CIVIL and ENVIRONMENTAL ENGINEERING

CORNELL ENGINEERING

UPDATE

Spring 2011

Lines of Evidence

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Cornell University

FROM THE Director


Phil Liu

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On cover:
Micrograph of bacterium, JS666, courtesy of T.E. Mattes.

Dear alumni and friends,

It has been a busy and productive year with many exciting things happening in the College and the School. First of all, professor Lance Collins, former Director of Mechanical and Aerospace Engineering School, became the Dean of Engineering College on July 1, 2010. He has been engaging faculty and staff in developing a new strategic plan for the College.

In our School assistant professor Ricardo Daziano joined our faculty after receiving his PhD in economics at Université Laval in Québec City in January 2011. His specialties are in microeconomics and applied econometrics of consumer behavior and, more specifically, in discrete choice modeling. His strengths add a new dimension to the area of sustainable systems engineering in both teaching and research.

I am happy to report that we are conducting a new faculty search in the area of structural engineering with a special focus on uncertainty quantification and probabilistic mechanics. We are searching broadly in many application areas, including smart and multifunctional materials, earthquake engineering, risk and reliability, hybrid physical/computational evaluation of materials and structures, sensing and structural health monitoring, and novel structural systems and materials supporting sustainable energy systems. We are hopeful that we will have another new faculty member in the fall of 2011.

Last fall, both undergraduate civil engineering and environmental engineering programs successfully underwent the Accreditation Board for Engineering and Technology (ABET) review. The site visit team praised our faculty for their dedication to both teaching and research. They are also very impressed by our fluid teaching laboratory and the White Instructional Facility. Although the official announcement will not come before the end of spring, the official exit briefings suggest that both programs will receive the full six-years accreditation.

Our faculty continue to conduct cutting-edge research in many fronts and receive national recognition. Most recently, the Strategic Environmental Research and Development Program (SERDP) of the Department of Defense honored professor Jim Gossett and his colleagues for their project, *Elucidation of the Mechanisms and Environmental Relevance of cis-Dichloroethene and Vinyl Chloride Biodegradation.* The project represents a culmination of years of research on the degradation of a variety of chlorinated ethene compounds and is significant in that the researchers were able to solve a key challenge in identifying organisms that can break down cis-dichloroethene and vinyl chloride. They were also able to analyze the degradative pathways used by the microbes. This is important in developing necessary so-called lines of evidence for assessing the progress of bioremediation at contaminated sites. (Professor Gossett's research is highlighted beginning on page three.)

In February 2011 I was very pleased to meet several alumni in an informal gathering in San Francisco. Then, in March, Dean Collins and I traveled to Asia to attend an alumni event in Beijing. We connected with key universities in Taiwan and China and met more alumni.

As always, we like to hear from you. Please feel free to send an email or drop in to visit; and, don't forget to join us for the annual Alumni Breakfast during Reunion weekend (see date on back cover). Come and celebrate with us.

Sincerely,

Class of 1912 Professor and CEE Director

lines of EVIDENCE

CEE Professor Jim Gossett's award-winning research collaboration leads to second quest

The culmination of years of research on the degradation of a variety of chlorinated ethene compounds led CEE professor **Jim Gossett** and fellow researchers to identify organisms that break down cis-dichloroethene and vinyl chloride as well as analyze the degradative pathways used by the microbes. Their research is important in developing necessary lines of evidence for assessing the progress of bioremediation at cis-dichloroethene and vinyl chloride-contaminated sites.

Their project, entitled the *Elucidation of the Mechanisms and Environmental Relevance of cis-Dichloroethene and Vinyl Chloride Biodegradation,* was conducted for the U.S. Department of Defense and won the Strategic Environmental Research and Development Program's Environmental Restoration Project of the Year award for 2010. Team members include Gossett, Evan Cox of Geosyntec Consultants, Inc., Jim Spain of the Georgia Institute of Technology, and Elizabeth Edwards and Barbara Sherwood Lollar from the University of Toronto.

Gossett's bioremediation work began almost three decades ago as he researched ways in which toxic pollutants could be degraded in the soil and ground water at contaminated sites. His particular focus was chlorinated ethenes (chloroethenes), one of the most common groundwater pollutants in the United States.

This group of synthetic compounds came into wide use after World War II, as they were used by both military and private industry as chemical feedstock, industrial cleaners, and solvents. From the 1940s through the 80s, chloroethene solvents were used in mixtures to degrease and decarbonize machinery, in dry-cleaning fluids, and even to decaffeinate coffee.

Whether through spills or leaks during use, or improper disposal after use, they found their way into the soil and water of thousands of sites worldwide. Close to home, chloroethene-contaminated groundwater can be found beneath Ithaca, Cortlandville, Endicott, and other nearby locales. According to Gossett, every strip mall in America with a dry cleaner is also probably underlain with chlorinated ethenes.

