XCurrents

MIT CHEMICAL ENGINEERING ALUMNI NEWS

The Practice School expands into India with its newest station *Mawana Sugars* (Page 6)

Letter from the Department Head

Welcome to the Fall 2009 edition of the MIT Chemical Engineering News. With this edition, we introduce a new format for the newsletter, along with a new name: *XCurrents*. The new name is derived from the word "excurrent," which means "running or extending out… continuing to the top," and reflects our mission for this newsletter: to provide not only the "current" happenings in our department and community, but to reach out and connect with alumni and friends all over the world, thus extending and strengthening our community.

We have worked hard to insure that the content continues to be relevant and informative for you, our audience. We plan to publish *XCurrents* twice a year (Fall and Spring) and encourage you to read it cover to cover and let us know what you think. I hope you enjoy it and would appreciate any feedback; please send your comments to

Highlights

Massachusetts Institute of Technology

Letter from the Department Head continued

our editor at melmils@mit.edu.

The past academic year has been an exciting and challenging one for the department. Once again, U.S. News & World Report ranked both our graduate and undergraduate programs number one among chemical engineering departments in 2009. This is our twentieth year as the top ranked program. Although such rankings should be taken with a grain of salt, it is gratifying to see the world-wide recognition of the program. It takes hard work, collaboration, and dedication from everyone - faculty, students, staff, and you, the alumni - to sustain and grow a successful program.

Prof. Emeritus Jeff Tester (with Rocky Jones) performs his last holiday skit with Prof. Jensen and fellow ChemE profs.

Since our previous newsletter, we've welcomed to our faculty three new members: Martin Z. Bazant, Jesse H. Kroll, and Hadley D. Sikes. Martin Z. Bazant joined us December 15, 2009, from MIT's Department of Mathematics, to make a switch to engineering science. He brings to our program much needed expertise in transport phenomena. His current research focuses on microfluidics and electrochemical systems with applications in energy storage, water purification, and "lab-on-a-chip" technology. His recent honors include being named one of Popular Science's "Brilliant Ten" in 2007 for his work on electrokinetic pumps for microfluidics. Jesse H. Kroll joined us in the beginning of 2009, as the department's first joint assistant professor with his primary appointment in the Department of Civil and Environmental Engineering. His research interests in atmospheric chemistry nicely complement the department's long standing efforts in airborne organics started by Adel F. Sarofim and the late Jack B. Howard. Hadley D. Sikes is the most recent member of the faculty. She joined us in August from Caltech where Professor Frances Arnold had been her mentor for her Burroughs-Wellcome Fund Career Award. This highly prestigious award bridges postdoctoral and junior faculty appointments so she will be able to also use it to launch her independent research program at MIT. Hadley's research interests include molecular biotechnology with particular focus on redox-active nanostructures. Also congratulations to Hadley on the birth of her daughter, Victoria, who joins a wonderful, growing group of young toddlers in the chemical engineering community. More information about our new faculty members is given inside the newsletter.

Prof. Jensen poses with members of the 08-09 GSC-X, who excelled this year at doing more with less budget.

Congratulations to Michael S. Strano who was promoted to associate professor with tenure. Michael has created an exciting research program in the area of nano-materials, specifically carbon nanotubes (CNTs), synthesis and surface chemistry. Among his many efforts, he has developed a deep understanding of how molecules react with CNTs to modify their spectroscopic properties. These fundamental studies have led to the development of new optical sensors enabling the in vitro monitoring of chemical species and reactions within individual cells, among other applications. Michael's exceptional research contributions were recognized by both a Materials Society Young Investigator Award and the AIChE Allan P. Colburn Award. The faculty as a whole continues to garner recognitions for their hard work. A list of some of these awards is on page 9 of the newsletter.

Several faculty members have elected to retire. Herb H. Sawin retired at the end of the academic year to a wonderful oceanside house in Rhode Island. He is working on a handbook on plasma processing for the semiconductor industry and plans to continue consulting. He'll return in January to teach his popular ICE class on statistical methods—the first prize in the paper airplane design contest is a ride in Herb's airplane. Greg J. McRae is taking early retirement November 1, 2009, and will remain at Morgan Stanley where he has been on leave the past two years to work on a wide range of exciting energy related issues. Jeff W. Tester takes early retirement at the end of the calendar year to return to his undergraduate and M.Sc. alma mater, Cornell, as the David Croll Professor of Sustainable Energy Systems, and associate director of the Cornell Center for a Sustainable Future. Fortunately, Greg and Jeff have chosen to become emeriti professors and stay engaged with their remaining PhD students and the department in general. More information on Herb Sawin's retirement is inside the newsletter and more information on

the retirements of Greg and Jeff will be in future editions of *XCurrents*. We are deeply grateful for their many outstanding contributions to the department and wish them the very best in their future endeavors.

Prof. Jensen talks with alumni at the 2009 ChemE Commencement Reception.

Thanks to the efforts of Arup K. Chakraborty, the graduate committee and our student office, we had an excellent year recruiting a very talented class of graduate students. The generous external support of the Practice School and our doctoral program through graduate fellowships continues to be an essential asset in our effort to attract the very best students. Beyond its value as a recruiting tool, funding for graduate fellowships is a critical element of our graduate educational philosophy. By providing fellowship support for Practice School students and first year doctoral students, we enable the students to focus on the core subjects of chemical engineering and explore the breadth of research opportunities without being conflicted by teaching assistantships or sponsor requirements. The student office continues to do a great job recruiting and assisting students under the leadership of Suzanne Easterly, who very appropriately received the School of Engineering's Infinite Mile Award for her outstanding contributions to the students and the department. A story about this award and other departmental awards appears in the newsletter.

Prof. Jensen thanks facilities manager Steve Wetzel for his work in the wake of the 2008 Halloween Steam Explosion.

The research volume of the department continues to grow. It has now surpassed $35M thanks in part to the activities of the MIT-Novartis Center for Continuous Manufacturing, the MIT Energy Initiative, and the many research proposals submitted by the faculty to industry and the federal government. The enhanced research activity has further accentuated our existing space problems. The current laboratory space is inadequate in terms of both quality and amount of space. The space allocated to the department is much less than that of other departments with similar levels of activity and faculty, such as Chemistry. Moreover, we lack an adequate level of fumes hoods and modern lab facilities. We are working with the senior administration to address these problems. We very much appreciate the alumni contributions that have helped us renovate laboratories for new faculty.

The space problems became acute Halloween Eve 2008, when a high pressure steam line ruptured in the subbasement and steamed the building for several hours. Fortunately, no one was hurt, but there was extensive damage to ceilings, walls, and equipment throughout the building. As a result, we have had repair crews in the building since then and a multi-million dollar cost is being negotiated with the insurance company. We are hoping that this activity will stimulate further renovation from the Institute itself. With all this building activity, including a new laboratory facility for the Novartis program, our terrific facilities manager, Steve Wetzel, has had a very busy year and we are grateful for his efforts. More detail about the steam incident appears inside the newsletter.

The financial situation has impacted the department. We have taken cuts and learned to live within our means, but fortunately been able to avoid reduction in staff and activities. The coming year will see further cuts, which we expect to be able to absorb—is no small part thanks to you, the alumni. The support you have given us over the years, and continue to provide, confer an essential mechanism for buffering the effects of the economical crisis. We deeply appreciate that many of you have continued to support the department through this crisis in spite of the economic hardships placed on everyone.

We hope you enjoy this issue of the newsletter. Please do write to us to let us know how you are doing and how we can continue to improve. Thank you for your support and best regards.

Klavs F. Jensen
Department Head
MIT Chemical Engineering Department

Practice School News by Professor T. Alan Hatton

I am happy to have the opportunity to share with you the latest news of the David H. Koch School of Chemical Engineering Practice, which continues to provide a unique opportunity for generations of chemical engineers to hone their technical leadership skills. Students augment their on-campus academic coursework by immersing themselves in high-profile industrial projects at host company sites. As many of you have experienced yourselves, this is an exciting and enriching program for both the students and host companies alike. During the summer of 2008 and the '08-'09 academic year, dozens of students, including seven from the Singapore-MIT Alliance, worked on projects in such far-flung places as Pennsylvania, India, Illinois, Minnesota, Massachusetts, Switzerland, Colorado and Singapore. I extend a tremendous thank you to our host companies who have helped provide the kind of education that only these hands-on, real-world challenges can offer!

The Stations

Summer 2008

BP Naperville, Naperville, Ill., Director Bob Fisher

The four-week session at BP focused on the use of alternative fuels while working with the BP Global Fuels Technology (GFT) division. Determining physical property characteristics associated with engine performance was the main concern of the project. The use of thermodynamics, reaction kinetics and transport phenomena, associated with both established and emerging technologies, along with experimental design techniques, were emphasized.

Cabot Corp. Billerica, Mass., Director Bill Dalzell

Cabot is the world's leading producer of carbon black, used in tires, other rubber products, and elastomers. They also make fumed metal oxides, inkjet pigments, and specialty metals and fluids.

At Cabot, the students made extensive use of their training in fluid mechanics, heat and mass transfer, high-temperature kinetics, process design and separation processes. Three new projects in July called upon the students to hone their skills in non-Newtonian fluid flow, surface chemistry and process modeling. The working environment at Cabot was highly technical, enthusiastic, and interactive, especially during the highly anticipated ice cream truck visits to the facility parking lot every Friday afternoon.

Cargill, Wayzata, Minn., Director Robert Laurence

Cargill is an international provider of food, agricultural, and risk management products and services with 124,000 employees in 59 countries. Its products are well known to American farmers, food service distributors and retailers, and pharmaceutical and dietary supplement companies.

The Cargill Station was started over ten years ago and still offers challenging problems. During August of 2008, students worked on projects dealing with aspects of the biodiesel process, kinetics, feedstock purification, and by-product utilization. The weather was beautiful during the students' stay, and they were able to enjoy a state fair, picnics with their hosts and inevitably some quality time in Cargill's tornado shelter.

Novartis, Basel, Switzerland, Director Claude Lupis

For this iteration at Novartis, the students worked on projects at a Novartis site in Stein, a train ride away from the main campus, as well at the main St. Johann campus. The Stein projects dealt with "key performance indicators," measures that the company uses to evaluate various performances, specific as well as overall. Two other projects at St. Johann comprised the development of new packaging strategies for numerous sites and countries and the investigation of the economic impact of continuous production on the manufacture of some specific Novartis drug projects.

During this time, Basel played host to an international art fair as well as the Euro soccer competition. It was a very good time to be a visitor to the city!

Fall 2008

General Mills, Minneapolis, Minn., Director Bob Fisher

To date, a grand total of 90 projects have been sponsored by General Mills; these most recent efforts were based at its James Ford Bell Technology Center (JFB TC) in a suburb of Minneapolis and at a Pillsbury facility in downtown Minneapolis on the Mississippi riverfront.

Transport mechanisms and temperature profiles within the multiple components of a food matrix comprised one project. Another project involved coating operations with subsequent drying and crystallization, requiring an understanding of material property characteristics such as development of nucleation sites and crystal growth kinetics versus amorphous phase generation. The other four projects involved technology assessment of competitive continuous aeration systems and the rheological behavior of nano-emulsions for use in existing product lines.

GlaxoSmithKline, King of Prussia, Penn., Director Claude Lupis

The (GlaxoSmithKline) GSK projects in the two sessions covered a wide range of subjects, such as the study of chromatography resins, the modeling of a milling process, the optimization of the crystallization of an active pharmaceutical ingredient, the assessment of a prototype for continuous film coating and the evaluation of the effects of particle size on processing and tablet dissolution.

