XCurrents

MIT CHEMICAL ENGINEERING ALUMNI NEWS

Course X alumni share their updates and memories as MIT prepares for its 150th birthday. (Page 28)

Letter from *Department Head Klavs F. Jensen*

This semester, MIT celebrates its 150th birthday. The campus is busy with events and symposia and planning for our first Institute-wide "Open House" in over thirty years, scheduled for Saturday, April 30th. In this festive environment, it's only natural to start thinking of the evolution of our own Course X. In an excerpt from the 1888 MIT Report to the President, the impetus for the creation of chemical engineering is explained:

"There are a great number of industries which require constructions, for specific chemical operations, which can best be built, or can only be built, by engineers having a knowledge of the chemical processes involved. This class of industries is constantly increasing, both in number and in importance. Heretofore, the required constructions have, generally speaking, been designed, and work upon them has been supervised and conducted, either by chemists, having an inadequate knowledge of engineering principles and unfamiliar with engineering, or even building, practice; or else by engineers whose designs were certain to be either more laborious and expensive than was necessary, or less efficient than was desirable, because they did not thoroughly understand the objects in view, having no familiarity, or little familiarity, with the chemical conditions under which the processes of manufacture concerned must be carried on. It was

HIGHLIGHTS

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Letter from the Department Head continued

to meet this demand for engineers having a good knowledge of general and applied chemistry, that the course in Chemical Engineering was established." (1888 MIT President's Report, Course X, Page 42)

Over the past 120 years, the discipline has certainly expanded its scope into the realms of energy, biomedical research, business and other areas, but the essence of our field remains the same. Chemical engineers solve problems and provide practical solutions in environments where chemistry, biology, and engineering converge.

As an alumnus/a of MIT Course X, you have helped to shape the department into its current role as a leader in chemical engineering research and education. We are deeply grateful to you not only for this, but for the continued support of our alumni through the years.

With this sentiment, the Spring 2011 *XCurrents* is dedicated to you, our alumni. In February, we asked you to send us updates on your lives and to share memories of your time in Course X. To our delight, we were inundated with news, and throughout the magazine, you will find reminiscences and information from Course X alumni around the world. Due to space constrictions, we were not able to include the entirety of some of the submissions, but you can find them all at web.mit.edu/cheme/alumni/. If you haven't already, I encourage you to submit your own news to be included on the webpage and in the fall 2011 *XCurrents*.

Chemical engineers solve problems and provide practical solutions in environments where chemistry, biology, and engineering converge.

This past fall, our faculty presented several research breakthroughs, which are also highlighted in this edition. Through his work with nanotubes, Professor Michael Strano's research group broke an MIT News Office record in September by publishing three papers in the course of a week. First, he and his team developed self-assembling photovoltaic technology that can repair itself. Secondly, his researchers observed for the first time single ions moving through carbon nanotubes, one at a time, which could help create detectors for water-desalination. Finally, Michael created an antenna from nanotubes that could make photovoltaic cells more efficient by concentrating solar energy.

All of our faculty have been busy: Professor Kristala Prather '94 used protein and metabolic engineering to boost bacteria's manufacturing capabilities. Greg Stephanopoulos, Bob Langer (ScD '74), and Paula Hammond '84 made strides in nanotechnology to help fight cancer. Paula also developed a layer-by-layer assembly that can help prevent infection from surgery. Karen Gleason made paper-thin solar cells and Patrick Doyle's hydrogel barcodes could simplify medical diagnostics. You can find more information about our faculty's work in the Research News section of the newsletter.

I'd also like to take a moment to mention some honors that have been achieved in the department. Professor Chris Love was named one of *Popular Science*'s "Brilliant 10"; just off the heels of Michael Strano, who made the list last year. Bob Langer was a recipient of the National Academy of Engineering's Founders Award. Greg Stephanopoulos was first runner-up for the ConocoPhillips Energy Prize and Kristala Prather won the School of Engineering's Junior Bose Award for Excellence in Teaching.

A big congratulations also goes to three recent well-deserved promotions: Chris Love and Kristala Prather to associate professor, and Pat Doyle to full professor. Chris has made an impact on immunology through his development of an imprinting technique for analyzing large numbers of individual living cells quantitatively and dynamically. His approach measures multiple characteristics of single cells, and from those data he can construct detailed profiles that describe the state and evolution of the cell itself or the multicellular population of which it is a member. Kristala's research interests are centered on the design and assembly of recombinant microorganisms for the production of small molecules, with additional efforts in novel bioprocess design approaches. A particular focus is the elucidation of design principles for the production of unnatural organic compounds within the framework of the burgeoning field of synthetic biology. Pat's research focuses on dynamics of soft matter and engineering applications of these materials. Research projects in his group include single molecule studies in nanofluidic devices, lab on chip devices for single DNA analysis, flow lithography for production of new soft matter, and barcoded particles for high multiplexed diagnostic assays. More details on these distinctions are under "Faculty News."

The department was privileged to host the Department of Energy's under secretary for science, Steven E. Koonin PhD '75, as the 2010 Hoyt C. Hottel Lecturer. More information on the lecture can be found on page 27, as well as a webcast of the lecture at web.mit.edu/cheme/news/hottel.html.

This spring, we have three major lectures planned: Tillman Gerngross of Dartmouth will discuss recent advances in yeast biotechnology at April 15th's Frontiers of Biotechnology Lecture; Gary Calabrese of Corning, Inc. will speak on "Engineering Products and Processes for a Sustainable World,"

at the Warren K. Lewis Lecture on April 29th; and the May 6th Alan S. Michaels Lecture will host Cato Laurencin PhD '87, whose lecture will be "Regenerative Engineering Paradigms for Musculoskeletal Tissues." I hope you will be able to join us for any or all of these events.

The Chemical Engineering Department is planning several demonstrations and presentations in Building 66 during the April 30th MIT Open House. Our graduate and undergraduate students are in the planning stages now and excited for the opportunity to show budding scientists the basics of chemical engineering through walking through non-Newtonian fluids and experiencing firsthand heat-transfer. If you are near Cambridge on that Saturday from 11am to 4pm, we hope to see you!

As an alumnus/a of MIT Course X, you have helped to shape the department into its current role as a leader in chemical engineering research and education.

Last year, I received a letter from **Robert A. Hard SM '49**, who, after reading the Spring 2010 alumni news, wrote:

> *"My years in the department were in the 47-49 era in the days of Profs Lewis, Gilliland, Hottel, McAdams and Meisner… In my day, we quailed at the enumerable complex formulas for heat and mass transfer that had been developed over the thirties and forties and wondered what use they might have in the real world.*
>
> *Over the years I have worked for Arthur D. Little, Union Carbide, Kennecott Copper, Occidental Petroleum and Cabot Corporation, always in R&D. I have over 40 patents covering those years. For most of this I can thank my education under those giants I have named above. I know that by now those formulas are old hat, but they do encompass the work of many, many grad students and researchers who did the ground work."*

Robert is right - it's easy today to take for granted the strong foundation of chemical engineering education and practice created through the hard work of those who came before us in Course X. This edition of the newsletter takes a moment to consider how today's strides in energy and biomedical technology, materials and pharmaceuticals could not have been made without the base laid by our emeriti faculty and alumni.