In the late 1980s and early 1990s, awareness of the toxicity of chloroethenes grew and research was beginning to show that several were suspected human carcinogens. This was also the era when the federal government decommissioned many military bases. Chlorinated ethenes were in common military use for aircraft and vehicle maintenance as well as for paint stripping and general building maintenance. Barrels of the solvents were often dumped at sites on bases, creating toxic underground plumes that contaminated the ground and water.

When bases were decommissioned and the military wanted to sell the land back to the public, they faced the difficult task of cleaning up the toxic sites before they could sell them. The U.S. Department of Defense became a major sponsor of research on remediation of these sites, funding research like Gossett's to help find new, more effective ways to break down the toxic compounds. (The Strategic Environmental and Development Program and its sister department of defense program, the Environmental Security Technology Certification Program, currently fund over $100 million a year in environmental research.)

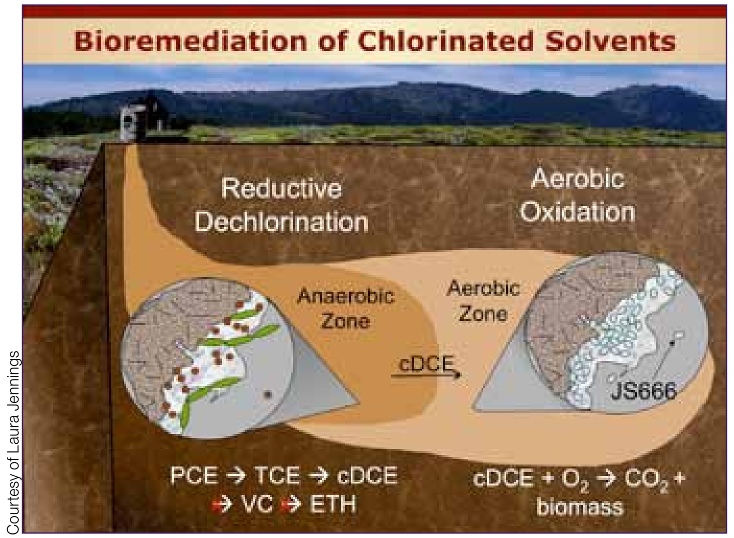
Prior cleanup methods included pumping out contaminated ground water and/or simply removing the contaminated soil. These methods had limited effectiveness as the toxic groundwater plumes had migrated over the years—often into inaccessible areas. The toxins tended to adhere to soil particles, making their extraction difficult. Such methods were also expensive. Therefore, Gossett and others were working on microbiological solutions that were more cost-effective and could produce better overall results.

The chlorinated ethenes include tetrachloroethene (PCE, with four chlorine atoms), trichloroethene (TCE, with three chlorines), dichloroethene (cDCE, with two chlorines), and vinyl chloride (VC, with one chlorine). In the late 1980s, Gossett, with his student, Dave Freedman, showed that some microorganisms in environments without oxygen could transform chlorinated ethenes by a stepwise process called reductive dechlorination that successively replaces chlorine atoms, one at a time, with hydrogen atoms, leading to the benign, non-chlorinated product, ethene.

About ten years later, Gossett, along with Cornell microbiology colleague, Steve Zinder, isolated the first bacterium, *Dehalococcoides ethenogenes*, capable of the complete dechlorination of PCE to ethene, paving the way for a suite of bioremediation technologies directed at chloroethene-contaminated sites. This was an elegant solution to the problem for many reasons, cost-effectiveness and efficacy being the main two.

Bacteria can access the toxic compounds and break them down where they are, whether sorbed to soil or not. As PCE and TCE, the most common initial chloroethene contaminants, are remediated by this reductive process, the appearance of lesser-chlorinated ethenes—

“Lines of evidence are critical to regulatory approval of a proposed bioremediation alternative.” *James Gossett*



Courtesy of Laura Jennings

referred to as daughter products—marks the breakdown process and allows the progress of remediation to be monitored and charted.

The ability to monitor the progress of the bioremediation is important, as such lines of evidence are required by state and federal regulators to demonstrate bioremediation effectiveness. It's not sufficient merely to claim remediation is happening because of an observed decrease in concentration of the original contaminant; that can be the result of dilution/dispersion, rather than real mass loss. Lines of evidence are critical to regulatory approval of a proposed bioremediation alternative.

Bioremediation of chloroethene-contaminated sites is achieved through a variety of technologies, including monitored natural attenuation, the process of letting nature degrade the toxins into non-toxic compounds with little outside intervention; and enhanced in situ bioremediation, where indigenous bacteria are stimulated by addition of nutrients and/or buffers.

More recently, bioaugmentation, the addition of specially adapted microbial cultures, has been employed with enhanced in situ bioremediation at some sites to speed the remediation process where suitable indigenous organisms are either absent or at low concentration. Gossett's various research programs have been directed at all of these bioremediation alternatives.

After years of investigating anaerobic reductive dechlorination, Gossett turned his attention to transformation mechanisms for chloroethenes occurring under aerobic, or oxygenated, conditions. The redirection of effort was the result of the increasing number of his encounters with sites where lesser-chlorinated daughter products (cDCE and VC) had apparently disappeared upon migration into oxygenated zones.