The station's proximity to Philadelphia provided numerous opportunities for sightseeing and cultural activities. The Philadelphia Museum of Art is one of the largest museums in the country and has a magnificent art collection (in addition to offering an excellent brunch on Sundays!). The visit of an old Amish homestead in the village of Bird-in-Hand in Lancaster County proved particularly interesting.

Singapore Station, Singapore, Director Robert Laurence

The Singapore Station involved three entities: GSK, Pfizer, and the Bioprocessing Institute (BTI) of A*Star.

The first session opened at GSK and Pfizer. The first project at GSK dealt with Multivariate Statistical Process Control (MSPC), requiring the application of MSPC to the process train. The second GSK project examined the reduction of vapor organic carbon (VOC) in the Jurong GSK Plant. The session at Pfizer (Project 3 and its continuation Project 4) dealt with waste minimization. Our students' work led to a number of options for greater segregation of Pfizer's waste streams. The second phase of the study produced a three-step process to separate and utilize the waste: organics could become fuel for the end-of-line thermal oxidizer, liquid sent to the in-house wastewater treatment plant, and solids to off-site incineration.

The last project at BTI dealt with a study of C-type lectins and pathogen recognition. C-type lectins play an important role in both innate and adaptive immune response. The project objective was to create a database describing the various interactions between C-type lectins and pathogens/self-ligands and their associated carbohydrates, if any. The students created a user-friendly interface with simple and advanced search features.

Members of the Singapore station visit the Botanical Gardens with Director Alan Hatton and Station Director Robert Laurence and his wife.

Social interaction was an important facet of the experience with trips to the Singapore Flyer, the Botanic Gardens, the Zoo, and Kuala Lumpur, along with many outstanding meals in the remarkable variety of cuisines in Singapore.

Mawana Sugars, New Delhi, India, Director Bill Dalzell

For the first time, the Chemical Engineering Practice School moved into India, to the Mawana Sugar Works, which manufactures and sells sugar and edible oils. The company offers its sugar products under the Mawana brand name and also produces caustic soda, hydrochloric acid, stable bleaching powder, sodium hypochlorite, hydrogen, and liquid chlorine in north India.

The projects tackled such problems as efficient energy utilization, reduction of sugar losses and crystallization control. The station director and students lived on the Mawana campus with the local employees and were immersed in the culture of the area. Read more about the students' engaging and enlightening experience on page 6.

Spring 2009

Novartis, Basel, Switzerland, Director Claude Lupis

This was our seventh station in Basel and the fifth for Claude Lupis, the station director. The projects were conducted at three different sites, Klybeck, Rosen and Stein, and a fourth, the Novartis campus of St. Johann, was chosen for the presentations. Eight students attended the station and conducted a variety of projects that ranged from Aspen process simulations to multivariate data analyses of drug manufacture and efficiency improvements in solvent recoveries and in energy consumption. It was particularly satisfying that in a project of the first session, a simple modification of the flow sheet of one process could save the company several hundred thousand CHF per year; indeed, on the Monday of the fifth week, operators were meeting with the students to implement that recommendation.

The students were in Basel to witness its ancient masked carnival, "Fasnacht," a three-day affair starting on the Monday after Mardi Gras. They also were able to enjoy guided tours of Lucerne and Colmar, nearby in Alsace, France.

NREL, Golden, Colo., Director Bob Fisher

The National Renewable Energy Laboratory (NREL) is funded by the Department of Energy and concerned with alternative and sustainable energy sources. Our projects included an analysis of thermal-chemical means to produce alternative fuels from synthesis gas obtained from biomass feedstocks. Two projects were devoted to understanding the possible mass transfer limitations associated with an acid pretreatment process. Determining the rheological properties of biomass slurries and combining these results with the use of CFD modeling techniques to evaluate reactor designs/performance characteristics were the accomplishments of another project. An analysis of the use of algae for bioprocessing, such as in biodiesel production, was also undertaken successfully.

Our students were able explore the local area in the foothills of the Rocky Mountains, including excursions to mountain towns, the "Garden of the Gods" and Rocky Mountain National Park.

The Mawana Station

by Station Director Bill Dalzell and Practice School Student Blair Brettman

From mid-October through mid-December, 2008, the first Practice School station to operate in India was held at the Mawana Sugar Works (MSW) outside the village of Meerut in the province of Uttar Pradesh. Meerut has a population about twice that of Boston and is about three hours by car northeast of Delhi. For most of the people at MSW this was their first time working with Americans and for the nine students, station director, and his wife this was our first trip to India.

Under the direction of Bill Dalzell and with the encouragement of his wife Pat Dalzell, the MIT students successfully completed three two-part projects in the plant. The first month's projects concentrated on modeling and planning, since sugar cane was not yet available and the plant not yet operating. During the second month, the students were busy in the plant and the lab running experiments and testing their recommended designs, which focused on analysis of refinery operations. The projects were centered on energy utilization and recovery for sugar production and power generation, efficient control of crystallization, and higher recovery of sugar. A major emphasis was placed on generating quantitative technical models for processes based on engineering fundamentals.

The folks from MIT and MSW learned a great deal from each other. The students learned to make do with limited equipment and facilities. They also learned that life in industry is very different in the US and India. Surprisingly, the three female MIT students were the only women, at any level or role, within the refinery that has several thousand employees. The engineers at MSW learned that mathematical modeling and use of process instrumentation within the plant can yield major understanding of process operations. They also learned that more frequent and thorough communication is critical to making rapid progress and that working smarter and more efficiently beats excessively long hours on the job. Many of the engineers at MSW work more than sixteen hours a day, seven days per week.

Local families welcome to Mawana the MIT Practice School students.

Thanks to the enthusiasm, hospitality, and generosity of the people at MSW we learned about and saw much of the culture, way of family life, architecture, religions, and customs of northern India. We lived on the MSW campus, along with the employees and their families, and became part of the MSW community. We arrived during Diwali, the biggest festival and family holiday in India, and one that can be described as a combination of Christmas and Independence Day. We, in turn, shared our custom of Thanksgiving with our MSW family complete with a skit in which one of the students was dressed as turkey.

The students take a break rafting down the Ganges River in the foothills of the Himalayas.

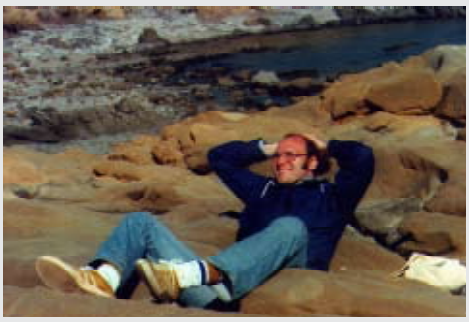
We had the opportunity to make three major weekend excursions to sites in northern India. Our first trip was to the plains region of India and Agra, the home of the Taj Mahal. At the halfway point of the session, we were taken to Jaipur, a desert city in Rajasthan known best for its colorful textiles. A final big trip took the students to Rishikesh, a location north of Mawana where the Ganges River exits the Himalayas. There the students were able to white-water raft on the Ganges and hike in the foothills of the Himalayas.

The Practice School experience at Mawana was a unique event for and enjoyed by the employees of MSW, the MIT students, and the station director and his wife. Hopefully, the MIT Practice School will continue to operate at MSW to the mutual benefit and enjoyment of MIT students and the staff at the sugar refinery.

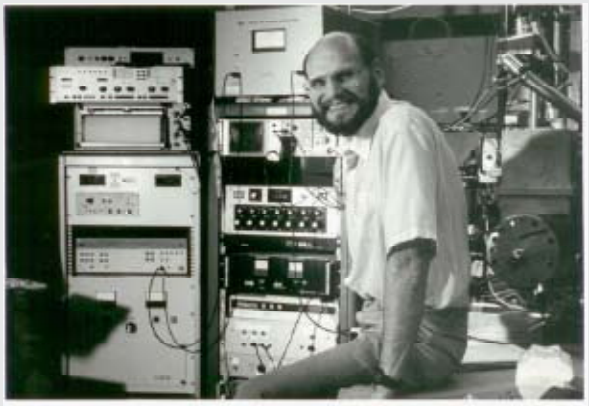
Practice School Awards Banquet

The speaker for our annual Practice School Dinner on October 22, 2008, was Mr. Siddharth Shriram, Chairman of Mawana Sugars, the latest Practice School Station to be established. The attendees learned much about industry in India and best practices that could be applied in any environment. We presented a number of awards to students for outstanding performance in the Practice School projects. The recipient of the Vivian Award was **Sarah Bashadi** of Ashland, Ky. **Gerald Adler** of Wilson, Wy. was rewarded for his enthusiasm for the program by receiving the Tester Award. **Brian Downs** of Kingsport, Tenn., was recognized for his personal generosity, integrity and commitment to the program through the Wojtowicz Award. Finally, **Dave Couling** of Columbus, Ohio, received the Rousseau Award for Leadership and Ethics in Chemical Engineering Practice.

Professor Herb Sawin Retires



After almost three decades as MIT faculty, Professor Herb Sawin has stepped down from teaching to become an emeritus professor. Herb was an early pioneer in the application of modern surface science tools to gain understanding and improving reactive thin film processes in microelectronics processing, in particularly in plasma processing. He made seminal contributions to the understanding of the ion and surface reactions governing the etch profiles, and the modeling of plasma discharge physics, he developed novel techniques for monitoring plasma processes, and explored new etching processes lowering the impact ozone depleting chemicals traditionally used in plasma processing. In recognition of the overlap and importance of Herb's work with electrical engineering, he held a joint position as Professor of Electrical Engineering and Computer Science. He was elected fellow of the American Vacuum Society, the major professional society for plasma processing.



Throughout his career, Herb worked to advance chemical engineering education. He developed the series of senior cap stone subjects, Integrated Chemical Engineering, affectionately known as ICE. He also helped develop 10.10, an introductory course which uses mass and energy balances with computer programming to solve chemical engineering problems. He also directed the graduate qualifying exam experience through several improvements.

At the 2008 annual AIChE meeting, Herb's former students, led by Professor **Jane Chang (SM '95 PhD '98)** of UCLA, hosted a symposium and reception in his honor. The day-long event was a discussion of advances in understanding plasma-surface interactions and thin films processing, highlighting Herb's many contributions to the field. This invited symposium, entitled "Topics In Plasma Science and Thin Film Applications - In Honor of Herbert H. Sawin," featured industrial and academic leaders from around the world, amongst them many of Herb's former students. They included Eray Aydil of the University of Minnesota, Demetre Economou of the University of Houston, **David Graves (SM '65, ScD '67)** of UC Berkeley, **Dimitrios Maroudas (PhD '92)** of the University of Massachusetts, Michael Mocella of DuPont, **Brett Cruden (PhD '00)** of NASA Ames Research, **Evangelos Gogolides (SM '87, PhD '90)** of IMEL, Greece, **Scott Lawing (PhD '97)** of Rohm and Haas, **Arpan Mahorowala (SM '94, PhD '98)** of IBM, Anthony Muscat of the University of Arizona, Steve Vitale of MIT Lincoln Lab and **Colin Wolden (SM '92, PhD '95)** of Colorado School of Mines.

Herb wins the 2009 Undergrad Teaching Award, chosen by current students.

The text of the etched wafer presented to Herb at the spring dinner in his honor.

The Chemical Engineering Department is grateful to Herb for his contributions to the department and field of chemical engineering and will miss his wise counsel as well as his engaging and enjoyable company. Fortunately, he'll return in January to teach his popular ICE class on statistical methods, where the first prize in the paper airplane design contest is a ride in Herb's airplane.