As always, I hope you enjoy this issue of the newsletter and I give a very hearty "thank you" again to all the alumni who contributed. We look forward to your feedback. Thank you for your support and best regards.

Klavs F. Jensen
Department Head
MIT Chemical Engineering Department

Department Head Klavs Jensen presents Professor Kristala Prather with the 2010 Junior Bose Award. Prather was also recently promoted to associate professor.

On the cover: In Course X's flagship laboratory course, 10.26, undergraduates are confronted with real-world problems requiring solutions with fixed deadlines and a limited budget, such as developing new approaches to biofuels as shown here.

Practice School News

As with each edition of the Chemical Engineering Alumni News, I am proud to be able to bring you the latest happenings of the Practice School and its stations.

I'm also happy to share with you a little piece of history on the pages after this letter. Recently, William Reed, Oak Ridge Station Director 1948-1950, stopped by the department and shared a memento from his days with the practice school: the Oak Ridge Practice School manual from 1948. The Practice School program has certainly expanded in the sixty years since then, but the basic principle is the same: MIT Chemical Engineering students solve real-world problems for host companies while honing their own technical abilities, communication skills, strategic leadership, and professionalism.

Below are the latest projects for our practice school students from the summer and fall of 2010.

Summer 2010 Stations

Novartis Pharmaceutical Corp., East Hanover, NJ
Directed by Claude Lupis

Once again, Thomas Blacklock was our Novartis coordinator, and everything ran without a hitch. Eight students attended the station. The first session was devoted to three projects. The first addressed the application of a software program to the process mapping and the analysis of a clinical manufacturing unit. The second studied the adsorption of volatile organic carbons, while the third investigated high performance liquid chromatography spectra for the prediction of certain production trends. In the second session, the projects ranged from the removal of metals in solution by fixed bed adsorption, to the analysis of a continuous blending step and to the use of low pressure steam for an overall reduction in energy consumption.

The Novartis Italy group takes some time off to sightsee in the old town.

The students took advantage of the station's proximity to New York City. A dinner, hosted by Dr. Blacklock, was particularly memorable and we all greatly appreciated his hospitality. Another highlight of our social calendar was attendance at a play by the Shakespeare Theatre of New Jersey in nearby Madison. "Arms and the Man" by George Bernard Shaw was a wonderful production that proved to be a real success with the students.

Cabot Corp. Superior Micro Powders, Albuquerque, NM
Directed by William Dalzell

Cabot Corporation hosted the Practice School for the past five summers at its facility in Billerica, MA. This summer the station was located at their Cabot Superior MicroPowders (CSMP) facility in Albuquerque. At this location, which was acquired by Cabot in May 2010, Cabot makes and commercializes powder-based materials for a variety of high-tech applications such as security taggants, fuel cell catalysts, graphics, and printed circuits.

The students worked on three projects that spanned the areas of chemical kinetics, fluid flow, and separation processes. For one project, the students studied the reactor conditions needed to reduce the presence of an undesirable byproduct and evaluated an alternative chemistry to produce the same product with no byproduct. A second group of students looked at a several alternative systems to feed droplets to a high-temperature reactor, and the students working on the third project found a way to filter and dialyze a fine-particle product that was considered essentially impossible prior to their work.

The students, the director, and his wife enjoyed the varied cultures in the Albuquerque area of New Mexico. There were ample opportunities to hike and enjoy the spectacular landscape of Central New Mexico, as well as the warm sunny weather. Several of them had to try a balloon ride since Albuquerque is at the world's epicenter of ballooning.

Fall 2010 Stations

Novartis Pharmaceutical Corp., Siena, Italy
Directed by Claude Lupis

This was our second station with the Vaccines and Diagnostics (VD) division of the Novartis Pharmaceutical Corporation and, as with the first, was held in the old city of Siena, in Tuscany. Six students attended the station. They were assigned four projects, mostly associated with the optimization of several critical steps in the production of vaccines, such as fermentation, chromatographic , and lyophilization cycles. The processes on which they worked were being readied for transfer to production and thus obtaining results in a timely fashion was critical. This provided the students with additional motivation and, happily, the results obtained appeared to well satisfy our sponsors.

As in the previous year, the students were partnered with "peer mentors", i.e., young people of the Technology Development

Students Maolong Liu and Ethan Gillett devour the Chili Crab at Singapore's No Signboard Restaurant.

division who assisted them in the laboratories and provided them with an instant social network. This meant that the students discovered certain aspects of Italian life they would not have been able to find on their own and that they had a great time. Siena is also a magnificent medieval city, famous for its horserace, known as "il Palio", in the large fan-shaped Piazza del Campo, heart of the city and its social scene. In addition, the proximity of countless touristic sites provided great opportunities for excursions.

The technical challenges of the projects, the warm hospitality of our Novartis colleagues, the marvelous local food, and the beauty of the country, all ensured the success of this station.

National Renewable Energy Laboratory, Golden, CO
Directed by Bob Fisher

Commonly referred to as NREL, this federally supported facility deals with alternative/sustainable energy sources, including thermo-chemical and bio-chemical platforms. Our projects focused on process intensification and technology assessment efforts requiring a thorough understanding and application of fundamental chemical engineering principles. The projects included an analysis of a biochemical route to produce alternative fuels from renewable sources. An understanding of unique downstream processing needs obtained via bench scale experimentation was accomplished, as well as two economic analyses. One was related to the use of algae as a source of lipids as the main product or a feedstock for further bio-processing. The other addressed development of new products from a process incorporated in a traditional bio-refinery.

The group took advantage of being in the foothills of the Rocky Mountains, and experienced the must-see Garden of the Gods"and Rocky Mountain National Park. The NREL sponsors were very welcoming, and established a true collegial and nurturing environment.

Merck/Schering Plough, Singapore
Directed by Bob Laurence

Merck had recently merged with Schering-Plough and the site was a legacy plant from Schering-Plough in Tuas West. At this site, the students worked spiral jet milling and solvent recovery. The first group designed a system to recover solvents with a yield of over 90%, yielding over $2.3 MM/year profitability and also improved yield through a multi-step process producing API (Active Pharmaceutical Ingredients), making recommendations that could improve yields by as much as 10 percent.

The weekend between the project sessions gave the group time to fly to Bali and enjoy the Indonesian hospitality. The group also had earlier opportunities to sample the numerous Singapore cuisines with meals at food courts and hawker stations. Perhaps one of the more challenging was Chili Crab at the No Signboard Restaurant, Singapore's answer to Boston's No Name Restaurant.

Vale Soluções em Energia, Sao Paulo, Brazil
Directed by Bob Hanlon

On the next page, Bob recounts his experience as director of the Practice School's first station in South America.

As I write this, we have a new station operating at Sgcenergia in Gussing, Austria. I look forward to sharing with you in the next newsletter that team's work and adventures!