It is known that cDCE and VC can be oxidized to CO_2 by oxygen-breathing microbes, but only if some other energy or carbon source such as methane is also present, as the microbes derive no apparent benefit from the oxidation of cDCE or VC. Indeed, the intermediates of chloroethene oxidation by O_2 are actually quite toxic to the microbes that carry out this process.

Yet the role of oxygen-dependent degradation in the absence of co-substrates like methane was not well established. So Gossett, with Spain, their students and post-doctoral students, searched for O_2-linked oxidation of VC and found it in about half the sites where they looked. They went on to isolate and characterize 12 strains of bacteria capable of growth from aerobic oxidation of VC without co-substrate and delineated the biochemical pathways used.

More importantly, they isolated and characterized the first, and still the only, microorganism, *Polaromonas* sp. strain JS666, capable of deriving growth using oxygen to degrade cDCE to CO_2. As the only such organism known, JS666 is a candidate for use as a bioaugmentation agent at sites where the PCE/TCE daughter product, cDCE, has migrated to oxygenated zones in the subsurface. Gossett and his Geosyntec, Georgia Tech, and University of Toronto colleagues are actively developing this technology and have conducted a field trial of bioaugmentation with JS666 at a cDCE-contaminated site in Chesapeake, VA.

Still more recently, Gossett searched for evidence that lesser-chlorinated ethenes (cDCE and VC) could be oxidized (to CO_2) in the absence of oxygen. This SERDP-sponsored research derived from mysterious disappearances of cDCE and VC in what were allegedly oxygen-free zones without concomitant appearance of the expected daughter products from reductive dechlorination (VC and ethene, respectively).

“At some sites, the absence of a mass-balance in oxygen-free zones between parent compounds and expected products of reductive dechlorination has led investigators to postulate the existence of oxidative mechanisms occurring under anaerobic conditions,” Gossett explains. “Examples would be oxidative mechanisms coupled to iron or manganese reduction.”

A lengthy, but ultimately unsuccessful search, for such microbes was conducted and over 400 bottles of site sediment and groundwater screened.

Sampling soil at a chloroethene-contaminated site at the Savannah River National Laboratory in South Carolina

Gossett's team then began to explore the possibility that the supposed anaerobic conditions cited by other researchers who witnessed VC or cDCE oxidation to CO_2 were actually aerobic and that oxygen was present at such low concentrations as to be virtually undetectable. With some elegantly simple experiments in which oxygen was slowly permeated into microbial cultures, Gossett was able to demonstrate the sustained, aerobic oxidation of VC at steady-state oxygen concentrations below 0.02 mg/L—conditions easily confused with anaerobic by current, state-of-the-art, field-characterization tools—according to his 2010 article, “Sustained Aerobic Oxidation of Vinyl Chloride at Low Oxygen Concentrations” in *Environmental Science and Technology.*

While one can never prove something does not exist, Gossett's research raised the bar, with respect to claims for anaerobic oxidation, while suggesting a plausible explanation for the disappearance of lesser-chlorinated ethenes from supposedly oxygen-free zones without the appearance of the usual daughter products of reductive dechlorination. All of this prompts the need for tools to assess and monitor the now myriad transformation possibilities for the chlorinated ethenes at subsurface sites and makes lines of evidence necessary.

Tracking the appearance of lesser-chlorinated daughter products easily monitors reductive dechlorination—the conversion of higher-chlorinated choroethenes to ethene. However, oxidative processes of chloroethene transformation merely result in carbon dioxide and chloride—products already quite abundant in the subsurface. With increased awareness of the importance of such oxidative processes in remediation of chloroethenes, comes the problem of providing regulators and stakeholders with evidence of them and of monitoring progress during bioremediation. Any apparent decrease in concentration of chloroethenes is insufficient proof of degradation activity since poor mass-balances are a fact of life in dealing with subsurface groundwater contaminant plumes.

Therefore, Gossett and colleagues are focusing their research on developing lines of evidence based on biomolecular and isotopic markers. An enhanced understanding of the biochemical transformation pathways for oxidative transformations of chloroethenes is leading to molecular probes based on genes and transcripts (mRNA) that are specific to the relevant microorganisms and their relevant transformation pathways. Such tools have already been successfully applied in the bioaugmentation field trial of JS666 to track the distribution of the microorganism in the aquifer after its addition.

Compound-specific isotopic analysis offers an additional assessment tool. Gossett's collaborators at the University of Toronto, Edwards and Sherwood Lollar, are providing the team's CSIA expertise. Carbon atoms exist in different isotope forms. The transformation of chloroethenes changes the ratio of heavy (13C) to light (12C) carbon atoms in the remaining pool of chloroethenes because molecules with the lighter isotope are biologically transformed faster than those with the heavier isotope.