Faculty News

The Chemical Engineering Department Welcomes Three New Professors

The Chemical Engineering Department is pleased to welcome newly appointed **Assistant Professor Hadley S. Sikes**, who starts her appointment fall 2009.

Professor Sikes completed her Ph.D. in Physical Chemistry at Stanford University, focusing on electron transfer through conjugated oligomers. She then conducted postdoctoral work with Professor Frances Arnold at Caltech and Professor Chris Bowman at the University of Colorado. At Colorado, she developed polymerization reactions for signal amplification in the detection of molecular recognition, including detection of the influenza virus. Most recently, the Burroughs-Wellcome Fund Career Award enabled her to launch an independent research program while at Caltech, and she will be able to extend this funding into her early years at MIT. Professor Sikes's research interests include molecular biotechnology with particular focus on redox-active nanostructures. She uses molecules and supramolecular assemblies to address both fundamental questions and societal needs. At MIT, she plans to pursue directed evolution of thermostable enzymes that generate reactive oxygen species, redox polymerization-based amplification for low-cost, high-throughput detection of biomarker panels, rare cells, and epigenetic states of genes during tumorigenesis, and electrode-driven biocatalysis.

Associate Professor Martin Z. Bazant joined the department in December of 2008. Professor Bazant received his BS in mathematics and physics from the University of Arizona in 1992, and was awarded a Department of Energy Computational Science Graduate Fellowship prior to arriving at Harvard University for his graduate work in physics. Before joining the Chemical Engineering faculty, Professor Bazant was a faculty member in MIT's Mathematics Department where he led the Nonlinear Electrokinetics Group, the Dry Fluids Lab, and the Applied Mathematics Computational Laboratory.

Professor Bazant is broadly interested in physical transport processes and applied mathematics. His current research focuses on microfluidics and electrochemical systems with applications in energy storage, water purification, and "lab-on-a-chip" technology. Topics include nonlinear electrokinetics, super-hydrophobic surfaces, super-capacitors, fuel cells, and rechargeable batteries. Professor Bazant's honors include being named one of Popular Science's "Brilliant Ten" in 2007 for his work on electrokinetic pumps for microfluidics, which can be used to build a portable diagnostic lab, "lab-on-a-chip."

Assistant Professor Jesse H. Kroll comes to us as a junior faculty member in the Department of Civil and Environmental Engineering with joint position in Chemical Engineering.

Professor Kroll's research involves the experimental study of the properties and chemical transformations of organic species in the Earth's atmosphere. His interests include environmental and atmospheric chemistry, and he is pursuing the development of new analytical tools for the characterization of atmospheric organics. Professor Kroll received his PhD from Harvard University in 2002 and comes to MIT from his investigator role at Aerodyne Industries, Inc.

Professor Michael Strano Earns Tenure

Congratulations to Professor Michael Strano, who was awarded tenure in July of 2009.

Professor Strano's research is in the area of nano-materials and nanoparticle surface chemistry. His interest is how molecules adsorb and chemically react with low dimensional materials where geometric constraints or patterning provide quantum confinement of electrons. Such materials include carbon nanotubes, semi-conductor nanocrystals and graphene nano-ribbons as examples. A feature of his work is the development of new spectroscopic assays to understand and test theories of low dimensional surface chemistry, solving fundamental theoretical problems and pioneering new engineering applications of low dimensional materials.

In May 2009, a research team led by Professor Strano was awarded a $5 million, five year grant by the Office of Naval Research to build "ultra-fast microchips for computation and communications, as well as research new electronic surveillance systems." He is one of a handful of MIT researchers working with graphene, the newest form of carbon, just a single atom thick and potentially a successor to silicon. Professor Strano is also aiding in the development of virus-built batteries which could eventually power cell-phones, other electronic devices and even cars.

We applaud Professor Strano for this very well-deserved promotion.

Professor Patrick Doyle Earns Guggenheim Fellow and Miniaturisation Prize

Professor Patrick Doyle is among the 180 artists, scientists and scholars awarded 2009 fellowships by the John Simon Guggenheim Memorial Foundation.

The foundation selects fellows on the basis of "stellar achievement and exceptional promise for continued accomplishment." Professor Doyle will work on the development of soft functional microparticles.

Professor Doyle also earned the 2008 Pioneers of Miniaturisation prize, given out by the Royal Society of Chemistry through the Lab on a Chip Journal. The $5,000 award is for young to mid-career scientists for extraordinary or outstanding contributions to the understanding or development of miniaturised systems.

Professor Chris Love Deemed W. M. Keck Distinguished Young Scholar in Medical Research

Professor J. Christopher Love has been named a 2009 Keck "Distinguished Young Scholar," and plans to study how the human immune system responds initially to HIV using microtechnologies that allow study at the single-cell level. This work may help researchers realize new treatments for HIV/AIDS and eventually other diseases through rational design of immunotherapies and vaccines.

The Young Scholars program awards up to $1 million to support the scientist's research activities for a period of up to five years. Since its inception in 1998, the Young Scholars program has awarded 54 grants.

Professor Love also earned a Human Immunology Grant from the Dana Foundation for his research in single-cell immunology; he uses technology to understand how certain cells help limit HIV infection from progressing to AIDS, a situation that occurs in a small percent of infected individuals who never develop the disease.

Other Faculty Awards and Honors

- Arup Chakraborty was elected Fellow of the American Association for the Advancement of Science and was invited to deliver the 2009 Raman Memorial Lecture of the Swadeshi Science Congress.
- Gregory N. Stephanopoulos was awarded the American Chemical Society's 2010 E. V. Murphree Award in Industrial and Engineering Chemistry.
- Bill Green became editor-in-chief of the International Journal of Chemical Kinetics.
- George and Greg Stephanopoulos were honored by the Massachusetts State House on Greek Independence Day (April 24, 2009) with Greek Independence Day Lifetime Achievement Awards for their contributions to the field of chemical engineering.
- June 2009's BusinessWeek deemed Bob Langer New England's Top Innovator. The publication stated "with over 600 patents in his name, MIT Professor Langer is second only to Thomas Edison as the most inventive American in history. Bob's work during his decades at MIT has resulted in the creation of 25 companies." Bob Langer also received the 2008 AIChE Founders Award.
- Michael Strano earned AIChE's 2008 Allan P. Colburn Award for Excellence in Publications by a Young Member of the Institute.
- Paula Hammond was named Bayer Professor of Chemical Engineering.

Did you know?

At AIChE's Centennial meeting in November 2008, 50 chemical engineers were identified as "Chemical Engineers of the Foundation Age;" 17 of these were MIT faculty or alumni. Of the 100 chemical engineers selected as "Chemical Engineers of the Modern Age," 24 were MIT faculty, former faculty, or alumni.The current faculty members honored included Professors Clark Colton, Klavs Jensen, Ed Merrill, Bob Langer, Charles Satterfield and George Stephanopoulos.

Research News

Professor Michael Strano and student Daniel Heller Develop Carbon Nanotubes to Aid Chemotherapy

Sensors, made of carbon nanotubes wrapped in DNA, can detect chemotherapy drugs such as cisplatin as well as environmental toxins and free radicals that damage DNA.

"We've made a sensor that can be placed in living cells, healthy or malignant, and actually detect several different classes of molecules that damage DNA," said Professor Michael Strano, senior author of a paper on the work that appeared in the Dec. 14, 2008 online edition of *Nature Nanotechnology*.

Such sensors could be used to monitor chemotherapy patients to ensure the drugs are effectively battling tumors. Many chemotherapy drugs are very powerful DNA disruptors and can cause serious side effects, so it is important to make sure that the drugs are reaching their intended targets.

"You could figure out not only where the drugs are, but whether a drug is active or not," said Daniel Heller, a graduate student in chemical engineering and lead author of the paper.

In future studies, the researchers plan to use the sensors to study the effects of various antioxidants, such as the compounds in green tea, and learn how to more effectively use toxic chemotherapy drugs.

For more information, go to http://web.mit.edu/newsoffice/2008/nano-sensor-1214.html.

Bob Cohen and Colleagues Outfit Cells with Polymer "Backpacks"

MIT engineers have outfitted cells with tiny "backpacks" that could allow them to deliver chemotherapy agents, diagnose tumors or become building blocks for tissue engineering.

The polymer backpacks allow researchers to use cells to ferry tiny cargoes and manipulate their movements using magnetic fields. Since each patch covers only a small portion of the cell surface, it does not interfere with the cell's normal functions or prevent it from interacting with the external environment.

"The goal is to perturb the cell as little as possible," said Professor Bob Cohen, an author of the paper.

The researchers worked with B and T cells, two types of immune cells that can home to various tissues in the body, including tumors, infection sites, and lymphoid tissues -- a trait that could be exploited to achieve targeted drug or vaccine delivery.

Cellular backpacks carrying chemotherapy agents could target tumor cells, while cells equipped with patches carrying imaging agents could help identify tumors by binding to protein markers expressed by cancer cells.

Another possible application is in tissue engineering. Patches could be designed that allow researchers to align cells in a certain pattern, eliminating the need for a tissue scaffold.

For more information, go to http://web.mit.edu/newsoffice/2008/cellbackpack-1106.html.

Chris Love and Colleagues Create New "Protein-Printing" Technique to Study Immune System Defense

Professor Chris Love's work, reported in the online edition of the Proceedings of the National Academy of Sciences the week of Nov. 3, 2008, could help researchers develop and test new vaccines for diseases including HIV, fungal infections and antibiotic-resistant bacterial infections.

"We're building a toolkit which we can use to look at how an immune response develops successfully. Then we aim to use that information for reverse engineering vaccines that would invoke that same type of response," said Professor Love, senior author of the paper.

Currently, the only way to test whether a vaccine has worked is to examine a patient's blood sample for the presence of antibodies. However, such tests do not offer a comprehensive picture of the immune system's ability to fight off infection, Professor Love said.

"We don't know the diversity of antibodies generated, and we don't know how well they're responding to the pathogen. We don't know how poised the immune system is to respond to challenges it might face," he said.

His team's new approach generates information including the number of B cells present, whether they produce antibodies, the type of antibody they produce (for example, those that promote a long- or short-term response), the specificity (for a target like a protein from a virus or bacterium), and affinity (strength of binding to the target).

"This is the first time that it's possible to look at the diversity of antibody responses from primary cells, and measure a full set of their molecular characteristics, directly," he said. "This really does give you a snapshot."

In addition to vaccine development, the technique could be used to build a profile of a patient's immune system and its response to treatment for allergies, cancer or infectious diseases. "You could potentially track how the immune system is responding over time," Professor Love said.

For more information, go to http://web.mit.edu/newsoffice/2008/vaccination-1103.html.

Professors Prather and Stephanopoulos Use Bacteria to Better the Environment

Professor Kristala Jones Prather sees bacteria as diverse and complex "chemical factories" that can potentially build better biofuels as well as biodegradable plastics and textiles.

"We're trying to ask what kinds of things should we be trying to make, and looking for potential routes in nature to make them," she says. She and Professor Gregory Stephanopoulos are trying to create bacteria that make biofuels and other compounds more efficiently.

Professor Prather is developing bacteria that can manufacture fuels such as butanol and pentanol from agricultural byproducts, and Professor Stephanopoulos is trying to make better microbial producers of biofuels by improving their tolerance to the toxicity of the feedstocks they ferment and products they make.

Metabolic engineering involves not only creating new products but also developing more efficient ways of making existing compounds. Recently, Professor Prather's group reported a new way to synthesize glucaric acid, a compound with multiple uses ranging from the synthesis of nylons to water treatment, by combining genes from plants, yeast and bacteria.