Best regards,

T. Alan Hatton
Director
David H. Koch School for
Chemical Engineering Practice

Yes, but what does it mean?

MIT Practice School at Vale Soluções em Energia, Brazil

Bob Hanlon
Station Director

A great learning offered by the Practice School program is how to continually take a step back, look at the big picture, and then ask, what does this mean? The students at this station learned how to do this time and time again. They performed many calculations but soon learned that while such efforts often suffice in the classroom, they don't suffice in the real world where answers need to be put into context and then developed into strong conclusions and impactful recommendations. For example, instead of simply saying, our calculations show that X performs better than Y, the VSE students learned to do the necessary additional work to be able to say, … X performs better than Y for the following reasons… and here's what this means for this project and for your company.

The VSE students further learned that a necessary component of the above is the absolute need to develop a complete understanding of the fundamental chemical engineering principles involved in their project. Only upon such a solid foundation could they build a solid project, one in which they were in full command to proactively tell others the technical underpinnings of their work as opposed to having others ask.

The students acquired a great education at VSE, learning the above professional skills as an outcome of working on projects involving such classic chemical engineering topics as heat pipes, water desalination, corrosion, and coal gasification. In keeping with the typical Practice School experience, none of the students had any background in these topics prior to VSE, and all became very proficient in these topics within a very short time period. And this too became a great education. They now know that they can walk into any situation, rapidly come up to speed, and almost immediately contribute.

VSE generously enhanced our professional experience by creating two half-day tours during our stay. The first was to Brazil's National Institute for Space Research (INPE), where we observed all that goes one when building and testing a satellite prior to launch. The second was to Embraer, the world's #3 airplane manufacturer, where we saw some fascinating assembly lines for commercial aircraft.

I love the following quote from Eleanor Roosevelt: "Do one thing every day that scares you."

One of the best side-benefits (for both students and directors!) of conducting programs at such locations as VSE, which is located in São Jose dos Campos just outside São Paulo, is the opportunity to see new sights and to learn about other cultures.

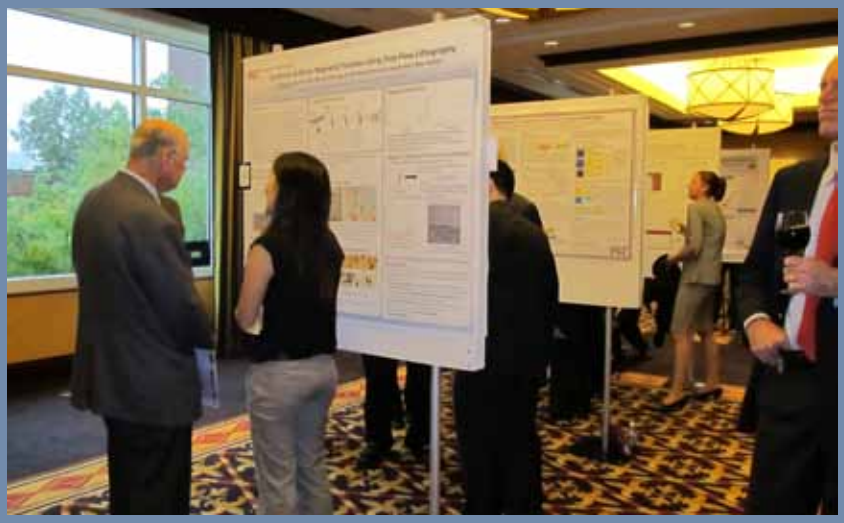
VSE Practice School conquers Pedra de Bau! From left to right: Maolong Liu, Bob Hanlon, Vaibhav Jain, Nisarg Shah, Ethan Gillett, Dave Borrelli, Barry Tanny.

Our VSE hosts kindly helped guide us towards such activities: visiting small villages of beautifully colored homes, hiking scenic but challenging mountain trails, tasting delicious churrasco (such great cuisine was admittedly challenging for the vegetarians in our group), cheering at a loud and energized soccer game in São Paulo, and walking along the beautiful beaches in Rio de Janeiro. Regarding the last item, I guess one additional learning for the students is that life is not always fair. Each time an attempt was made to visit the Brazilian beaches, the temperature dropped and the rain clouds appeared. Each time.

One final and unforgettable experience for the entire group occurred during our visit to Rio. I love the following quote from Eleanor Roosevelt: "Do one thing every day that scares you." But in Rio I learned that it's one thing to be inspired by this quote when sitting in a comfortable leather chair at home, and an entirely other thing when standing on the edge of a cliff, waiting to run off a ramp and hangglide over Rio. Turning inspiration into reality was quite confronting! The VSE students were about as adventurous as any I've seen, and they effectively pulled me out of my comfort zone and put me on the edge of that cliff right there with them. And each and every one of us made that jump and enjoyed the experience of a lifetime, slowly gliding down to beautiful Rio below. This was a great team effort and provided me with my own personal learning experience, for which I thank the students here.

2011 Practice School Dinner

In October 2010 at the Hotel Marlowe in Cambridge, the department held its annual Awards Banquet for the Practice School, attended by industrial sponsors, MIT administration officials, and students, faculty and staff of the department. At the pre-dinner poster session, students showed off their research to the industry visitors. Our speaker was Dr. Tom Van Laar, Head of Technical Operations for Novartis Pharmaceuticals AG in Basel, Switzerland. In a highly engaging talk, Dr. Van Laar discussed his own personal experiences with the Practice School Program and his perspective of today's pharmaceutical industry and the skills needed to be a leader in the industry.



2010 Practice School Award Winners

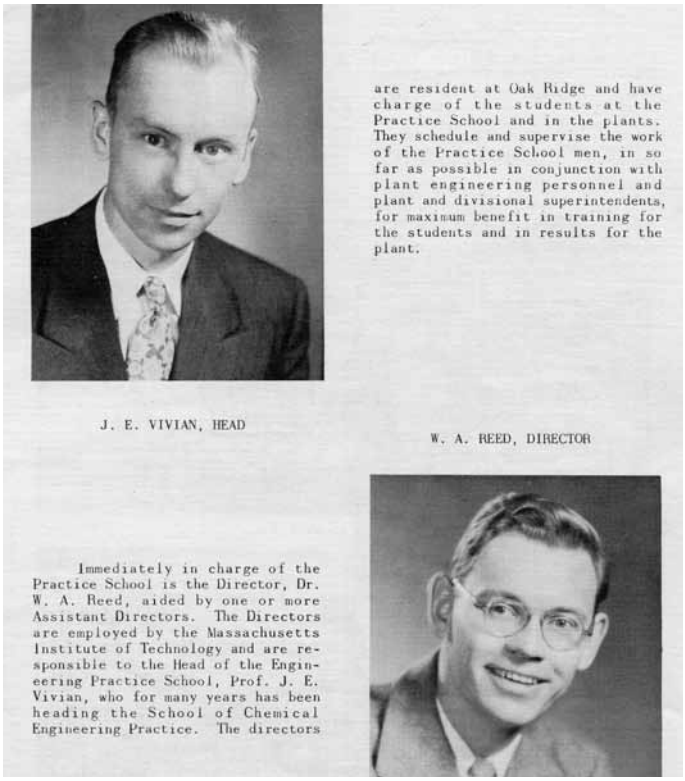
William Rousseau Award: Jacqueline Douglass & Christy Petruczok
Wojtowicz Award: Eric Shiue & Amrit Jalan
Jefferson W. Tester Award: Tatyana Shatova
J. Edward Vivian Award: Michael Stern

The Engineering Practice School at Oak Ridge, 1949

In 1948, just as World War II ended, the Engineering Practice School at Oak Ridge was established to "afford practice and education in atomic energy plant problems."