Monitoring isotopic enrichment, such as the change in 13C/12C, is one tool being investigated by the research team. The degree of enrichment can also distinguish between reductive and oxidative transformation mechanisms because breaking C-Cl bonds results in a different isotopic enrichment signature than the breaking of C-C bonds.

While there is much work still to be done, Gossett—with his students and collaborators at Geosyntec, Georgia Tech, and the University of Toronto—are collectively contributing to the arsenal of bioremediation technologies and monitoring tools that address an important contamination problem of global significance.

Student Project

Engineering answers to sustainable cooking

Building a cooker in Sabana Grande

Engineers for a Sustainable World are applying knowledge gained in CEE 4920 to improve the design of existing solar cookers used in Sabana Grande, Nicaragua. The cookers provide a sustainable alternative to wood-fired cooking—a method that substantially contributed to the area's deforestation.

In collaboration with Grupo Fenix, part of the Universidad Nacional de Ingeneria in Nicaragua, and Las Mujeres Solares de Totogalpa, a women's organization in Sabana Grande, the team is working to find better insulation materials and improve the cooker's design. The CEE team has worked with the groups since 2006 to make the cookers more robust, easier to build, and easier to repair.

The three major factors in the cooker's design are always expense, use of locally available materials, and the customs and needs of the women receiving them. To decrease the cost and make the materials easily accessible, the team only uses items available in Nicaragua. The framing is made of local wood and cut by local carpenters and the women of Las Mujeres Solares de Totogalpa. It is assembled to form an inner case frame. The exterior casing is made of light galvanized sheet metal—a practical cover for the moist climate—and the interior casing is made of fiberboard and very thin aluminum sheets that came from recycled newspaper printing plates. The top is double-glazed, and all the cavities are insulated while a thin steel, black plate on the cooker's floor absorbs light and converts it to heat. The heat is then transferred to pots inside the cooker through conduction, convection, and radiation. On a clear, sunny day, these ovens typically reach 160°C or 320°F, warm enough to cook most foods.

Grupo Fenix and Las Mujeres Solares de Totogalpa partnered with the CEE team since 2006 to increase awareness of sustainable technologies and expand uses of renewable energy. Members of Las Mujeres Solares de Totogalpa formed a collective to develop, build, sell, and use solar cookers to reduce the amount of cooking done with wood. CEE's solar cooker team and Grupo Fenix work to support their efforts. Reducing the need for woody fuels helps keep women and female children from undertaking the dangerous task of collecting wood. Every day they walk several kilometers, machetes in hand, to bring back fuel for their adobe ovens. In addition, women and children encounter allergens and irritants released by the burning wood as they cook causing smoke damage to their lungs and eyes.

In past collaborations with Las Mujeres, the team improved the glazing, interior case, door, and lid of the solar oven, and with the high quality of technical exchange and the development of strong, supportive, and respective long-term relationships, the CEE team and Nicaraguan groups expect their partnership will remain fruitful.

GIVING BACK

Alumni contributions make a mark on CEE

CEE Class of 1949 alumni (front to back) Carl Irwin, Bob Engelbert, Lee Regulski, Dirck TenHagen, Wendel Kent, John "Jack" Gilbert, Lee Metzger, Walter Priester, Jim Spencer, and Russell Meyer. Not pictured: Norm Baker, Paul Carver, George "Skip" Freeman, and William Langhorst.

Inspired by the success their exemplary education provided, CEE alumni are champions for their school. After more than 60 years of dedication, the class of 1949 is no exception.

"There's this feeling in America that you should contribute to organizations that have helped you," Wendell Kent '49 said.

Individually, and as a group, Kent's class consistently endeavors to give back to CEE. From a fellowship to project funding, alumni contribute their resources to bolster the school's students, their educations, and the future of the profession.

"As your career progresses, you begin to ask: why am I here? And, the big answer that comes back is, 'I got a degree from Cornell,'" Jack Gilbert '49, the class president, said. "So you want to give back."

The first class fundraising effort was a fellowship for their 45th reunion. In honor of the occasion, they decided to contribute money for what they called a Master of Engineering Fellowship Fund in Civil Engineering. The scholarship helps students pursuing their undergraduate and master's degrees in five years.

The project was a success, and the spirit of giving only grew.

"We didn't have anyone who had huge amounts of money, and, if we did, we didn't know it; so someone in the School suggested we raise money for an electronic classroom," Kent said. "But, 50 people giving $1,000 starts adding up, and the professors tell me every little bit counts."

The electronic classroom opened in 1994 and was the first of its kind on the engineering quad. Its success led to the next class project: a curing room for concrete.

At the time, the School stacked freezers, one on top of another, when specimens needed temperature control. However, with donations from the class of 1949, the School was able to install a new temperature-controlled curing space in the Bovay Laboratory. It is now the best temperature-controlled space in the School, Tim Bond, the lab manager, said.

The Class of 1949 is just one example of CEE alumni rallying to strengthen their School. All alumni support plays a valuable role in student preparation for the working world, Director of Administration for CEE, Joe Rowe, said. It also strengthens CEE as it continues to be a leading institution in the civil and environmental engineering fields.