She is also working on bacteria that transform glucose and other simple starting materials into compounds that can be used to make biodegradable plastics such as PHA (polyhydroxyalkanoate). In Professor Stephanopoulos' laboratory, researchers are developing new ways to produce biodiesel, plus other compounds including the amino acid tyrosine, a building block for drugs and food additives; biopolymers and hyaluronic acid, a natural joint lubricant that can be used to treat arthritis.

Both labs collaborate in a project to engineer the isoprenoid pathway in yeast and bacteria, which is responsible for the biosynthesis of many important pharmaceutical compounds. The two labs are investigating methods to make different compounds with higher activity while improving productivity.

For more information, go to http://web.mit.edu/newsoffice/2009/bacteria-energy-0217.html.

Other Research News

- Professor Greg Rutledge's electrospinning work profiled by TechTalk.
- Professors Gleason and Strano research graphene, a potential "miracle" material.
- Professor Michael Strano helps engineer viruses that build lithium-ion batteries.
- Professor Bob Langer's research helps fight frizz.
- Professor Arup Chakraborty helped establish the Ragon Institute to find new ways of preventing and curing human disease through harnessing the power of the immune system. He hosted its first symposium June 12, 2009.
- ChemE Grad Student (Hammond Group), Seung Woo Lee's work on nanotube superbatteries featured in Tech Review.
- Graduate student Andy Wijaya uses gold and light to help control drug delivery.
- Professor Dane Wittrup makes an antibody discovery that could help fight cancer.
- Professor Bob Cohen and post-doc Anish Tuteja present design rules for oil-repellant materials.
- Professor Paula Hammond, graduate student Nathan Ashcraft, and postdoctoral researcher Avni Argun's fuel cell work profiled in Technology Review.
- Professor Alan Hatton interviewed on the September issue of ACS Nano podcast about his recently published paper.
- Professor Chris Love and colleagues introduce novel technology for analyzing single blood cells.
- Professor Paula Hammond and team use virus to create microbatteries.

For more information on these and other research stories, go to web.mit.edu/cheme/news/

Student News

Spring 2009 Awards Day by Jeffrey Mo

Chemical Engineering celebrated the excellence of its faculty, students, and staff on May 11, 2009, during the annual Awards Day ceremony. Hosted by Department Head Klavs Jensen and Academic Administrator Suzanne Easterly, 32 members of the Chemical Engineering community were honored for both their contributions to the department and MIT at large, as well as for their academic excellence.

The Infinite Mile Award, an Institute-wide recognition given to staff members who have consistently gone above and beyond what is expected of them, was presented to **Sara Darcy**, the financial coordinator for several departments including Chemical Engineering, and to **Suzanne Easterly**. Sara has only been at MIT for three years but in that short time has proven herself to be both highly dedicated and professional. A familiar face to all of MIT's graduate students for almost the past decade, Suzanne's humor, flexibility, and efficacy belie her genuine empathy and concern for the well-being of her students. The Quarter Century Club also recognized **Professor George Stephanopoulos** and administrators **Barbara Balkwill** and **Glori Collver-Jacobson** for their twenty-five years of service to MIT.

Prof. Alan Hatton presents the Individual Accomplishment Award to administrator Beth Tuths.

Internal awards were presented to several staff members. **Rosangela dos Santos**, administrator to Professors Greg Stephanopoulos and Charlie Cooney, was presented with the 26th annual Outstanding Employee Award for her services to both faculty and students. Not knowing that she was to receive the award, Rosanagela was conned into attending the awards ceremony as a chaperone for the graduate students in the Stephanopoulos and Cooney labs! The Individual Accomplishment Award was given to **Beth Tuths**, administrator to Professor Alan Hatton and Lecturers **Robert Fisher** and **Claude Lupis**, and to **Steve Wetzel**, facilities coordinator to the department and a recipient of one of last year's Infinite Mile Awards. Beth was noted for her tireless efforts on behalf of the Practice School and Steve was recognized for his around-the-clock service after the Halloween steam pipe explosion in Building 66.

Student leadership was also recognized. **Kathryn Schumacher**, a senior hailing from Frederick, Maryland, was awarded the Chemical Engineering Department Special Service Award for her year as the president of the student chapter of AIChE. The same award was also presented to second-year graduate students **Adekunle Adeyemo**, **Joshua Allen, Emily Chang, Himanshu Dhamankar, Jyoti Goda, Patrick Heider, Jaisree Iyer, Becky Ladewski, Bradley Niesner, Michael Petr, Justin Quon**, and **Yuxi Zhang** for their roles on the Graduate Student Council (fondly known as the GSC-X). These twelve young engineers come from China, India, and Nigeria, in addition to seven American states and represent the strong diversity within our student body!

Academic Administrator and Infinite Mile Award Winner Suzanne Easterly watches over the Awards Day festivities.

Juniors and seniors in Chemical Engineering were the recipients of many awards for their academic achievements. Pennsylvania students **Michael Blaisse '09** and **Timothy Humpton '10** were this year's Merck Fellow and Genentech Scholar, respectively, for scholastic excellence. Junior **Shenwen Huang** of Mayfield Heights, Ohio was presented with the Cunningham Scholar Award, which is aimed to promote women in engineering. Memphis, Tennessee senior **Jacqueline Douglass** was awarded the Robert T. Haslam Cup for outstanding professional promise, an honor bestowed upon Professor Kristala Jones Prather fifteen years ago. Several Institute-wide awards were also presented to graduating seniors: Santa Clarita, California native **Johnathan Cromwell** was presented with the William L. Stewart Jr. Award for his extracurricular involvement, and **Alona Birjiniuk** from Weston, Massachusetts was named the Henry Ford Scholar after having maintained a cumulative GPA of 5.0 after seven semesters at MIT. Finally, the oldest award in the Department of Chemical Engineering, the Roger de Friez Hunneman Prize, was presented to senior **Jason Whittaker** of Wayland, Massachusetts in recognition of his outstanding scholarship in both class and research.

Graduate students midway through their PhD degrees give a seminar on their research every Monday afternoon in both the fall and spring semesters. This year, the awards for Outstanding Seminar Presentation, as chosen by their

peers, were given to **Wayne Blaylock** of Crossville, Tennessee (Fall 2008) and **Joseph Scott** of Royal Oak, Michigan (Spring 2009), both of whom were TAs for classes in Fall 2008 – Wayne for 10.25 (Industrial Chemistry and Chemical Process Pathways) and Joe for 10.34 (Numerical Methods Applied to Chemical Engineering). **Ming Yang**, an international graduate student from China and the Fall 2008 TA for 10.40 (Chemical Engineering Thermodynamics), was also recognized by his fellow students with the Rock Award for athletic leadership.

Finally, awards were presented for excellence in teaching. Graduate students **Jamila Saifee** of Tarzana, California and **Vicki Dydek** of Arlington, Virginia were voted, by their students, the Edward W. Merrill Outstanding Teaching Assistant and the Outstanding Graduate Teaching Assistant for their work in Winter 2009's 10.37 (Chemical and Biological Reaction Engineering) and Fall 2008's 10.50 (Analysis of Transport Phenomena), respectively. Students also voted for the C. Michael Mohr Outstanding Faculty Award (from undergraduates) and the Outstanding Faculty Award (from graduate students), with the tallies in favor of Professors **Herb Sawin** and **Arup Chakraborty,** respectively.

Congratulations to all award winners!

Students admire the 2009 iteration of the ChemE "Rock" Award during the post-Awards Day reception in Walker Lounge.

Photos courtesy of Kangy Mao

2008 Chemical Engineering Fellowships

A Star Graduate Fellowship
Yuqiong Li, Cornell

Alkermes Fellows
Zan Liu, Tsinghua
Michael Stern, Lehigh

BP MIT Energy Fellow
Sean Kessler, Lehigh

Caja Madrid Fellow
Maria Jose Nieves Remacha, U Complutense de Madrid

Enel Spa Cai MIT Energy Fellow
Todd Ferguson, RPI

Eni MIT Energy Fellow
Jason Kovacs, GaTech

Frederic A. L. Holloway '39 Fellow
Yeqing Fu, Tsinghua

Merck Fellow
Vanessa Pruzinsky, Notre Dame

Edwin R Gilliland '33 Fellow
Andrew Hilmer, Rochester

Haas Family Fellows
Vivian Hsieh, U of British Columbia
Tatyana Shatova, CalTech

John Henry Grover (1948) Fellow
Matthew Blackburn, UF

Robert T. Haslam (1911) ChE Fellows
Caroline Chopko, Princeton
Xianwen Mao, Tsinghua
Andrew Silverman, UF
Achim Wechsung, Rhenish-Westphalian Tech. U
Andrew Bouchard, FSU
Kareem Douglas, CCNY
Juhyun Song, Seoul Nat'l U
Steven Elliott, Vanderbilt
Cheri Li, Stanford

George M. Keller (1948) Fellow
Yuko Kida, UC Berkeley

George M. Keller (1948) Chevron
Rosemary Kanasty, Michigan State
Seok Joon Kwon, Seoul Nat'l U

David H. Koch (1962) Fellows
Amrit Jalan, IIT-Bombay
David Liu, CalTech
Eric Shiue, UC Berkeley

William & Margaret Rousseau
Armon Sharei, Stanford
Spencer Schaber, MN Minneapolis

Landau ChE P.S. Fellows
Harry An, Carnegie-Mellon
Deepak Dugar, IIT-New Delhi
Micah Sheppard, UPenn
Nathaniel Vacanti, UConn

ChE Practice School Fellows
Rachel Howden, Harvey Mudd
Asha Parekh, IIT-Kharagpur
Xiaochuan Yang, Tsinghua

Robert T. Haslam (1911) Pres.
Thomas Wasylenko, Princeton
Vanessa Pruzinsky, Notre Dame

Tae-Sup Lee Graduate Fellow
Seok Joon Kwon, Seoul Nat'l U

Jerry (1940) & Geraldine Mcafee
Wen-Hsuan Lee, Nat'l Taiwan U
Karthik Shekhar, IIT-Bombay

MITSCEP 1936 Course Xa
Yuqiong Li, Cornell

R. C. Reid (1954) & G. Williams
Nicholas Parsons, MI Ann Arbor

Keith & Helen Rumbel Fellow
Geraldine Paulus, Leuven

Adel F. Sarofim (1962) Fellow
Brian Robeson, Tulane

Arch Chilton Scurlock (1943)
Jamila Saifee, UCLA

John C. Sluder (1941) Fellow
Kittipong Saetia, Northwestern

H. (1953) & L. Stern PS Fellow
John Martin, USC

Frank Hall Thorp Fellow
Agustin Javier Lopez Marquez, U Simon Bolivar

Rosemary Wojtowicz Fellow
Kristin Vicari, Northwestern

DuPont-MIT Alliance Fellow
Kevin Lin, MI Ann Arbor

Lemelson Presidential Fellow
Jennifer Njoroge, Carnegie-Mellon

Walsh (1937) Memorial Pres.
Looh Choong, MN Minneapolis
Jeremy Jones, Purdue
Shawn Finney-Manchester, Brown
Jeffrey Mo, U of Calgary
Vasiliki Panagiotou, Aristotle U
Christy Petruczok, Clarkson

NSF Fellows
Rosemary Kanasty, MI State
Christy Petruczok, Clarkson

NSF and NDSEF Fellow
Steven Elliott, Vanderbilt

NSF and NDSEG Fellow
Cheri Li, Stanford

A Halloween Surprise for Bldg. 66

On Halloween Eve 2008 (Friday, October 31, 2008), a steam pipe violently ruptured in the subbasement of Building 66 due an effect known as a "water-hammer." The pipe ripped a hole through an office wall and immediately began to fill the area and the building with 400-degree steam at 200 psi, continuing for hours. Fortunately no one was hurt, but undergraduate and graduate students who were in the building when the rupture occurred had quite a story to tell. MIT facilities rose to the occasion and crews worked straight through the weekend to make the building safe.