According to the 1991 *Flagship*, a history of the Practice School, the MIT students who attended "had access to all three of the major Oak Ridge installations: the Gaseous Diffusion Plant, Electromagnetic Separation Plant and Oak Ridge National Laboratory. (George Jasny '51 remembers that to work in these three plants, he had to take three separate physical examinations.) All technical work by the students became government property, and (after FBI clearance) students and staff would have access to classified information and be subject to Atomic Energy Commission security regulations. The students were housed in WWII dormitories that had become available for Oak Ridge Visitors."

Below and to the right are images from the the Oak Ridge Practice School manual from 1949, courtesy of William Reed, the station's director. Although the equipment, environments and fashions have changed, it is apparent that the core values of the Practice School remain unchanged today. ◊

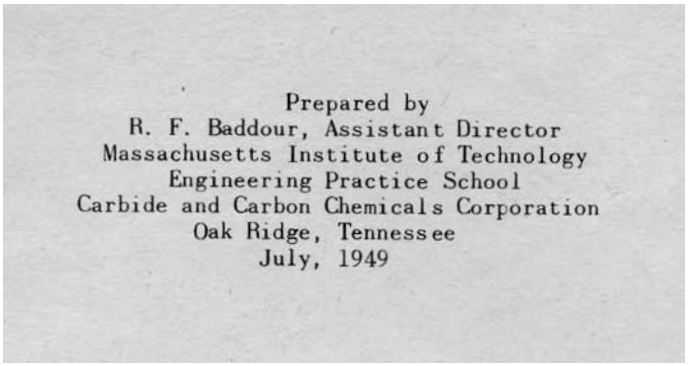


are resident at Oak Ridge and have charge of the students at the Practice School and in the plants. They schedule and supervise the work of the Practice School men, in so far as possible in conjunction with plant engineering personnel and plant and divisional superintendents, for maximum benefit in training for the students and in results for the plant.

J. E. VIVIAN, HEAD

W. A. REED, DIRECTOR

Immediately in charge of the Practice School is the Director, Dr. W. A. Reed, aided by one or more Assistant Directors. The Directors are employed by the Massachusetts Institute of Technology and are responsible to the Head of the Engineering Practice School, Prof. J. E. Vivian, who for many years has been heading the School of Chemical Engineering Practice. The directors



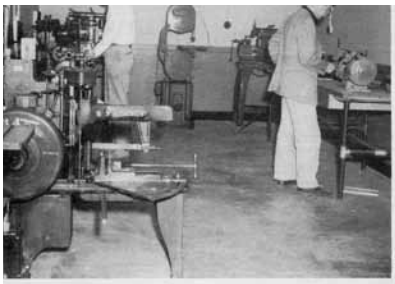
Effective Communication

Engineering to a great extent is a group undertaking, and achievement may hinge strongly on effective communication among the men in the group. The results of a technical investigation have little utility unless they can be understood and used by others. Thus it is of prime importance for an engineer to develop the ability to present technical reports with clarity, conciseness, and forcefulness. From the engineer's personal point of view, other people must often form an opinion of him based on the quality of his presentations. Just as he can command respect from his readers with a well-designed written report, even more can he impress an audience with a good talk, for he has considerably more opportunity to use the forcefulness of his personality in transmitting ideas.

Practice School men gain facility in writing by reporting the results of their investigations. An assignment is not complete until an acceptable written account of the work is submitted. When the first write-up is turned in, it is reviewed by the staff for such points as clarity, logic, completeness, grammatical construction, form, and neatness. It is then returned with a list of criticisms and suggestions. After being revised by the students, it is resubmitted. This process is continued until the write-up is in a satisfactory form, after which it is reproduced and distributed.

To provide supervised practice in oral reporting, each man is required to give a twenty-minute discussion once each session on some

STRESS IS PLACED ON TRANSMITTING IDEAS CLEARLY, BOTH ORALLY AND IN WRITING



THE EQUIPMENT IS BUILT . . .

The request for a test or investigation frequently originates directly with the plant supervisors, and the assignments are always chosen with the concurrence and approval of the superintendent whose division is most interested in the results to be obtained. This problem selection is usually accomplished by a conference of the staff and the plant men. The assignment is then presented to a section of the student group in the form of a memorandum outlining the general problem and the specific information desired. The size of the section and the time allotted vary depending on the magnitude and scope of the assignment. They may range, for example, from two men on a limited research problem for one week to ten men on a comprehensive plant test for a month.

AND THE RESULTS ARE WRITTEN UP.

THE TEST IS MADE . . .

In no case is a man assigned to a problem alone, for cooperative effort is one of the factors stressed in Practice School work. In sections of three or more men, a group leader is appointed who is responsible for portioning and coordinating the work and seeing that the assignment is completed on schedule. The responsibility of being group leader for an assignment is alternated among the men.

The Practice

According to the late Prof. W. H. Walker, it is a truism to say that it is easier to acquire a knowledge of science than it is to apply intelligently and successfully this knowledge to the solution of technical problems. In recognition of this fact, the primary objective of the Practice School is to develop the student's ability to apply fundamentals by assigning him to a variety of challenging plant problems. Also, the confidence engendered by responsible execution of industrial problems from the point of inception to final completion and presentation of the results is a material aid in developing professional competence and maturity.

THE PROBLEM IS SELECTED . . .

THE ASSIGNMENT IS MADE . . .

Entertainment Facilities

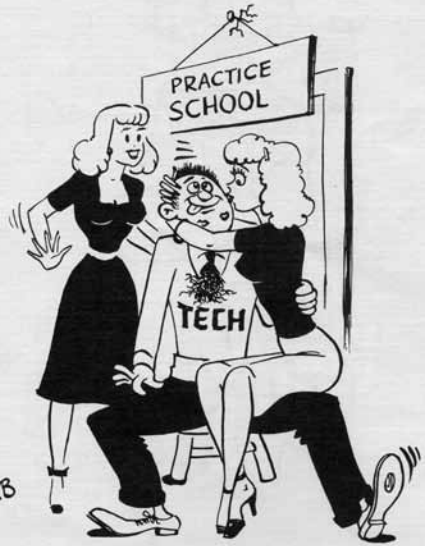
Oak Ridge is quite adequately provided with entertainment facilities. Following is a list of some of the clubs and social groups:

- Folk Dance Club
- Camera Club
- Film Society
- Music Listening Group
- Radio Operator's Club
- Duplicate Bridge Club
- Chess Club

There is also an Oak Ridge Symphony Orchestra and a Community Playhouse.