"At CEE, you learn the profession," Kent said. "You're learning specific things you have to learn somehow to be part of that profession—the tools of the trade. Where else can you learn them?"

Kent, his classmates, and other CEE alumni, know their selfless donations to the School and its programs play a positive role in the success of future engineers. Just as CEE put them on the road to success years ago, their contributions can help CEE launch others' careers today.

"My husband thought CEE gave him a good education; he made many friends, and it fulfilled all expectations for him," Joy Gilbert, wife of the late Richard Gilbert '49, said.

Therefore, Gilbert still contributes to the School where she met her husband as an undergraduate in home economics, and though she left Cornell to marry him, she returned for every CEE class of 1949 reunion, and plans to continue that strong class tradition.

At each reunion Gilbert's husband would take a class picture to send to CEE and the class president. In between events, the class would catch up on one another's lives but always end up asking what they could do to support their School.

"The civil engineers are a very loyal bunch," Joy Gilbert said.

They know without their CEE education, they would not be able to achieve the success they have today. Their generous donations and steadfast support help the School not only keep up with technological advances but also provide instruction and cutting-edge research opportunities for students.

"It takes alumni support to make this happen," Rowe said, and the students, faculty, and staff are grateful.

RICARDO**DAZIANO**

Ricardo Daziano showcases engineering design features of a low emission vehicle.

Adding new dimensions to sustainable systems engineering

Ricardo Daziano joined CEE in January, bringing with him a background in engineering and economics, and adding a new dimension to the area of sustainable systems engineering in the School.

With undergraduate and master's degrees in engineering from the University of Chile in Santiago and a PhD in economics from the Université Laval in in Québec City, Canada, Daziano is sharing his passion for math, engineering, and economics with CEE students as he continues his research on theoretical and applied econometrics of consumer behavior using discrete choice modeling—a tool used to understand how qualities of a good can affect consumers' decisions.

Bridging the gap between engineering and economics, these models help Daziano understand the importance of consumer demand within an engineering design project. For him, understanding travel behavior, both individual and industrial, is a personal challenge.

"For instance, a good solution to environmental problems is one that is not only technically sustainable, but also one that consumers would be willing to adopt," he said.

However, finding that solution requires information only researchers such as Daziano can provide. His specific empirical research includes the analysis of environmental preferences toward low-emission vehicles; modeling consumers' adoption of sustainable travel behavior; estimating their willingness to pay for renewable energy; and, forecasting consumer's response to environmentally friendly energy sources.

Four years spent as a demand analyst consultant in the private sector also provided insight on consumers' transportation behaviors. As Daziano worked on travel forecasts for toll highways, analyzed the demands of the Santiago subway, and the Santiago International Airport, he said he "developed an empirical sense of the complex interactions of the transportation, energy, environmental, and urban systems."

Future technology for recharging process of electric cars.

"In the end, I think that coming from engineering helped me because I had a broader view about the applied problems where economics could be used to design solutions," he added.

Daziano currently teaches a course on microeconomics of discrete choice. Graduate students from CEE, applied economics, and city and regional planning are taking notice and flocking to the new class. By the end of the course, students will be able to apply discrete choice models and interpret the information they provide across the disciplines.

CEE's new faculty member continues to work as a consultant in consumer choice modeling in areas such as transportation and sustainable tourism. He is a friend of a committee focusing on transportation demand forecasting under the auspices of the Transportation Research Board of the National Academies, a private nonprofit that provides services to the government, public, scientific, and engineering communities. Daziano is also affiliated with the European Association of Environmental and Resource Economists, the Government of Canada Scholars' Alumni Association, a research group in economic, energy, and natural resources, and the Center for Data and Analysis in Transportation CDAT at the Université Laval.

the birth of
ENVIRONMENTAL AND WATER RESOURCES SYSTEMS ENGINEERING

In the early 1960s engineers were being introduced to computers and their potential use in engineering design and analysis. At that time **Walter R. Lynn** was a young professor at the University of Miami and was invited to Cornell to talk about his pioneering research in applying systems analysis methods for wastewater treatment plant design and financing.

Few engineering faculty knew what systems analysis was, and no civil engineering department at any university had courses exploring how these methods could be applied to the design and operation of civil and environmental engineering systems.

The systems methods Lynn was using grew out of research conducted during WWII by economists and mathematicians aimed at improving the effectiveness of military and industrial activities. Instead of a focus on single-unit, single-purpose design and operation, the systems approach challenged engineers to think in terms of multi-unit, multi-purpose performance opportunities.

There was so much interest at Cornell in Lynn's work that he was offered an associate professorship in the School of Civil and Environmental Engineering along with the responsibility for directing the Public Health Service Training Grant Program, a program that Donald Gates, a sanitary engineering professor, started. Under Lynn's direction Cornell's leadership in Environmental and Water Resource Systems (EWRS) began.

