swept down, they scoured it away, leaving behind a "jumble of rock and gravel and sands." So, when it rains in the Northeast, Ogden says, the water seeps right into the soil. This means that the model parameter values used to examine runoff in the rest of country are probably not applicable to Connecticut watersheds.

In addition to his CAS2D work, Ogden has been studying the way runoff behaves in Connecticut. In Connecticut, floods tend not to happen immediately. Instead, rainwater infiltrates the ground, moves downhill within the subsurface, and raises the water table. Eventually, it may reach the surface and start to back up. Ogden hopes to provide researchers with Connecticut parameters for their models. These are needed, he explains, so that engineers can design structures, like culverts, or subdivisions, in a way that prevents floods.

But increased flooding is only one reason to worry about runoff. Pollution is another. As rainwater moves over the land, it picks up the contaminants lying on the ground—nitrogen, phosphorus, heavy metals, pathogens—and sweeps them into nearby lakes and streams. This polluted runoff, or non-point source pollution, is the primary source of water quality problems in the country today.

Here in Connecticut, an innovative program is directed at managing this issue. NEMO, Non-Point Source Education for Municipal Officials, was started in 1991 through UConn's Cooperative Extension System by university field faculty Dr. Chet Arnold and Dr. Jim Gibbons, who still co-direct the program. It is based on the knowledge that non-point source pollution can be reduced by proper land use, and on the insight that land use is ultimately controlled at a local level.

NEMO grew out of a 1991 Environmental Protection Agency (EPA) study of nitrogen pollution on Long Island Sound. "I was

frustrated," says Arnold, "that town officials didn't seem to be targeted for very much educational information with regard to water problems." There were large federal and state studies going on, he notes, but these were largely intended for state regulatory officials. The folks at the local level, who could actually put the information to use, weren't in the loop.

NEMO set out to change that. As an educational program, its goal is to teach town officials "enough about the larger picture so that they can ask the right questions when development is proposed." NEMO promotes the concept of natural resource-based land use planning; that is, planning based on identifying a town's resources, and then deciding what to protect and what to develop.

What makes NEMO effective, says Arnold, is that it presents these ideas to townspeople in the context of their world. "What we try to do, is show that, OK, water quality is what we're here for, but we realize that it's a function of land use. Then we start to tease apart all the other things that have to do with land use: the design of neighborhoods, the width of roads, the sidewalks, the parking, wetland review. Then, they start to be able to absorb it because it's been incorporated into their world." We spend a lot of time, says Arnold, taking technical information and trying to make it useful to these people.

Through GIS—geographic information systems—and other technologies, NEMO is able to illustrate the consequences of land use decisions. GIS-derived maps can, for example, estimate current levels of imperviousness based on remotely sensed land cover data. They can demonstrate alternative land use futures, showing how a town may look in the future if it is zoned in a particular way. Software currently under development will use interactive mapping to provide remotely sensed data on impervious cover. It will offer landscape rendering techniques which show buildings, making scenarios easier to grasp.

When Arnold talks about NEMO's accomplishments, he mentions things like zoning regulation changes and modified subdivision design. For example, Laurie Giannotti, NEMO's Connecticut Programs Coordinator, is helping Old Saybrook review its road standards. "Instead of piping storm water through catch basins, and using curbs, they're going to allow new developments to have roads that are narrower, and that drain off into grassy areas so that they produce less runoff," she says.

"Changing road standards sounds really boring," says Arnold. "It is really boring. But it has a very significant kind of impact."

NEMO's most important achievement, however, could be its ability to change people's minds: to help them realize that runoff matters, and that it can be controlled. In this, the program has been increasingly effective; it has already worked with over half of Connecticut's municipalities. In recent years, NEMO has averaged 150 presentations annually within Connecticut alone. Nationwide, over 19 states have already adopted the NEMO approach in some form. And NEMO is still developing new research, new tools, and new educational approaches.

But once a town, or even an individual, decides to address the issue of polluted run-off, then what? Altering road width, as in Old Saybrook, is one possibility. Others abound.

Dr. Jack Clausen, of UConn's Department of Natural Resource Management and Engineering, is evaluating how effective these "best management practices" (BMPs) actually are. His unique Jordan Cove project—the only federal study to examine BMPs in an urban/suburban setting—comprises twinned developments on the site of an old chicken farm in Waterford. One area, with 17 houses, will serve as the traditional section: it's a development like any other. The second, with ten homes planned, will incorporate a variety of BMPs: road surfaces that allow infiltration, bioretention gardens, shared driveways, home owner education on fertilizer use, and more. The study will monitor the developments over a six-to-ten year period.