Nearest the pipe explosion's "ground zero," this IT office sustained some of the worst damage.

The steam dissolved the ceiling tiles, turning them into "oatmeal" mush that had to be scooped up by shovels and by hand. All the ceilings in the central hallway areas came down or were so damaged that they had to be taken down.

The subbasement machine room was heavily damaged, as was the neighboring the Chemical and Biological Engineering teaching laboratory. A walk through the subbasement after the event showed melted plastic signage worthy of a Salvador Dali painting. In the Walker Lounge (66-201), the temperature rose so high that the sprinkler system was activated, further accelerating the damage.

Equipment in many laboratories were moisture-damaged by the prolonged steaming of the building. In general, the classrooms, labs, and offices in the northern area of Building 66 (facing the Alumni Pool and Stata Building) were hardest hit. Thanks to the enormous efforts of facilities, the building was open for teaching and research by Monday morning, albeit with no heat (but then heating/cooling problems are not new to the occupants of Building 66).

Hours after the event, steam envelops the Walker Lounge, adding drama to the Halloween decorations from the TG party earlier that evening.

The Chemical Engineering Department is still working to recover from the initial explosion and ensuing steam and water damage to our almost forty-year-old building. Repair crews have been in the building since the incident replacing mechanical infrastructure, ceiling, walls etc. A multimillion dollar cost is being negotiated with the insurance company. We are hoping that this activity will stimulate further renovation from the Institute itself.

Below are some accounts of the event, as told to Jeff Guo in the November 4, 2008 issue of the student newspaper *The Tech*:

Steam still lingers as a member of MIT Facilities cleans the hallway of the second floor after the the subbasement blast.

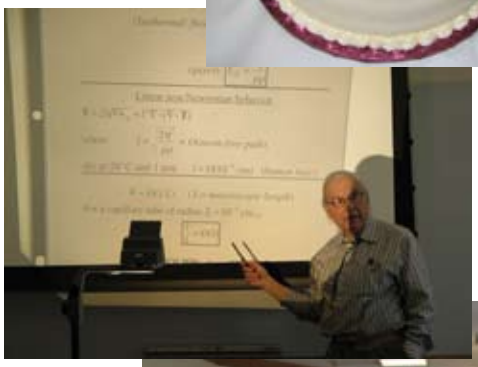
"Graduate students said they felt the building tremble as if there had been an earthquake. 'All of a sudden we heard this really loud explosion … you could hear this whooshing sound, and the whole building shook,' said Sanjoy Sircar, who was working in his lab on the third floor at the time. Sircar said he didn't immediately realize that it was a steam explosion. He said he and his lab mate just knew to get out immediately. 'I grabbed my coat, he grabbed his laptop, and we ran to save our lives,' he said.

'There was steam everywhere … you couldn't see anything inside,' said Sreeram Vaddiraju, a post-doc who was walking toward Stata when the explosion happened. Sircar said he saw the second-floor lounge flooded with water on Friday. Vaddiraju said there was water gushing down staircases when he tried to enter Friday night to assess the damage to his lab on the fourth floor.

Soaked and fallen ceiling tiles riddle a hallway on the fifth floor, six levels away from the initial explosion.

By as early as Saturday morning, the upper floors were mostly dry and some students were able to return to their labs to retrieve their belongings. Vaddiraju said the building was still 'extremely humid' — and quite smelly — on Saturday afternoon. 'My glasses fogged up,' he said. Vaddiraju said that his lab equipment was mostly functional, though the printers had stopped working."

Faculty Honor Professor Emeritus Howard Brenner on his 80th Birthday



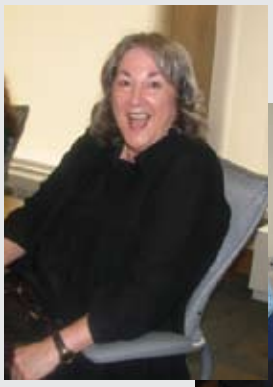
On March 16, 2009, Professor Emeritus Howard Brenner celebrated a significant milestone, his 80th birthday. The faculty held a party and asked him to speak on his research.

Professor Emeritus Brenner has co-authored three fluid dynamics books, namely "Low Reynolds Number Hydrodynamics (1965)," "Interfacial Transport Processes and Rheology (1991), " and "Macrotransport Processes (1993)." His honors include the American Institute of Chemical Engineers Lewis, Walker, and Alpha Chi Sigma Awards, the American Society for Engineering Education's Senior Research Gold Medal Award, the American Chemical Society's Kendall Award in Colloid Science, and the Bingham Medal of the Society of Rheology. He holds membership in the National Academies of Science and Engineering, and the American Academy of Arts & Sciences. Lifelong research interests focus on modeling chromatographic bio-particle separation processes in microfluidic devices and, more fundamentally, quantifying the molecular and convective transport of volume, viewed as a transportable, non-material entity.

Admin Barbara Driscoll Retires

After a quarter of a century supporting and sustaining the faculty, staff and students of the Chemical Engineering Department, Barbara Driscoll retired in October of 2008. At the party honoring her, the faculty thanked her for her invaluable years of supporting them and keeping them in line. Although we miss her knowledge, her company, and her clever wit, we wish her the best as she enjoys some well-deserved relaxation at her home on Cape Cod.

Thank you Barbara for everything!



Professor Clark Colton and Alina Haverty at the retirement party for Barbara.

Research Highlight by Professor Bernhardt L. Trout

Predictive Tools for Protein Aggregation and Binding

Protein aggregation has many undesirable effects, both for therapeutic proteins used in disease treatment and for proteins involved in biological processes. Aggregation causes therapeutic proteins to lose their activity, and raises concerns of potential immunogenicity. Similarly, protein aggregation in vivo is associated with a number of neurodegenerative disorders such as Alzheimer's and Creutzfeldt-Jakob diseases, and type II diabetes. Therefore, there is a tremendous need to understand the protein aggregation prone regions and to devise methods to prevent aggregation. Whereas protein aggregation is undesirable, protein binding is essential for many biological functions such as in cell signaling, metabolism, gene expression, and immune responses. Identifying these binding regions helps in understanding the protein function and in designing drugs to effectively target those binding regions involved in diseases such as cancer. Therefore, identifying protein aggregating and binding regions is of utmost importance to gain a fundamental understanding of biological processes, and to develop effective drugs. To this end, Professor Bernhardt Trout of MIT, together with Dr. Bernhard Helk of Novartis and team of post-doctoral assistants, Naresh Chennamsetty, Veysel Kayser, and Vladimir Voynov, is developing molecular computational and experimental techniques to predict accurately the protein aggregating and binding regions.

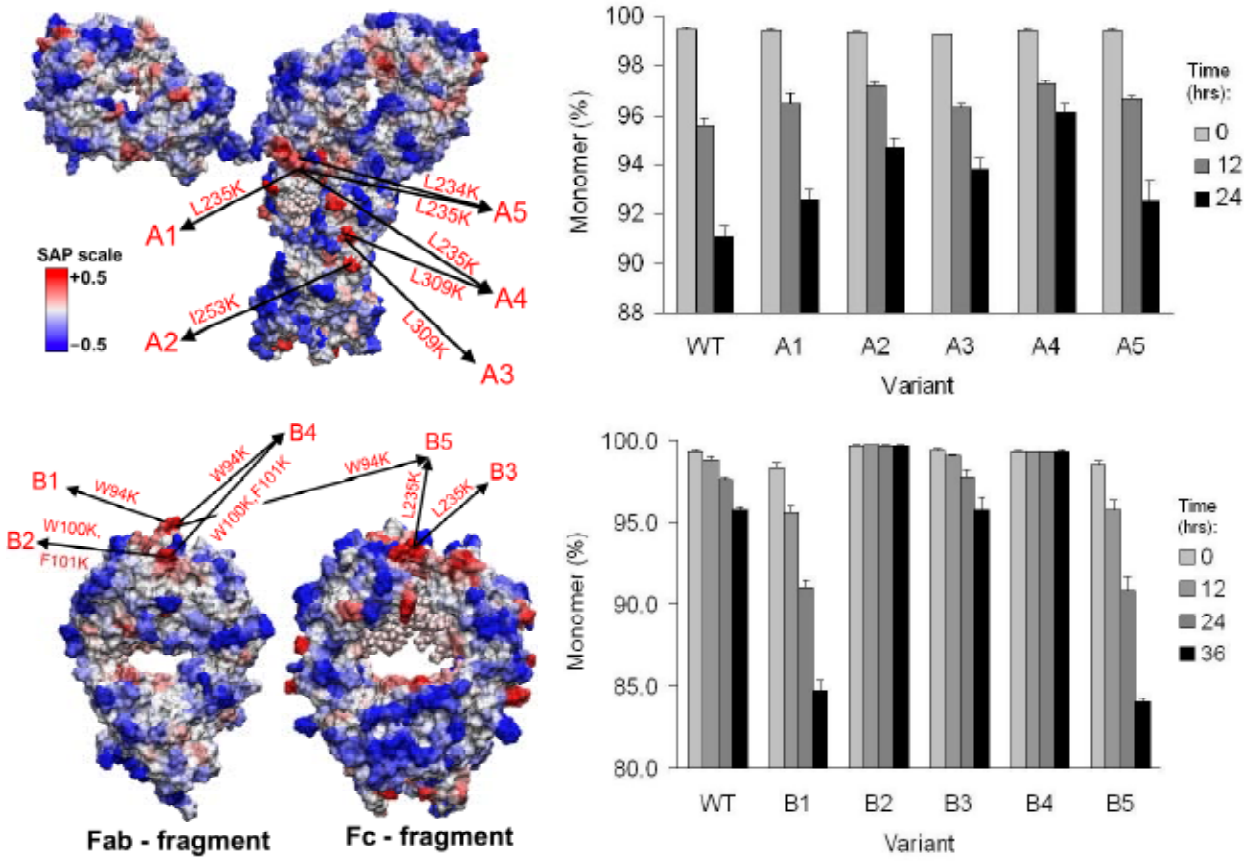


Figure 1. Spatial-aggregation-propensity (SAP) mapped onto antibody-A and antibody-B along with the peaks, A1 to A5 and B1 to B5, chosen for mutations. Also shown is the monomer loss from accelerated aggregation experiments that indicate the stability of wild type and variants.

A molecular computational technology called Spatial-Aggregation-Propensity (SAP) was developed that can predict both protein aggregating and binding regions with good accuracy (PNAS 2009). The SAP indicates the dynamically exposed hydrophobic regions that are prone to aggregation or binding. The SAP was applied to two model therapeutic antibodies, antibody-A and antibody-B, to predict their aggregating regions (Figure 1). Mutations engineered at sites responsible for the peaks of SAP led to antibodies of enhanced stability. The sites chosen for mutation are shown in Figure 1. The mutants were then tested for their aggregation behavior using accelerated aggregation experiments under heat stress. SEC-HPLC (size-exclusion high-performance liquid chromatography) was used to determine monomer loss over time after heat stress (Figure 1). The SEC-HPLC results for antibody-A indicated monomer increase from 91 percent for wild type to 92-97

percent for the variants, indicating enhanced stability of the mutants. Similarly for antibody-B, the SEC-HPLC results showed monomer increases from 95 percent for wild type to 96-100 percent for the variants, except for 2 mutations (B1, B5). Apart from this exception, the variants in general were more stable than the wild type, providing validation of high values of SAP corresponding to regions prone to aggregation. Thus, the SAP technology can used be along with genetic engineering techniques to design therapeutic proteins with enhanced stability.