The challenge at the time was how to move beyond the evaluation and planning of individual projects. With the introduction of computers, algorithms for solving more complex problems, and a new systems engineering mentality that sought to understand the world on a larger scale, engineers—for the first time—could look at multi-interdependent component systems and their combined performance. And, they could identify designs and operating policies that produced maximum net economic benefits or that represented the most cost efficient way of achieving desired standards.

The delineation of this new approach, as it applied to water, appeared in 1962 when faculty at Harvard University published the *Design of Water Resource Systems*. The book described how engineers could model, identify, and evaluate alternative designs and operating policies of river basin systems in their entirety. Furthermore, the text delineated how such models could be run on computers with simulations of not just one critical year but also many, including those with conditions that had not actually been observed.

Government engineers and engineering faculty were working collaboratively with faculty in economics and government; therefore, the book set forth in some detail the marriage of these three disciplines through the use of systems analysis methods and digital computers. The then-recent developments in economic theory, the use of new computational algorithms, and computer technology to analyze problems involving the design and operation of water resources infrastructure were especially emphasized.

Meanwhile at Cornell, Lynn was teaching a course in mathematical programming (optimization) methods, similar to those discussed in the Harvard book, but more focused on wastewater and water quality management issues. The course generated considerable interest among graduate students and some faculty. Many current and newly admitted graduate students eagerly began to apply these innovative systems ideas to a range of environmental and public health topics. New faculty also joined the 'systems program,' including Professor Micky Falkson, a welfare economist affiliated with the Harvard Water Program. He was recruited as a joint appointee to CEE and Economics to enhance the economics dimensions of this new program. Leonard Dworsky came to Cornell from the United States Public Health Service with his considerable knowledge and experience in water policy, planning and governance.


Walter Lynn teaching in the 1960s.

In the ensuing two decades, the new field grew as Cornell hired faculty in areas of operations research and economics; water policy and governance; resource and environmental economics; environmental law; environmental optimization and computational mathematics; groundwater modeling and management; stochastic hydrology and flood frequency analysis, and reservoir and hydropower operations. This group of individuals—some drawn from outside the traditional CEE disciplines—allowed Cornell to expand environmental systems research. The group grew to encompass economic and legal forces affecting the impact of management and regulatory decisions and to incorporate the latest computational mathematics methods to make use of rapidly growing computational power for analyzing complicated stochastic environmental systems.

Then, in the 1980s, the textbook written by faculty in the School titled *Water Resource Systems Planning and Analysis*, became extremely influential in spreading interest in EWRS around the world. It was followed later by a seminal UNCESCO publication, *Water Resources Systems Planning and Management: An Introduction to Methods, Models and Applications.*

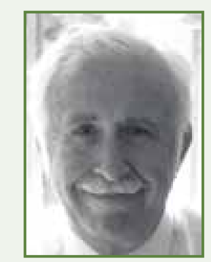
Environmental and water resource systems engineering is just as exciting now as it was in the 1960s, but today there are even more computer and computational resources. The additional resources make it easier to obtain real-time data, due to advances in instrumentation and sensor technology, telemetry, communications, and rapid data processing.

We must learn how these technological improvements can best help meet the challenges of an increasing population that demands more agricultural and industrial production, increasing stress on the availability of clean water and the ecosystems the water supports. We need water not only for human consumption and sanitation, but also for power production, recreation, environmental quality, and ecosystem health—all in an environment of increasing uncertainties of future supplies and demands.

And if that is not enough, our greater understanding of global atmospheric processes taught us we can expect greater hydrologic variability and uncertainty in the future due to changes in land use and climate. The future will be full of challenges and the demand for graduates trained in environmental and water resources systems should only increase.

Material for this article was contributed by professors Daniel P. Loucks, Christine A. Shoemaker, and Jery R. Stedinger. Copy editor Metta Winter.

Graduates establish programs



Walter Lynn and the faculty he hired were popular professors who attracted graduate students of great promise. Many went out and established centers of activity in environmental systems analysis at the Tennessee Valley Authority, the Rand Corporation, Johns Hopkins University, the Universities of California at Berkeley, of Illinois, of Pittsburgh, and at the Massachusetts Institute of Technology, to name a few.

Walter Lynn's national influence

From the outset, Walter Lynn wanted the impact of Cornell's program to be as intellectually broad as possible and have a reach beyond the Ithaca campus. As an adjunct professor of public health at what was then called the Cornell Medical College in New York City, Lynn taught a course introducing medical doctors to systems methods for the diagnosis of diseases. He was also a consultant to the World Health Organization, and in that capacity, he brought the organization's leaders to campus to learn more about how the analysis methods might be of value to them and their agency.

In addition, Lynn initiated what has become an ongoing series of informal workshops in water resources systems analysis. The first was held in the mid-1960s in New York City. For the workshop Cornell joined members of the Harvard Water Program and two other seminal thinkers: Warren Hall, who led the water resources systems program at UCLA, and Abraham Charnes of Northwestern University, one of the founders of systems analysis methods.