Oak Ridge has an 18-hole golf course, an outdoor swimming pool, and facilities for both tournament and non-tournament tennis, ping pong, basketball, softball, football and bowling. The TVA lakes and parks in the surrounding area are open to the general public for boating, swimming, fishing, and picnicking.

A factor not to be overlooked in the social life of the Practice School men is the relatively large number of Oak Ridge girls who take a personal interest in making their stay enjoyable.



"A factor not to be overlooked in the social life of the Practice School men is the relatively large number of Oak Ridge girls who take a personal interest in making their stay enjoyable."

Practice School Memories

Alumni recall life in the Practice School trenches

Nick Haritatos SB ’52 SM ’53

In the winter of 1952-53 our group of 6 students was assigned to the Practice School station at the Bethlehem Steel Company, located in a suburb of Buffalo, New York.

At that time, steel mills used large quantities of water and thus had slurries of dilute fines to dispose of. The purpose of each clarifier was to separate dilute slurry into an almost clear stream of water that could be recycled and a concentrated slurry that could be disposed of. One of our assignments was to carry out tests in the company’s clarifiers with the aim of improving their efficiency and thus their operating costs.

When we arrived at the control room for the clarifiers we were told that we would not be allowed to turn any of the valves on the piping. Only plant operators could turn the valves because one of the previous Practice School groups had turned the wrong valves and flooded the EXECUTIVE parking lot, which was next to the clarifiers. We soon discovered that plant operators claimed to be too busy to turn valves for us so it looked like our project was doomed. We did not want to have to report complete failure of our project at the weekly progress reports so we decided to bring this problem to the attention of the area superintendant.

At the meeting, we started out by describing our strategy for the experiments and pointed out the potential for some large improvements in the efficiency of the units. We could see that the superintendent was impressed with the program. Then we told him that unfortunately we could not conduct the experiments because we couldn’t get an operator to turn valves for us. At that point the superintendant picked up the phone and talked to the foreman of the clarifier section. So for the next few days we had an operator working with us full time to turn valves. Fortunately our program was successful.

Since Buffalo is close to Niagara Falls, we planned to visit the Falls during a weekend break between projects. Our group of 6 students consisted of 3 Americans and one each from Australia, Cuba, and Japan. After we looked at the Falls from the American side we decided to cross over into Canada to see another view of the Falls. At the passport control gate at the American side of the bridge crossing the Niagara River we were waved through. But at the Canadian passport control gate we were told that 5 of us could return to the United States but our Australian student had a passport that did not allow reentry to the US.

Fall 1971 American Cyanamid Practice School Group. Bernard Jackson ’72 at far right.

To get around this problem, they proposed to stamp his passport with wording that said that he was an undesirable person and would not be allowed to enter Canada. [Although he had left the US, he had not actually entered another country so technically he had not left.] So he walked back across the bridge and was allowed back into the US while the rest of us got to see the Falls from the Canadian side. For the next few days, we kidded him by saying what a shame it was that a country that was part of the British Commonwealth would not let a member of another British Commonwealth country enter.

Peter Silverberg SB ’60 SM ’61

Went to Practice School in the fall of 1960. The Esso refinery in Linden, NJ still exists but Valero owns it now. From the New Jersey Turnpike it looks the same. The American Cyanamid plant in Bound Brook, NJ is gone.

Bernard Jackson ’72

You haven’t lived until you’ve worked around ethyl mercaptan (pesticide ingredient) and have it absorbed subcutaneously such that when you play basketball for months afterwards the stink still oozes forth and repulses oneself. Such was my experience at the Bound Brook, NJ American Cyanamid Station in the fall of 1971. Thankfully, I went on from there to have a splendid career for 37 years in, first, environmental engineering and, later, aerospace spacecraft propulsion. Course X was the best decision I could have made.

Favorite teachers: I had some real negative experiences with a few professors, but I shall be forever indebted to Professor Herman Meissner (he got me my first job at Arthur D. Little) and Prof. Jack Howard & his dear wife, Carolyn (they were just, simply, angels!).

Dominic Rodrigues MSCEP ’92

I co-founded a biological-inspired technology company ~4 years ago with a brilliant young man, whose original work began ~6 years before that. My MIT/Course X experiences remain at the heart of this journey, in two ways:

Practice School challenged me in nearly every intellectual and emotional way. No experience since then has really seemed as

"Practice School challenged me in nearly every intellectual and emotional way. No experience since then has really seemed as tough. So, the resolve to weather the ups and downs of a tech start-up was readily available, courtesy of Course X."

- Dominic Rodrigues MSCEP '92

tough. So, the resolve to weather the ups and downs of a tech start-up was readily available, courtesy of Course X.

When I first stepped onto campus, the very spirit of MIT made me want to change the world. Nearly twenty years later, it still does. I may well have that chance through my company. We shall see...

Thank you Practice School. Thank you Course X. Thank you MIT. ◊

Memories of Course X...

William Hagenbuch BS '40 MS '41

FRESHMAN FOR TWO YEARS...

I was enjoying my freshman year at Miami University in Oxford, Ohio very thoroughly - my parents thought TOO THOROUGHLY!! So they arranged for my transfer to MIT. Most credits from Miami were acceptable, but I had to take advanced standing examinations in math & science because those courses were so different at MIT. So I took the exams - and got a grade I'd never heard of before: FF!!! DOUBLE F meant that I could not repeat the exam, but I was admitted as a freshman. Then I proved my ability by making the dean's list!

Frederick Gander SB '42 SM '46

Starting graduate school in early 1946 after four years in the US Navy Reserve was quite a shock. It was also a shock to get back a quiz from Prof. Harold Mickley with a mark of 23. The shock was lessened by finding that it was the top grade.

Col. Martin E. Sorte SM '47

In 1947 Prof. Hoyt Hottel asked me to build a one inch supersonic ram jet test bed as my Master's thesis since the large test bed took so much power that it dimmed the lights on the campus. I got to M 0.96 with butane but when he suggested I use hydrogen, I begged off. I could smell butane leaks but not hydrogen and the test bed was put together with some pieces from the salvage yard.

David S. Hacker MS '50

There were some serious limitations among some of the faculty in the 50's. The prevalent attitude was that no other school was good enough, i.e. Max Jacob's "Heat Transfer" was excoriated by Doc McAdams. He couldn't accept this monumental work.

William Eykamp '65

When I passed the dreaded qualifying exam, I went to Ed Gilliland (a great and a good man) to inquire about thesis advisors. I was in industry, drawing a salary, and wanted my sojourn between paychecks to be brief. Ed was very sympathetic, saying he had been working to lower the entry-to-exit time back to 36 months. He had a little list of the faculty and their ranges of dwell times. Ed was a wildly successful man, but this was a goal too far.