The SAP technology was also demonstrated to predict protein binding regions with good accuracy. The SAP tool was applied to two model proteins, an IgG1 antibody and EGFR, to predict their binding regions. For EGFR, the binding regions with EGF, TGF, and with another EGFR correlate well with SAP peaks (Figure 2). For the antibody, the binding regions with Fc-receptor, protein-A and protein-G correlate very well with SAP peaks. Some of these peaks also coincide with confirmed aggregating regions shown in Figure 2. Thus, the SAP tool shows that some of the protein binding regions overlap with the aggregating regions. This presents a challenge for therapeutic protein design because unfavorable aggregation needs to be prevented while preserving the protein binding necessary for its function. This challenge can be addressed using SAP analysis followed by protein engineering. Using SAP, the sites near the binding site that are involved in aggregation can be found and modified to decrease aggregation propensity while preserving binding. This was demonstrated using the IgG1 antibody where the aggregation prone regions near the protein-A binding sites were modified to decrease aggregation while preserving the binding capacity (PNAS 2009). Similar protein engineering based on SAP could be performed near the antigen binding regions to decrease aggregation propensity while preserving activity. Thus, the SAP tool described here could be used to design stable therapeutic proteins, while at the same time preserving their binding capacity.

In summary, several molecular computational and experimental techniques were developed to predict protein aggregating and binding regions. The SAP technology based on molecular computations was used along with genetic engineering techniques to predict and validate the aggregating regions of therapeutic antibodies. Apart from antibodies, the SAP tool was employed to identify aggregation prone regions on other proteins and peptides as well. With the mounting number of protein therapeutics, this technology could greatly improve the developability screening of candidate bio-pharmaceuticals, or in further stabilizing the selected candidates. The SAP technology could also be used to predict protein binding regions, especially for the proteins of interest as disease targets. Furthermore, it can determine the yet unknown binding sites for numerous proteins coming out of structural genomics initiatives, thereby providing important clues to their function.

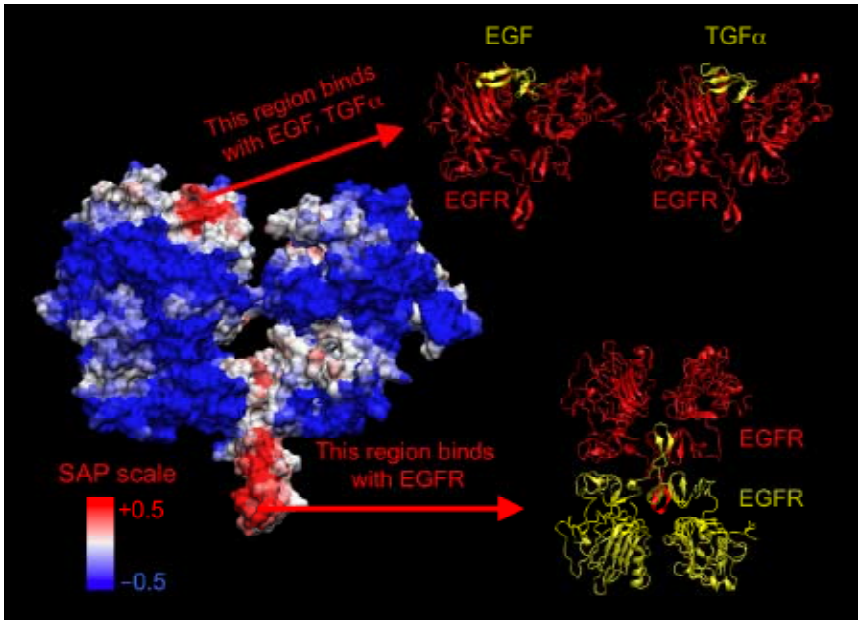
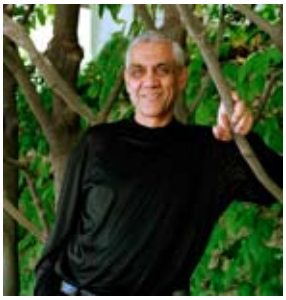


Figure 2. Spatial-Aggregation-Propensity (SAP) mapped onto the EGFR structure. The high SAP regions that bind with EGF, TGFα and another EGFR are also marked.

Lectureships and Events

in the Chemical Engineering Department

The Hoyt C. Hottel Lecture



Extrapolate the Past... or Invent the Future

Vinod Khosla

Founder, Khosla Ventures

September 23, 2008

(co-sponsored by the MIT Energy Initiative)

In Fall 2008, the MIT community played host to Vinod Khosla, founder of Khosla Ventures. His lecture, co-hosted by the MIT Energy Initiative.

For the first part of Mr. Khosla's lecture, he expressed the desire to "do what Professor Hottel wanted you to do, which was to learn to think." After giving perspective on how he thinks about energy and the questions one should be asking today, Mr. Khosla gave a "sampling" of the kinds of technologies his company is currently working on. "My principle goal is to… fire up your imagination. If one person walks out with…one new idea, I'll consider this talk successful."

While quoting Aristotle and George Bernard Shaw, Mr. Khosla explained his fundamental philosophy as "if people think something can be done, then it's probably already being done." When considering an investment or strategy, his company does not consider forecasts or a rate of return; if something makes economic sense and is important, then "you stick with it. You stick with it through setbacks and everything else, because it's worth it. I don't mind failing, as long as it's worth succeeding."

After discussing present work in biofuels, new battery technologies, HD lighting, and "living homes", Mr. Khosla ended his enlightening talk with his favorite quote, "The willingness to fail gives us the freedom to succeed" and a list of areas "ready for replacement."

For more information and to view the webcast of Mr. Khosla's lecture, go to http://web.mit.edu/cheme/news/hottel/index_2008.html

Vinod Khosla was a co-founder of Daisy Systems and founding Chief Executive Officer of Sun Microsystems where he pioneered open systems and commercial RISC processors.

Sun was funded by Kleiner Perkins and in 1986 Mr. Khosla switched sides and joined Kleiner Perkins Caufield & Byers (KPCB). In 2004, driven by the need for flexibility and a desire to be more experimental, to fund sometimes imprudent "science experiments", and to take on both "for profit" and for "social impact" ventures, he formed Khosla Ventures. Khosla Ventures focuses on both traditional venture capital technology investments and clean technology ventures. Social ventures include affordable housing, microfinance among others.

Mr. Khosla holds a Bachelor of Technology in Electrical Engineering from the Indian Institute of Technology in New Delhi, a Master's in Biomedical Engineering from Carnegie Mellon University and an MBA from the Stanford Graduate School of Business.

The Hoyt C. Hottel Lectureship was established in early 1985 to recognize Professor Hottel's contributions to the intellectual climate of the Chemical Engineering Department, to the encouragement of students over six decades, and to the foundation and direction of the Fuels Research Laboratory. The lectureship is intended to draw eminent scholars to MIT - preferably in the fields of combustion and energy technology - for short periods of residency in order to stimulate future generations of students. The inaugural Hottel Lecture was presented in April 1985 by Professor Hottel himself.

The Frontiers of Biotechnology Lecture

Synthesis at the Interface of Chemistry and Biology

Peter Schultz

Scripps Professor of Chemistry, Scripps Research Institute

Director, Genomics Institute, Novartis Research Foundation

March 20, 2009

Professor Peter Schultz started his lecture to a standing-room-only crowd with memories of his work in Building 18 as a postdoctoral associate. He was happy to be back at MIT to see some of the new work going on: "It's like being a kid in a candy store."

Professor Schultz's energetic lecture discussed the work of his laboratory at the Scripps Institute. His research program combines the tools and principles of chemistry with the molecules and processes of living cells to synthesize new molecules and molecular assemblies with novel physical, chemical and biological functions. By studying the struc-

ture and function of the resulting molecules, new insights can be gained into the mechanisms of complex biological and chemical systems. His present projects include the generation and characterization of catalytic antibodies, methods for adding new building blocks to the genetic codes of prokaryotic and eukaryotic organisms, problems in biological structure, recognition and catalysis, drug discovery, and materials science and chemical and genomics studies of stem cell biology, oncogenesis and orphan/neglected diseases.

For more information and to view the of Professor Schultz's lecture, go to http://web.mit.edu/cheme/news/biotech/frontiers_2009.html

Peter G. Schultz graduated (summa cum laude) from the California Institute of Technology in 1979 and continued there for his doctoral degree (in 1984) with Professor Peter Dervan. He then spent a year at the Massachusetts Institute of Technology with Professor Christopher Walsh before moving to the University of California, Berkeley, and the Howard Hughes Medical Institute.

Schultz is currently the Scripps Professor of Chemistry at The Scripps Research Institute and Director of the Genomics Institute of the Novartis Research Foundation. He has made a number of major contributions to science including: (1) the discovery of catalytic antibodies, and their use to study fundamental mechanisms of biological catalysis and the evolution of binding and catalytic function; (2) the development of technology that for the first time enables the systematic expansion of the genetic codes of living organisms to include unnatural amino acids beyond the common twenty; and (3) the development and application of combinatorial methods in chemistry and biology including the first generation of combinatorial materials libraries and the isolation of molecules that control stem cell proliferation and fate.

The Frontiers in Biotechnology Lectureship was established in 1999 through a generous donation from Dr. Noubar Afeyan to acknowledge the enabling technologies and developments that have sustained the growth of biotechnology and life sciences. Some of these include bioprocess engineering (upstream and downstream processes), bioanalytical developments, advanced and new instruments, novel delivery concepts, biomedical devices, rational drug design, computational methods, bioinformatics, and information technology. It is the intent of this Lectureship to recognize and honor achievements on the "frontiers of biotechnology" and the distinguished scientists and engineers responsible for them.

The Alan S. Michaels Lecture

Recognition and Delivery: The Next Generation of Medical Microdevices

Nicholas A. Peppas (ScD '74)

Fletcher S. Pratt Chair of Chemical Engineering, Biomedical Engineering, and Pharmaceutics, University of Texas at Austin

April 3, 2009

The MIT Community packed the Gilliland Auditorium to hear Professor Nicholas Peppas discuss medical microdevices. He started with a tribute to Professor Michaels, whom to him was a "mentor, teacher, friend, and an inspiration… you cannot imagine what a man he was. We were frightened and at the same time excited to be next to his presence."

Professor Peppas detailed his work in creating miniaturized systems to inprove the treatment of disease, advanced detection and therapy, and cost effective processes. The overarching goal, and the reason he entered this field, is to improve the quality of life for this patients.

To end his lecture, Professor Peppas discussed his life as a graduate student in the Merrill Lab from 1971-1973. At the time, there was discussion that the "new" building, Building 66, would not be big enough, but it was built anyway. He was a postdoctoral associate with Professors Colton and Smith in 1975-1976 and thanked the department and the Michaels family for their support.

For more information and to view the webcast of Professor Peppas's lecture, go to: http://web.mit.edu/cheme/news/michaels/michaels_2009.html

Professor Nicholas Peppas is the Fletcher Pratt Chair of Chemical Engineering, Biomedical Engineering and Pharmacy at the University of Texas at Austin. He is a leader in the fields of bionanotechnology and molecular recognition processes, nanodevices for controlled drug delivery, and intelligent biomaterials. Among other medical devices, he has developed, patented and/or commercialized intraocular lenses, materials for vocal cord restoration, nanodelivery systems for oral administration of insulin to type I diabetic patients, and systems for oral delivery of calcitonin for treatment of postmenopausal women suffering from osteoporosis.