Cornell-Cantabria program awarded for innovation


At a ceremony in March, associate professor Edwin "Todd" Cowen poses with Best Practices in International Partnerships award recipients after winning an honorable mention for the Cornell-Cantabria Exchange Program.

The College of Engineering and the Universidad de Cantabria received an honorable mention for Best Practices in International Partnerships from the International Institute of Education for the Cornell-Cantabria Exchange Program (CCEP).

The award recognizes the most innovative and successful models of internationalization of campuses because engineers need to possess global skills, and increasingly in the United States, the ability to understand Spanish.

"The CCEP was designed specifically to address these two challenges," Provost W. Kent Fuchs said, "to allow students with a solid high-school background in the Spanish language to take Cornell College of Engineering curriculum-approved courses, primarily in English, while studying at the Universidad de Cantabria in Santander, Spain, for a full academic year."

The institute presented the annual IIE Andrew Heiskell Awards for Best Practices in Internationalization at a ceremony in New York City on March 18, 2011, as part of the sixth annual Best Practices in Internationalization Conference.

View of the Engineering Quad during the summer.


news student, alumni, and faculty

AguaClara

The student engineering team AguaClara is anything but stagnant. The six-year-old engineering team researches and designs gravity-powered, non-electric water treatment plants for Honduran communities. To help bring their designs to fruition, they work with the Honduran nonprofit Agua Para el Pueblo. During winter break, 21 AguaClara team members and their leader, Monroe Weber-Shirk, visited Honduras for the sixth annual AguaClara trip.

Over the past year, a student team has been working on a stacked rapid-sand filtration system that would be a final cleaning step before the water is chlorinated and sent to taps. They will incorporate this new technology into their plants to make them more efficient and produce even cleaner water. Their system is also simpler than most and does not require electricity—consisting of several sand filters stacked on top of each other. The students took a prototype of their filter to Honduras and demonstrated it to several communities. For more information: *http://aguaclara.cee.cornell.edu/.*

ASCE

The École de technologie supérieure will host the 2011 ASCE Regional Conference in Montreal, Canada on April 29-30. ASCE members plan to compete in both the Concrete Canoe and Steel Bridge competitions.

ESW

Engineers for a Sustainable World, ESW, are working on an energy efficiency project, a solar oven project, and the biomass energy project. During 2011 spring break, a delegation of students traveled to Nicaragua to continue collaboration with their partner organization there. In addition to the longer-term academic projects in solar ovens, biomass, and energy efficiency, the student chapter based in Hollister Hall carries out shorter-term extracurricular activities.

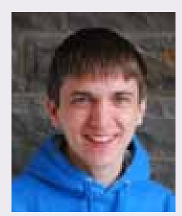
Student Awards

Catherine Hanna CEE '11, has received research support through a grant by the Intel Foundation, directed by the Semiconductor Research Corporation Educational Alliance's Undergraduate Research Opportunities program for her project, *Synthesis and Single Crystal Growth of Transition Metal Orthosilicates.*

Dara Perl CEE '11 is the recipient of 2011 Moles scholarship. The annual scholarship goes to a deserving and academically qualified senior studying civil engineering with high academic standing with expressed interest to pursue a career in the construction industry.

Engineering Learning Initiatives, or ELI, is a program that enhances the student learning experience and allows for faculty-mentored undergraduate research. Funds from corporate and alumni partners sponsor awards. The following students are recipients:

Elyssa Dixon EnvE '12 for her project with Professor Edwin Cowen involving mass loading rates from spring runoff in a small tributary to Cayuga Lake.



Bryan Oakes CEE '12 for his project on spectral reflectance of wetted soils with Professor Bill Philpot.

Paul Richter CEE '11 for his work with Professor Peter Diamessis on numerical simulation of internal gravity wave beam transformation at a simulated sharp oceanic pycnocline.

Sarah Stodter EnvE '11 for a project she is working on with Professor Leonard Lion about foam filtration for point of use water treatment.

The CEE Graduate Research Symposium was held on January 28, 2011. The third-annual event provided an opportunity for CEE graduates to present to their peers and faculty, a paper, poster, or both on their current research. The following graduate students won cash prize awards:

Po-Hsun Lin received the first-place prize for his talk, *Enhanced Particle Capture through Aluminum Hydroxide Addition in Rapid Sand Filtration.*

Deborah Sills second-place prize for her talk entitled *Assessment of Commercial Hemicellulases for Saccharification of Alkaline Pretreated Perennial Biomass.*

Alexandra King received the third-place prize for her presentation entitled Predicting *Velocities and Mixing Rates in Flow through Aquatic Vegetation.*

C. Colin Hollister received the first-place prize for his poster entitled *Adsorption of Phosphate, Ammonium and Nitrate to Various Biochars.*

Blair Johnson received second-place award for her poster on *Sediment Resuspension and Bed Morphology in Highly Turbulent Flows*.