Basil Safos '80

Myself, Mike Whelan '80, and Steve Oliva '80 were sitting in the back row of Mike Modell's Thermo lecture, when suddenly he pointed to me and asked rather sharply, "What's the temperature? What's the pressure??" Sadly (but not uncharacteristically), that particular particle of wisdom eluded me, as it did my cohorts. Professor Modell seemed not surprised by this...

2010-2011 Chemical Engineering Fellowships

Graduate financial support continues to be an essential ingredient for maintaining the quality of our graduate programs. This funding helps MIT Chemical Engineering recruit the very best students by providing support for the first academic year so they can concentrate on core graduate level coursework, free of the demands of teaching and research. The result is a firm base in engineering science on which to build future graduate studies.

Fellowships come from many different arenas: industrial and research organizations, as well as alumni individuals and groups. We are very grateful for this support!

First year graduate students Sven Schlumpberger, Victor Adalsteinsson, and Ghassan Wakim mingle at the October 2010 Practice School Dinner.

Alexander Graham Bell Post Graduate Scholarship

Iain Hamilton, McGill

Alkermes Fellow

Brandon Heimer, UT Austin

Connie Gao, CalTech

Appelstein ('80) ChemE Fellow

Mary Schnoor, Yale

Arch Chilton Scurlock ('43) Fellow

Iain Hamilton, McGill

BP MIT Energy Fellow

Bomy Lee Chung, GaTech

Canada FE

Noemie-Manuelle Dorvel Courchesne, U of Ottawa

Charles and Hilda Roddey Fellow

Miles Honkawa, MIT

ChE Practice School Fellows

Ghassan Wakim, U of Ottawa

Kristin Vicari, Northwestern

Sayalee Mahajan, U of Mumbai

Landau ChE Practice School Fellows

Aditya Kunjapur, UT Austin

Justin Keingartner, Iowa State

William Gunther, UIUC

David H. Koch ('62) Fellows

Adam Tatusko, Clarkson

Carl Schoellhammer, Berkeley

Ji Sam Wong, Cornell

Juhyun Song, MIT (MSCEP)

Li Tan, U of Cincinnati

Michael Keith Santos, Stanford

Po-Yen Chen, NTU

Qing Xu, Tsinghua

Sivaraman Ramaswamy, IIT Chennai

Yuran Wang, Tsinghua

DOE Computational Science Graduate Fellow

Zachary Ulissi, U of Delaware

Edwin R Gilliland '33 Fellow

Joseph Lim, U of Maryland College Park

Eni MIT Energy Fellows

Qing Xu, Tsinghua

Sayalee Mahajan, U of Mumbai

Sven Schlumpberger, GaTech

Frank Hall Thorp Fellow

Kaja Kaastrup, Berkeley

Kwanjeong Scholarship

Juhyun Song, SNU

Wm. & Margaret Rousseau Fellow

Mariah Hoover, MIT

R. C. Reid ('54) & G. Williams Fellow

Noemie-Manuelle Dorvel Courchesne, U of Ottawa

George M. Keller ('48) Chevron Fellow

Stephen Morton, NC State

George M. Keller ('48) Fellow

Sagar Chakraborty, IIT Kharagpur

Haas Family Fellow

Ben Renner, U of Tennessee

Jouha Min, Cornell

Shengchang Tang, Tsinghua

Irene Brockman, UMich Ann Arbor

H. ('53) & L. Stern Prac. School Fellow

Shengchang Tang, Tsinghua

Jerry ('40) & Geraldine Mcafee Fellow

Andrew Tsavaris, Princeton

Lee Drahushuk, Cornell

John C. Sluder ('41) Fellow

William Gunther, UIUC

John Henry Grover ('48) Fellows

Bomy Lee Chung, GaTech

Viktor Adalsteinsson, Penn State

MITSCEP 1936 Course Xa Fellow

Aly Eldeen Eltayeb, Cairo U, IIT (MS)

Saudi Aramco MIT Energy Fellow

Po-Yen Chen, NTU

Walsh ('37) Memorial Pres. Fellows

Mark Keibler, U of Maryland

Robert T. Haslam ('11) ChemE Fellows

Christopher Lam, Rice

Kaja Kaastrup, Berkeley

Mark Keibler, U of Maryland

Mark Molaro, UT Austin

Stephanie Schulze, CalTech

Sven Schlumpberger, GaTech

Vishnu Sresht, IIT Bombay

Robert T. Haslam ('11) Pres. Fellow

Christopher Lam, Rice

Rosemary Wojtowicz Fellow

Irene Brockman, UMich Ann Arbor

Wing S. Fong ’54

Alumnus Highlight

In 2010, the Chemical Engineering Department introduced the Wing S. Fong (1954) Memorial Fund, established through the help of his wife Lourdes, daughter Genevieve, and family friend Dominick Sama (SB ‘54 SM ‘55 ScD ‘60). We are grateful for their support and are proud to continue Mr. Fong’s legacy of fostering education in chemical engineering.

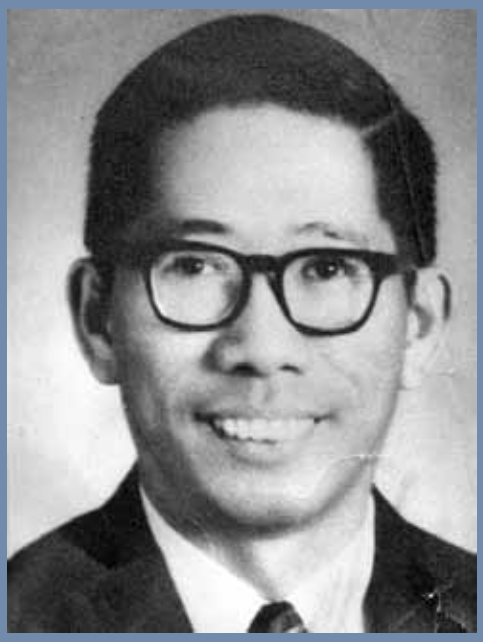
Wing S. Fong was born in 1931 in Manila, Philippines, to Chinese immigrants from Canton. He spent his childhood in the busy commercial area of Chinatown. World War II interrupted his high school education when the Japanese occupied the city of Manila. After the war, his parents sent him back to China to continue his education. However, due to poor health, his mother eventually took him to San Francisco to finish high school.

In California, he flourished. After high school, he went to Menlo College in Menlo Park, CA. During his first year there, one of his professors noticed his ability in math and drafting, and encouraged him to apply to MIT. Wing didn’t even consider any other school. He only applied to MIT, and was accepted.