Roads and other infrastructure—sewers, water, electricity—have already been completed in both neighborhoods. On the BMP side, the road was constructed of pavers: hexagonal tiles that fit together in such a way as to leave gravel-filled spaces for water to flow through.

"We're also doing driveway treatments," says Clausen. "We're going to be comparing this paver to a gravel driveway, an asphalt driveway, an old-style two-track driveway, pervious concrete."

The BMP section will replace roadside sewers with grassy swales, designed to retain runoff on site. The ten-foot-wide swales are designed to look like part of a lawn. But underneath, to encourage infiltration, lies several feet of pervious sandy loam. Bioretention gardens on each lot also accept runoff. "We're saying that the big issue here, the first enemy, is the amount of water coming off site. If you can slow down the amount of water coming off, you're going to slow down the non-point source pollution problems."

Clausen is also involved in a project to find ways to slow runoff in already existing neighborhoods. In agricultural areas, he says, farmers understand that their actions affect water quality. But in urban/suburban areas, individuals don't yet take responsibility for the runoff on their land. Clausen believes that should happen.

But significant challenges remain in understanding the management of runoff in urban and suburban areas, says Clausen. "How good can we get? What's achievable in new development, and how can we retrofit already existing neighborhoods?" Jordan Cove will provide some of the answers.

"If you look at the environmental research that's being done [at Uconn], it's really of high quality. It's very significant work," says George Hoag. It makes sense, he says, for a land-grant university in a state like Connecticut, with rich natural resources, to have a strong environmental research program. "The thing I'm most proud of," he says, "is how we have developed that over the past decade."***— Karen Miller, science writer.***

Science Facilities *(from page 12)*

One other piece of new construction will be an addition to the B-wing at the back of Sterling Hall of Medicine. The extension will be completed in 2002, and "will clean up the perceived back door of the medical school," says Bollier, and hide the loading dock. This change will a undoubtedly be a pleasant one for the Yale Child Study Center, whose own "front door" and handsome octagonal Neison and Irving Harris building (opened in 1999) are adjacent.

Commitment and Promise

The impressive surge in construction in pharmaceuticals, academics, and biotechnology reflects the growth of Bioscience as a whole in Connecticut. According to the Fifth Annual Economic Report put out by CURE (Connecticut United for Research Excellence), which organizes the state's Bioscience Cluster, growth in the sector is outstripping expectations, with a 75% increase in research and development spending from 1995 to 1999, and a 42% increase in employment over the same time period.

The commitment to science in the form of capital expenditures by academics and industry promises rich resources for mutual enhancement in the different segments of the Cluster, both in opportunities for collaboration between basic research and industry, and in the generation of the highly trained workforce needed to support this fast-moving industry. As CURE President Debra Pasquale said, "This is a time of unprecedented opportunity and potential in our goal to achieving global leadership in bioscience, and that's cause for great celebration."***—Grace Gray, science writer***

New Venues for Biotechnology

Expansion isn't limited to the pharmaceuticals and universities. Biotechnology is also looking at a number of new venues.

In Hamden, construction will soon start on the Hamden Bioscience Campus, which is a collaborative venture between Kaleng Construction and O+A Architects, both of Fairfield. With 750,000 square feet of planned laboratory space, this dedicated biotech facility is designed to provide a state-of-the-art research space, including redundant utilities to prevent disruptions to research.

In Hartford, the Biomedical Engineering Alliance and Consortium (BEACON), has extended its efforts to promote collaboration between industry, academia, and medicine into its third phase—business incubation (see *CASE Reports,* 14,1). Beacon has moved into new quarters at One Congress Street in Hartford, where it will be offering "dry" laboratory and office space to new and emerging businesses. Access to "wet" laboratory space can also be arranged through BEACON partners.

New Haven's Science Park Development Corporation (see *CASE Reports*, 14,4) recently approved a development agreement with Lyme Properties LLC of Cambridge, MA. Lyme properties will have the exclusive right to develop Science Park, including the renovation of existing facilities and the construction of new ones. The total cost could exceed $200 million.

In downtown New Haven, the old SNET building at 300 George Street is being renovated as laboratory space and already has two tenants, Achillon Pharmaceuticals and Molecular Staging. The developer for the George Street Biotechnology Center is Winstanley Enterprises of Concord, MA.—G.G.

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