Kristopher Baker was the third-place winner for his poster on the *Effect of Discretization on the Fragmentation of Brittle Materials.*

Alumni

Jeanine Plummer B.S. '93, an associate professor of civil and environmental engineering at Worchester Polytechnic Institute is the recipient of the McGraw-Hill/AEESP Award for Outstanding Teaching in Environmental Engineering and Science. This award is given annually to honor a faculty member who has made substantive contributions directly through class-oriented teaching as enhanced through the development of new pedagogical techniques.

Faculty

Wilf Brutsaert received an honorary membership in the Japan Society of Hydrology and Water Resources. This honor was awarded for his numerous lifetime contributions to hydrologic and water resources science, as a token of gratitude and appreciation by the Society. His nomination was officially approved on September 8, 2010 in Tokyo at the Society's general assembly.

Peter Diamessis is a recipient of the 2010 College of Engineering's Daniel M. Lazar '29 Excellence in Teaching Award.

Oliver Gao is a recipient of the 2010 College of Engineering James and Mary Tien Excellence in Teaching Award.

Ken Hover became president of ACI in September 18, 2010 upon the passing of President Richard Stehly. Ken will begin his own elected one-year term April 7, 2011.

Christine Shoemaker is the 2010 recipient of the College of Engineering James M. and Marsha D. McCormick Advising Award.

Graduate Research Symposium attendees with CEE director: (left to right) Po-Hsun Lin, Deborah Sills, Phil Liu, Kristopher Baker, Blair Johnson, C. Colin Hollister, and (not pictured) Alexandra King.

CEE Class of 1949 in February 1949, from left to right:
(first row) L.L. Conable, Jr.; W. Goodman; D.A. Buchanan; H.T. Jenkins; N.A. Christensen; J.R. Vazquez; M.D. Schwartz, V.B. Moore, Jr.;
(second row) G.L. Kaplan; H.J. Payeras; L. B. Rasmussen; C.C. Michaels; G.V. Pesco; M. Taylor; V.A. Plumb; W.J. Hickey; C.E. Burtch; P.E. Sundheim;
(third row) J.W. Dawson; J.M. Buck; I.K. Chann; R. Lipian; W.A. Kanenbley; W. Mendenhall; J.E. Roberts; F.L. Baumann; R.E. Peters; C.P. Irwin;
(fourth row) A.J. Schrauth; D.L. Cownie, Jr.; R.S. Chapman; A.R. Treleaven; D.E. Caruthers; J.B. Rogers; R.W. Englebert; R.S. Mattie; H.C. Murphy, Jr.; K. Bender; J.J. Gilbert, Jr.

Contact us with your news:
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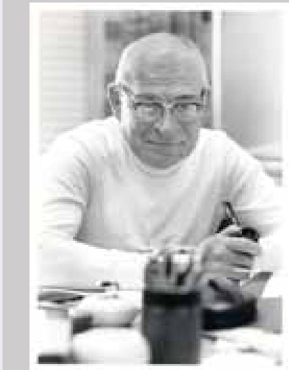
www.cee.cornell.edu

MEMORIAM



George Bernard Lyon

Former Professor and Assistant Director of CEE

George Bernard Lyon died December 13, 2010 at the age of 93. Born September 8, 1917 in Hancock County, Illinois, George grew up in the state's farm country.

After graduating from the University of Illinois in 1940, George pursued a master's degree in engineering at the State University of Iowa where he specialized in hydraulics and fluid mechanics.

Before coming to Cornell, he worked for the U.S. Engineer Department Hydraulics Laboratory in Iowa City where he constructed a model for the MacArthur Lock at Sault Sainte Marie, Michigan. After the lock was built, he worked for the Army Corps of Engineers during World War II, building docks and other structures in the South Pacific.

After the war, George began his next career: teaching. From 1947 to 1984 he served as an assistant professor at Cornell University in the School of Civil Engineering and later served as Assistant Director of the School of Civil and Environmental Engineering. In 1950, he married his wife, Betty Taylor, and they had three children.

During his 37 years at the university, George worked as an engineering consultant, participating in site selection studies for the capital of Brazil and took part in reservoir, drainage, and flood-control studies. In addition, he provided computations for a book of tables for surveyors, the Solar Ephemeris, for 23 years.

He is survived by his sister, Ruth Linner, his children, Kathryn Lyon Graham, Maud Lyon, and Robert Lyon, a granddaughter, and a step-grandson. His wife, Betty, predeceased him.

Cornell University

School of Civil and Environmental Engineering

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Upcoming Events

Reunion 2011:

June 9-12

Saturday, June 11

Alumni breakfast buffet: Plan to attend this year's free CEE alumni breakfast from 7:30 to 9:30 a.m. in the McManus Conference Center at 166 Hollister Hall. All alumni(ae) and their families are invited. If you are planning to attend, please contact us via e-mail at civil_env_eng@cornell.edu or by phone at 607.255.3690.

Homecoming 2011:

September 16-18

Cornell vs. Bucknell

Zinck's Night 2011:

October 20

To learn more about Zinck's Night, visit: www.alumni.cornell.edu/zincks/