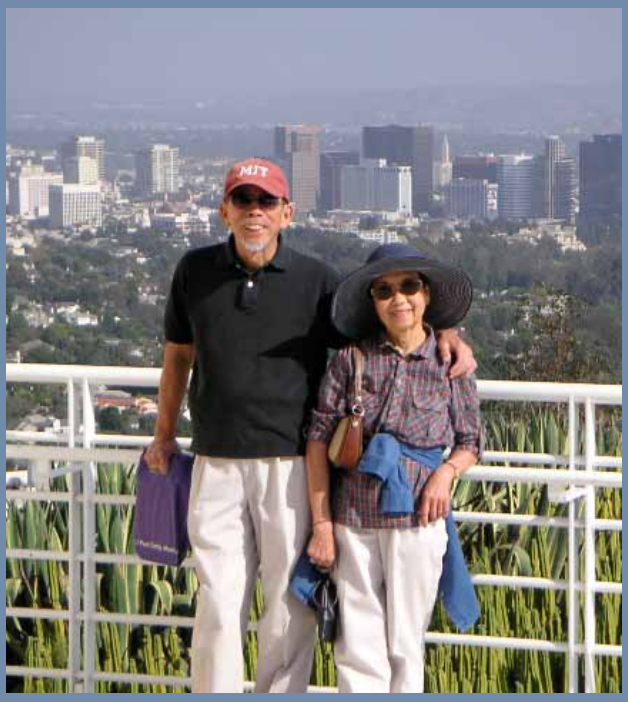
He stayed at MIT, finished his undergraduate degree, and went on to obtain his Master’s degree in chemical engineering.

He was employed by chemical companies up and down the East Coast in New York, New Jersey, Connecticut, Maryland, and Washington DC. Always interested in doing better, he looked for the next challenge.

In 1966, he finally decided to go back to where he started in California. He worked for Stanford Research Institute until he retired in 1996.



Wing S. Fong during his time at MIT.



Wing and wife Lourdes (Lulu) on vacation post-retirement.

Wing S. Fong was a serious student. He took every engineering, chemistry, and physics class he could. But he didn’t neglect the other aspects of campus life. He took every classical music appreciation class he could, and participated in many International House activities.

He always loved his time at MIT. He made the best of friends, and wore his Brass Rat proudly.

We hope that this annual award will help another chemical engineering senior of Chinese descent with the highest cumulative GPA, and will honor the memory of Wing S. Fong, and his hard work and dedication to his adopted home, university and country.

The first recipient of the Wing S. Fong (1954) Memorial Award will be announced during the annual departmental Awards Day on Monday, May 9, 2011.

Faculty News

Kris Prather honored for excellence in teaching

Professor Kristala Jones Prather was selected to receive the 2010 Junior Bose Teaching Award, which is awarded each year in recognition of "an outstanding contributor to education from among the junior faculty of the School of Engineering."

Prather has been described in teaching evaluations as an engaging and enthusiastic lecturer, and demonstrated her dedication to her students when, in 2008, an infrastructure disaster rendered the department's teaching laboratory unusable. Department Head Klavs F. Jensen recalls, "Even when the department was hit by a major steam pipe explosion that destroyed the facilities used for the laboratory, Kris's devotion to teaching and creative development of alternative lab modules allowed our students to complete this important, required laboratory subject." Prather won the Department of Chemical Engineering's "Outstanding Faculty Award for Undergraduate Teaching" in 2006.

Prather was named a Technology Review "Young Innovator" in 2007 and received the Camille and Henry Dreyfus Foundation New Faculty Award in 2004. She is the second member of the chemical engineering faculty to earn the Junior Bose Award; Professor Paula T. Hammond was a recipient in 1999.

Gregory Stephanopoulos first runner-up for ConocoPhillips Energy Prize

The ConocoPhillips Energy Prize recognizes new ideas and original, feasible solutions in three areas that can help improve the way the U.S. develops and uses energy: developing new energy sources, improving energy efficiency, and combating climate change.

Out of more than 200 entries, Professor Greg Stephanopoulos was named first runner-up for his "Bioprocess and Microbe Engineering for Total Carbon Utilization in Biofuel Production," an approach that uses either carbon dioxide alone or with plant carbohydrates to produce biofuels. The process uses a specially designed microbe that can convert carbohydrates to oil and carbon dioxide, and another microbe converts the carbon dioxide to ethanol or other organic substances.

Each of the five finalists received an award of $25,000 to further the development of their concept. As first runner-up, Stephanopoulos received an additional $50,000. The winner received an additional $100,000.

For more information, visit www.conocophillips.com/energyprize.

Chris Love named one of *Popular Science*'s 2010 "Brilliant 10"

Popular Science has named MIT Assistant Professor of Chemical Engineering J. Christopher Love, 33, to its annual "Brilliant 10" list of top young scientists.

Love was honored for his work in immunology: he has developed an imprinting technique for analyzing large numbers of individual living cells quantitatively and dynamically. His approach measures multiple characteristics of single cells, and from those data he can construct detailed profiles that describe the state and evolution of the cell itself or the multicellular population of which it is a member.

The magazine stated that Love's work "could solve long-standing medical mysteries: how the immune system responds to HIV infection, what methods doctors should use to diagnose deadly allergies, and why drug production is so inconsistent, and thus so expensive."

Love is the second MIT chemical engineering professor in two years to be honored with the magazine's "Brilliant 10" label. In 2009, Michael Strano, 34, the Charles and Hilda Roddey Associate Professor of Chemical Engineering, was honored for his work with confined quantum materials (such as graphene). His work "has the power to transform cancer medicine, solar power, electronics and more," according to the magazine.

In July 2010, Love was also named the Latham Family Career Development Professor. Allen Latham, Jr., a member of the Class of 1930, and his wife, Ruth, established this chair.

Bob Langer receives NAE Founders Award

Institute Professor Robert Langer received the Founders Award from the National Academy of Engineering on October 3, 2010 at the Academy's annual meeting.

Langer was chosen for the honor for "the invention, development, and commercialization of methods and materials for drug delivery and tissue engineering, mentoring of young scientists, and the promotion of the nation's health." The award recognizes outstanding professional, educational and personal achievements to the

benefit of society, and it includes $2,500 and a gold medallion.

Langer is widely known for his work on controlled-release formulas in drugs. His breakthrough in this area allows drugs to be released into the body on a sustained, periodic basis so that patients can take drugs less frequently while receiving extended benefits. Sustained-release properties are now common in many drugs on the market today and have led to new developments in the treatment of specific health problems, such as brain tumors.

Three professors promoted



Professors J. Christopher Love and Kristala Prather (above left and center) have been promoted to associate professor without tenure, while Pat Doyle (right) is now a full professor.

Love is an associate member at the Eli and Edythe L. Broad Institute, and associate faculty at the Ragon Institute of MGH, MIT, and Harvard. He was named a Dana Scholar for Human Immunology and a Keck Distinguished Young Scholar in Medical Research in 2009.

Prather is the recipient of a Camille and Henry Dreyfus Foundation New Faculty Award (2004), an Office of Naval Research Young Investigator Award (2005), a Technology Review "TR35" Young Innovator Award (2007), and a National Science Foundation CAREER Award (2010). Prather is also an investigator in the multi-institutional Synthetic Biology Engineering Research Center (SynBERC) funded by the National Science Foundation.