Peppas was educated in chemical engineering at the National Technical University of Athens, Greece (Dipl. Eng., 1971) and at the Massachusetts Institute of Technology (Sc.D., 1973). He is a member of the Institute of Medicine (IOM) of the National Academies, the National Academy of Engineering (NAE), the National Academy of France (Pharmacy section), and the Academy of Medicine, Engineering and Sciences of Texas (TAMEST). He has received honorary doctorates from the University of Ghent (Belgium, 1999), University of Parma (Italy, 2000), and the National and Kapodistrian University of Athens (Greece, 2000).

He is the author of 1,050 publications and 45 US and international patents, and the coauthor or coeditor of 34 books and volumes. He is one of the most cited scientists in the world. He is President of the International Union of Biomaterials Societies (2008-12) and a member of the Board of the Biomedical Engineering Society. He has served as President of the Society for Biomaterials in 2003-04, President of the Controlled Release Society in 1987-88 and Director of AIChE in 1999-2002. Peppas has been elected a Fellow of AIMBE, APS, MRS, AIChE, SFB, AAPS, AAAS and ASEE. He has been recognized with more than 100 national and international awards including the Founders, Walker, Institute Lecture, Materials, and Bioengineering Awards from AIChE, the Galletti Award from AIMBE and the Founders Awards of both SFB and CRS. Peppas has supervised the theses of 82 Ph.D. students, including 35 current professors in other Universities.

The Alan S. Michaels Distinguished Lectureship in Medical and Biological Engineering was established in 1995 to stimulate the collaboration of the medical profession, life sciences industries, and chemical engineering researchers.

The most exciting and promising developments in medicine and the life sciences - those leading to improved therapies for the treatment or mitigation of intractable diseases, and strategies for prevention of debilitating or life-threatening genetic deficiencies - are largely emerging from discoveries in molecular biology and biochemistry, in concert with those in the sister-sciences of immunology, pharmacology, and genetics. These developments involve, in a very direct way, the basic tools that are the hallmark of the chemical engineer's profession: molecular thermodynamics, chemical reaction kinetics, homogeneous and the heterogeneous catalysis, fluid mechanics, and mass- and energy-transport processes. Few other engineering disciplines are as well qualified to deal with the microscopic and molecular phenomena affecting living systems.

The Warren K. Lewis Lecture

The Impact of Mega Economic Trends on the Chemical Industry & ChemE Profession

William F. Banholzer

Executive VP and CTO,
Dow Chemical Company

April 17, 2009

Dr. William Banholzer began his lecture issuing a challenge: "The world is facing undue challenges now: not only are we facing a global economic collapse but we're struggling with how to balance a need for energy with our concerns over global warming. How are we going to feed the planet? How are we going to generate enough clean water? ... Chemical engineering is the most uniquely capable field for addressing these issues."

Dr. Banholzer gave an alternate title to his lecture: "How Chemical Engineering Fundamentals Can Change the World." Dow has goals to reduce energy intensity and has already reduced them by 22%. It has now vowed to lower its greenhouse emissions by 25%. Dr. Banholzer presented a case study of eliminating completely carbon dioxide emissions from a coal and gas fired power plant in Germany. A company approached him that could clean the CO2 emissions, turning it into hydrogen, chlorine, and baking soda. Dr. Banholzer then asked the audience what they would do if they were him: would they collaborate with the company or reject the offer? What questions would they ask? Watch the webcast to learn the answer.

Other cases at Dow were presented, each showing how chemical engineering fundamentals can help come to the best business and environmental answer.

For more information and to view the webcast of Dr. Banholzer's lecture, go to:

http://web.mit.edu/cheme/news/lewis/index-2009.html

William F. Banholzer is Executive Vice President and Chief Technology Officer of The Dow Chemical Company, located in Midland, Michigan. He is a member of the Dow's Executive Leadership Committee, Management Committee, chairs the company's Innovation Committee, and leads Dow's research and development activities across the globe. Banholzer serves on Dow's Venture Capital Board, Dow AgroSciences' Members Committee, the Dow Foundation, and the governing Council of the U.S. National Academy of Engineering. He is a member of the Board of

Directors of Dow Corning Corporation and serves on the Board's Corporate Responsibility Committee.

Prior to Dow, Banholzer had a 22-year career with General Electric Company (GE), where he was vice president of Global Technology at GE Advanced Materials, responsible for worldwide technology and engineering.

In 2002, Banholzer was elected to the U.S. National Academy of Engineering, one of the highest distinctions that can be accorded an engineer. He is one of only 105 active chemical engineers elected to the prestigious institution, which honors those who have made "important contributions to engineering theory and practice" or demonstrated "unusual accomplishment in the pioneering of new and developing fields of technology." In 2006 he was elected by the Academy membership to serve as one of 12 councillors comprising the governing body of the NAE.

Banholzer serves as a presidential nominee to the MIT Corporation Visiting Committee for the Department of Chemistry. He also sits on the advisory board for chemistry and chemical engineering at UC Berkeley, is a member of the American Chemical Society and the American Institute of Chemical Engineers.

Banholzer earned a bachelor's degree in chemistry from Marquette University and master's and doctorate degrees in chemical engineering from the University of Illinois. He is a certified Six Sigma Master Black Belt, holds 16 U.S. patents and has over 80 publications, which have received more than 1000 citations, for his work in the field of engineering and chemistry.

The Warren K. Lewis Lectureship was established in 1978 to recognize Professor Lewis's revolutionary impact on chemical engineering education. One of MIT's first students in chemical engineering, he made seminal impact to the discipline. By developing the concept of unit operations, first proposed by A. D. Little and William Walker, he revolutionized the design of chemical engineering processes and equipment. Throughout his career, Professor Lewis was mindful of the needs of industrial practice; accordingly, the Lewis lecture features speakers from industry and academia.

You are invited to attend the

2009 Hoyt C. Hottel Lecture

in the Chemical Engineering Department

"Membranes: The Vanguard of Large Scale Low Energy Intensity Separations"

William J. Koros,
Roberto C. Goizueta Chair for Excellence in Chemical Engineering
and
GRA Eminent Scholar in Membranes, Georgia Tech

Friday, December 4, 2009
3:00 p.m.
66-110
Reception at 2:30pm in 66-201

William J. Koros is an advocate for technology-assisted strategies to reduce the energy intensity and carbon dioxide footprints of chemical processes. He is leader in the development of advanced separation membranes and sorbents and an expert in the formation of advanced hollow fiber membranes and sorbents with composite structures.

For more information, go to
web.mit.edu/cheme/news/hottel.html

Alumni News

We want to hear from alumni like you!
Please direct news to: ***Melanie Miller, Editor***
Email: ***melmils@mit.edu***, Phone: ***617-253-6500***, Fax: ***617-258-8992***

Clyde Smith (MS '35) is fairly good shape at 97. He has been retired for 32 years after spending 35 years at Berkley. During his retirement, he was a volunteer docent at the California Academy of Science for 20 years.

Thomas McCarthy (SM '52)'s company, Croft Stainshiel Ltd. of Dublin, Ireland, is involved in recovering resources from waste to replace the use of natural mineral resources. His current activity focuses on incinerator bottom ash, from which can be recovered non-ferrous metals such as copper, nickel, and zinc. This large mineral fraction has potential uses in the construction industry. Incineration of non-recyclable municipal solid waste is a key part of waste treatment in most of Europe, and growing; over 20 million tonnes are available in Europe at this time. McCarthy states "This is all about reducing the depletion of natural resources or sustainability, and it is also a profitable business under normal market conditions which seem to be returning – slowly."

Kymus Ginwala (BS '52, SM '54) has retired after 22 years as serving as the CEO of Northern Research and Engineering Corp.(an MIT start-up). He has continued working, advising companies in the US, India, Japan and South Africa on business and technology development. Ginwala was in the department at a classic time when McAdams, Lewis, Gilliland (who was his neighbor later on in Belmont) were there as well as Fritz Meissner and Manson Benedict who were great mentors. Ginwala still comes to campus helping set up an MIT-South Africa program, as well as with companies whom he advises.

Harlan Walker '55 still has his Brass Rat. Myalgic encephalomyelitis and diabetes keep him housebound, but he keeps up with the news with four newspapers.

Richard P. de Filippi (SM '59, ScD '62) has been elected chair-elect designate of the American Hospital Association's (AHA) Board of Trustees. De Filippi will assume the chairmanship in 2010, making him the top elected official of the largest hospital and health system association in the United States.

Fariborz Ghadar '68, University of Pennsylvania's William A. Schreyer Professor of Global Management, Policies and Planning, was profiled in the international Metro newspaper for his latest project, "Global Techtonics," which studies developing trends in technology, nature, and society slowly revolutionizing the business environment of the future.

Donald Anthony (SM '71, ScD '74), chief technology officer for Great Point Energy, spoke at West Virginia University in October 2008 about the commercialization of a technology to convert coal or petroleum coke into pipeline-quality synthetic natural gas. Great Point Energy develops catalytic gasification technology to convert coal, petroleum coke and biomass into natural gas while capturing and sequestering carbon dioxide. Employing its proprietary conversion and carbon capture technology, GreatPoint Energy produces ultra-clean natural gas from abundant domestic sources.

Peter Balbus '82, founder and managing director of Pragmaxis LLC, was a featured speaker at the 2nd Annual Business Innovation Conference at the suburban Chicago Rice campus of Illinois Institute of Technology (IIT) in Wheaton, Ill., in October 2009.

Ivan Fong (SB '83, SM '84) was nominated by President Obama and has become the General Counsel for the US Department of Homeland Security.

Keith Dionne (SM '88, PhD '90) became president and CEO of drug development company Surface Logix in October 2008.

David Gray (SM '89, PhD '92) has been appointed to the newly created position of vice president, strategic development, at GT Solar International, Inc., a global provider of specialized equipment and technology for the solar power industry. Gray will lead the company's non-organic growth initiatives, focusing on the acquisition of complementary products and technology, and will also support the development and execution of business strategies to drive organic growth.

Aleksander Franz (SB '90, SM '91)'s company, Lilliputian, has spent six years developing a pocket-size fuel cell that runs on butane and can charge a smart phone through a USB cable (now a standard in almost all smart phones). Lilliputian calls the device a "portable power solution." Lilliputian's work was profiled in the October 13, 2008 edition of Newsweek.

Neelan Choksi '92's company Lexcycle was bought by Amazon in Spring of 2009. Lexcycle (pronounced like the word "lexical") makes the e-book reader application Stanza for the iPhone, iPod Touch, and desktop.

Ravindra Kane (SM '95, PhD '98) has been named the P.K. Lashmet Professor at Rensselaer Polytechnic Institute. He also won the 2008 Young Investigator Award from the American Institute of Chemical Engineers' Nanoscale Science and Engineering Forum.

Dora Farkas '98 has authored the book "The Smart Way to Your Ph.D. (200 Secrets from 100 Graduates)." For more information on the book, go to www.yourphd.com.

John Santini (PhD '99) was named one of Popular Science's 2008 Brilliant 10. Founder and CEO of Micro-

CHIPS, Santini is building under-the-skin microchips that deliver drugs straight into the blood.

Carlos Rinaldi Ramos (SM '01, PhD '02), professor of chemical engineering at the University of Puerto Rico-Mayagüez, was named a 2009 "Emerging Scholar" by the publication *Diverse Issues in Higher Education*.

Christiane Gumera '03, who is currently working toward her PhD in biomedical engineering at Georgia Tech, was profiled in Manila Standard Today. Her team is developing polymers to regenerate damaged central nervous system cells.

IN MEMORIAM

Thomas M. Bennett '43 1922-2009

Thomas Maurice Bennett, 86, died peacefully at home after a long struggle with Parkinson's disease on Friday, Feb. 27, 2009.

After graduating with a degree in chemical engineering from MIT, he was commissioned as a second lieutenant in the US Army, where he proudly served in North Africa and France until 1945 as part of the World War II greatest generation, eventually attaining the rank of captain. Upon his return to civilian life, Tom joined The Lummus Company as a chemical engineer, where he had eventual responsibility for global petrochemical research and development. He attended the Polytechnic Institute of Brooklyn, and was licensed as a professional engineer in New York and New Jersey.

Upon his retirement, Tom and his wife Kay moved in 1988 to Westover, and then to Princess Anne, Maryland, in 2005. Tom was active in St. Elizabeth's Roman Catholic parish, serving as chairman of the building and maintenance committee and taking on numerous other responsibilities.

George M. Keller '48 1923-2008

George M. Keller, former chairman of the Standard Oil Company of California in the 1980s and eventually the Chevron Corporation, died in October 2008, in Palo Alto, Calif. He was 84.

George Matthew Keller was born in Kansas City, Mo., on Dec. 3, 1923. His mother died when he was in the first grade, and an aunt nurtured his passion for science. At age 10, at the DuPont exhibit at the Chicago World's Fair of 1933, he became mesmerized by chemistry.

He enrolled in MIT, then joined the military as a sophomore, serving as an Army Air Forces meteorologist. He returned to MIT, and after graduating in 1948, received four oil-company job offers. He eventually joined Standard Oil at his wife's choosing. She died in 2007.

Mr. Keller is survived by three sons, Bill, of Manhattan; Bob, of Denver; and Barry, of Granite Bay, Calif.; and six grandchildren.

Mr. Keller began at Standard Oil by designing refineries, and served in positions of increasing responsibility, starting as a design and construction engineer on refinery and chemical facilities when the company changed to Chevron.

In 1967, Keller was named assistant vice president of Foreign Operations. The following year he was promoted to assistant to the president. He was named vice president of the corporation in July 1969; a director in August 1970; vice chairman in February 1974; and chairman of the board in May 1981. He retired from the company on Dec. 31, 1988.

"George was a true leader and visionary, and he was deeply respected by all those who had the fortune to work with him," said David O'Reilly, current chairman and chief executive officer of Chevron. "His tireless efforts in leading the acquisition of Gulf Oil created the foundation for the Chevron we know today. On behalf of our board of directors and 59,000 employees around the globe, we are truly saddened by his passing."

Salvatore Santo '51 1925-2009

Salvatore ("Sal") Santo passed away Thursday, March 12, 2009, just two weeks shy of his 84th birthday. After serving in the US Army from 1943 to 1946, Sal graduated from MIT in 1951with a degree in chemical engineering. He then moved to California and worked for a series of companies, including Standard Oil, before joining Ralph M. Parsons Corporation in Pasadena, where he was employed for 35 years until his retirement in 1994.

In addition to his professional accomplishments, the center of his life was his family; especially his wife of 45 years, Una. He is also survived by his four children Susan, Stephen, Matthew and Marianne.

Sal's strength of character, wisdom, and his unwavering love and devotion as provider, protector, and guide will be greatly missed.

James J. Isenberg '75 1944-2008

James Jacob Isenberg, of Newark, Ohio, formerly of Chestnut Hill, Mass., passed away Sunday, Nov. 23, 2008. He was a strong supporter of the Chemical Engineering Department, and the cherished son of the late Joseph Meyer and Laura (Stein) Isenberg; the dear brother of Judith Ellen Sarkisian, of Elkins Park, Pa.; and loving uncle of Brie Laura Sarkisian.

Arturo Martin de Nicolas y Garcia (SB '49, SM '51) 1929-2009

Arturo Martin de Nicolas y Garcia, age 79, of Austin, was born in Madrid, Spain on September 8, 1929 and was called to heaven peacefully in his sleep in the early hours of Wed., February 18, 2009. The son of a Spanish physician, lawyer and deputy to the Spanish Cortes (Congress) and a Cuban-born mother, he left Spain for England with his parents and two sisters in 1937 when the Spanish Civil War broke out. In 1940, at the start of World War II, the family went to Cuba, where his father became the head of a textile company. Arturo entered MIT at sixteen, graduating with honors as a BS and MS in chemical engineering, and later from NC State with an MS in textiles. In 1960, he became an exile once more after Fidel Castro took power in Cuba and left for the United States with his wife Berta and two young sons. The family later lived in Chile, and Costa Rica, returning to the United States in 1980. He enjoyed classical music, chess and stamp collecting, travelling often to his native Spain. He is survived by his wife, Berta; sons Arturo, Juan, Jorge and Pedro; grandchildren Andres, Alex and Paulina; sister Delia and her husband Oscar Prado; and his nephews, nieces and cousins in the US and Spain. A memorial to Arturo's life can be found at www.mem.com.

Alumna Highlight Suege Omnik '06

Suege Omnik '06, an Inupiat/Korean from Anchorage, Alaska, is using her MIT Chemical Engineering education to help her hometown. Suege returned to Alaska after graduation to work for ASRC Energy Services. She is engineering designs for modules that extract heavy oil from North Slope oil wells.

Before coming to MIT, Suege was mentored and supported through the Anchorage School District program, the University of Alaska Anchorage's "college bridging" program for aspiring Alaska Native engineering and science students, summer internships with BP and later ConocoPhillips.

At first Suege was unsure of which engineering program to follow, but decided on chemical engineering because she found it most interesting.

She tells the Alaska Journal for Commerce (AJOC), "In civil engineering we work with structural objects; mechanical engineering involves things with moving parts, but chemical engineering deals with what things are made of and how it all fits together," as for her post-graduation work, she states, "I liked science and math in high school, and I was good at it. I've always wanted to help Alaska, and working in the petroleum industry offers me huge opportunities to do that."

Suege is now part of BP Exploration (Alaska) Inc.'s team working on ways to commercially produce the massive heavy oil resource of Alaska's North Slope. Heavy oil, as well as natural gas, is considered the long-term future for the North Slope petroleum industry. There are large deposits around the existing producing fields of the Slope, but it is not yet known if it can be economically produced. Suege's BP team is engaged in testing pilot production wells and processing facilities to see if the oil can be produced.

(Thanks to Tim Bradner, AJOC. Photo courtesy of Rob Stapleton, AJOC)

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This honor roll is a special salute to those who have given over $100 to the MIT Chemical Engineering Department for the period of July 1, 2008, through June 30, 2009.

Thank you to everyone who has supported us throughout the year!

Every effort has been made to ensure the accuracy of this list.
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Herbert L. Spivack ’49
Arthur L. Squyres ’53
Arnold F. Stancell ’62
John E. Stauffer ’57
Harvey G. Stenger Jr. ’84
Leonard I. Stiel ’59
Herbert L. Stone ’53
Bayard T. Storey ’55
Pieter Stroeve ’73
Catherine E. Teague Sigal ’81
Jefferson W. Tester ’71
Michael P. Thien ’88
Edward F. Thode ’42
Keith M. Thompson ’64
Jean Tilly ’83
Sonja L. Tong ’01
Olev Trass ’58

George A. Truskey ’85
Margaret C. Tsai ’99
W H. Tucker ’46
Antonio Tuells Juan ’65
Howard T. Tupper ’52
Jaime A. Valencia-Chavez ’78
William D. Van Vorst ’43
Friedrich K. Von Gottberg ’92
David L. Wagger ’92
Eva C. Wan ’81
Stephen S. Wan ’82
Beatrice Wang ’99
Benjamin N. Wang ’07
Robert A. Ware ’84
Douglass J. Warner ’59
Alfred E. Wechsler ’55
Nancy L. Wechsler ’55
James C. Wei ’54
Robert F. Weimer ’61
Martin A. Welt ’57
Gary L. White ’77
Lawson E. Whitesides Jr. ’71
David A. Wickham ’84
Carl V. Wikstrom ’90
Richard J. Wilcox ’85
John A. Wilkens ’77
Lucile S. Wilkens ’77
Richard C. Willson III ’88
Graham A. Woerner ’76
Byron B. Woertz ’39
Patrick S. Wong ’62
Benjamin H. Wood Jr. ’62
Wesley Wright Jr. ’57
Vijay M. Yabannavar ’88
Hiroshi Yagi ’79
Bruce S. Yarmoska ’79
Michael J. Yaszemski ’95
Kai W. Young ’58
Michael Zeltkevic ’99
Lei Zhang ’95
Yizu Zhu ’92
Allyn J. Ziegenhagen ’59
Eric M. Zilberkweit ’58
Samuel Znaimer ’81
Irwin S. Zonis ’52
Andrew L. Zydney ’85

Blast from the Past

A special thank you to **Stanley Charm (SB ’52, ScD ’57)**, who recognized himself and Course 20 student **Bill McComis (PhD ’64)** in the previous newsletter’s photo that he estimates is circa 1958.

Also thank you to **Phil Closmann (SM ’48)** and **Malcolm Brown (BS ’66, MS ’67)**, who recognized Professor Gilliland and **Stu Nemser (SB ’66, SM ’68, ScD ’72)** in a photo in the Spring 2009 newsletter.

This was a very popular photo! **Ronald Eisinger (SB ’71, SM ’71)**, writes: “To my surprise, I recognized a photo in the “Blast from the Past” section of the Spring 2009 Alumni News. The photo shows the lab where I carried out experimental work for a Masters Thesis in 1970 - 1971 in the old Chemical Engineering Bldg (Bldg 12?). I remember all three people in the photo. They are, from left to right, Dr. Gilliland (my Masters’ thesis advisor), Stu Nemser, and Russ Jones. Stu, then working on his PhD, took a job at DuPont in Parkersburg, WV. Russ, after earning a PhD at Berkeley, worked for a while at Union Carbide in South Charleston, WV. I live in Charleston, WV, having worked here for Union Carbide and the Dow Chemical Company for 27 years. The West Virginia connection is coincidental.”

Below are new photos culled from the MIT Chemical Engineering archives. Are you or anyone you know in them? Email *melmils@mit.edu* if something is familiar!

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ADDRESS SERVICE REQUESTED

FALL 2009 Chemical Engineering Department Seminar Schedule

All Seminars are Fridays at 3pm in 66-110. Reception at 2:45pm.

September 11, 2009
Nucleation of Organic Molecular Crystals: Evidence for the Two Step Nucleation Model
Allan Myerson, Illinois Institute of Technology

September 25, 2009
Low Temperature Plasmas: From Nanoscale Etching to Medicine
David Graves, UC Berkeley

October 2, 2009
Statin Biosynthesis: Fundamentals and Applications
Yi Tang, UCLA

October 16, 2009
Designing Next Generation Materials: Building Blocks for Self-Assembly
Sharon Glotzer, University of Michigan

October 30, 2009
Reaction Engineering Classics in Cell Culture Bioprocessing
Wei-Shou Hu, University of Minnesota

November 6, 2009
Design and Control of Finite-time Distributed Parameter Systems
Richard D. Braatz, Illinois-Urbana Champaign

November 20, 2009
Interfacial Engineering of Liquid Crystals
Nicholas L. Abbott, Wisconsin-Madison

December 4, 2009 (reception 2:30 in 66-201)
HOYT C. HOTTEL LECTURE
Membranes: The Vanguard of Large Scale Low Energy Intensity Separations
Bill Koros, Georgia Tech

WE HOPE TO SEE YOU AT AIChE!

You are cordially invited to attend the

Annual MIT Alumni Reception
The 2009 Annual AIChE Meeting

Monday, November 9th, 2009
7:00 – 9:00 p.m.

Room: Canal A/B/C
Opryland Hotel
Nashville, Tennessee

See “y’all” there!