Research projects in Doyle's group include single molecule studies in nanofluidic devices, lab on chip devices for single DNA analysis, flow lithography for production of new soft matter, and barcoded particles for high multiplexed diagnostic assays. Among his recent honors are a 2009 Guggenheim Fellowship and the 2008 Pioneers of Miniaturization Prize from the Royal Society of Chemistry, Corning and Lab on Chip Journal. ◊

Professor Emeritus János M. Beér honored

At the 2010 Clearwater Clean Coal Conference, attendees and organizers of the conference took a moment to pay tribute to Professor Emeritus János M. Beér at a dinner in his honor on June 8, 2010. Citing his "burning passion for freedom, music, rowing, combustion, environment, friendship, and most of all, life," the dinner included talks by his colleagues and a champagne toast.

The official conference tribute to Professor Beér:

"It is a privilege and an honor to welcome you to tonight's gala dinner where we honor the remarkable life and career of Dr. János M. Beér, Humanitarian, Freedom Fighter, Musician, and Distinguished Professor.

János has been an integral part of this conference for many, many years, and he has been truly a gift to us as he shared his expertise through his work on the Conference Committee on so many important energy issues of the day."

Throughout the night, attendees saw clips from many aspects of János's life on the screen. In addition, musical selections offered during the dinner were favorites of his and pieces that he played in his musical career.

Pictured at right are Professor Beér and his wife, Marta, taken during the June 2010 dinner. ◊

Research Focus: Targeting Cancer

Articles by Anne Trafton, courtesy of the MIT News Office. For more information, go to *web.mit.edu/cheme/news/*

In the past 40 years, scientists have learned a great deal about how cells become cancerous. Some of that knowledge has translated to new treatments, but most of the time doctors are forced to rely on standard chemotherapy and radiation, which can do nearly as much damage to the patients as they do to the tumors. Targeted treatments are on the horizon, but more needs to be done to make them a reality.

Direct Delivery

Nanoparticles could accurately target tumors, avoiding side effects.

Doxorubicin, a drug commonly used to treat leukemia and other cancers, kills tumor cells by damaging their DNA. Though the drug is effective, it can also be toxic to heart cells. In 2005, the FDA approved a new type of doxorubicin, known as Doxil. In this new formulation, the drug is wrapped in a fatty coating called a liposome, which hinders its ability to enter heart cells (and other healthy cells).

Doxil, usually prescribed for late-stage ovarian cancer, represents the first generation of cancer treatments delivered by tiny particles. Doxil particles are on the scale of millionths of a meter, but scientists are now working on nano-sized particles, which are measured in billionths of meters. Such particles could allow doctors to give larger doses of chemotherapy while sparing healthy tissue from dangerous side effects.

Liposomes were first discovered about 50 years ago, but more recently, scientists have realized that large synthetic molecules (polymers), such as polyethylene glycol (PEG) can be nontoxic and do not induce an immune response. PEG, which consists of a long chain of repeating units called ethers, can be attached to degradable polymers to form tiny, drug-delivering particles. Those particles are remarkably stable and can protect drugs from the body's own immune system, which otherwise might destroy them before they reach their destination. Around 15 years ago, scientists led by MIT's Institute Professor Robert Langer discovered that PEG also lends itself to chemical manipulation, allowing scientists to create customized drug-delivery particles.

"As nanoscience began to evolve and we became adept at creating our own nanoparticles, we found ways to specifically design nanoparticles so they had properties we wanted," says Paula Hammond, the Bayer Professor of Chemical Engineering and member of the David H. Koch Institute for Integrative Cancer Research at MIT. For example, scientists can design particles to discharge their drug payload when they encounter acidic pockets inside a tumor cell.

Scientists can also target nanoparticles specifically to attack tumor cells. There are two ways to do that — one passive and one active. In the 1980s, scientists realized that the blood vessels surrounding tumors have tiny holes, up to 500 nanometers in diameter, that allow small particles to flow from the bloodstream into the fluid surrounding the tumor.

While that passive targeting gets nanoparticles to the right place, the particles wash away after about 12 to 24 hours, says Hammond. "If you want the chemotherapy to get closer to its target, then you need to do something to cause the cancer cell to take it up," she says.

To that end, she is working on new ways to actively target nanoparticles by decorating them with molecules that bind to proteins found in large quantities on tumor cells. For example, they can attach proteins that bind to folate receptors, which are located in high density on cancer cells because the cells need large quantities of folate to produce new DNA as they divide. However, folate receptors are also found on healthy cells, in smaller numbers, so there is still a chance of unwanted side effects.

Another promising application for nanoparticles is delivering RNA interference — tiny strands of RNA that can block cells from producing the proteins encoded by cancerous genes. Building on that idea, Hammond is now working on nanoparticles that would deliver a one-two punch, alternating layers of RNA and chemotherapy drugs.

Hammond is optimistic that nanotechnology will end up helping cancer patients, possibly within the next three to five years. "I think it provides way too many benefits for us to pull away from it," she says. ◊

"If you want chemotherapy to get closer to its target, then you need to do something to cause the cancer cell to take it up."

- Paula Hammond on using nanotechnology to target cancer.

Turning off Cancer Genes

RNA interference holds much promise as a cancer treatment, but technical challenges remain.

A single cancer cell may harbor dozens or even hundreds of mutant genes. What if you could shut off one, two or even a dozen of those genes, all at once? Some scientists believe that they will soon be able to do just that through RNA interference, a natural process that happens within cells.

For a cell to fulfill its genetic fate, information must be carried from DNA in the nucleus to the ribosome, the part of a cell where proteins are made. RNA interference disrupts this flow via snippets of genetic material, known as siRNA (short interfering RNA). SiRNA binds to messenger RNA (mRNA) molecules, destroying the mRNA before it can deliver instructions to the ribosome.

"It offers the potential to turn off essentially any gene in a cell," says Daniel Anderson, a member of MIT's David H. Koch Institute for Integrative Cancer Research. That means scientists can try to shut off the genes that cause cancer cells to go haywire, growing out of control and breaking free from their usual constraints to travel through the body to start new tumors.

Delivery, delivery, delivery

Getting RNA into a cell is no easy task. RNA is a large, negatively charged molecule — just the kind of thing that cells normally try to keep out. Scientists have been able to slip siRNA through cell membranes by wrapping them in other molecules to disguise their negative charges, but once inside, the RNA has to be released from its coating.

Delivery is "the number one hurdle" facing RNA interference, or RNAi, says Steven Dowdy, professor of molecular medicine at the University of California, San Diego. "If you can't deliver it, it doesn't work."

Six years ago, Dowdy — who was a postdoctoral associate at the Whitehead Institute in the early 1990s — dropped his research on delivering tumor-suppressor proteins to pursue RNAi as a cancer therapy. "There's nothing that even compares to the potential of RNA," he says. "The problem with every drug used against cancer today is that they can't be adapted. With siRNA, you can adapt the drug as the cancer is evolving."

He envisions that in 10 or 20 years, doctors will be able to sequence an individual patient's tumor to see which cancer-causing genes have been activated, then deliver siRNA specific to that gene. The process could be repeated with any cancerous cells that survive the first round, turning cancer into a manageable condition.

Right now, one of the leading candidates for RNAi delivery is a type of fatty molecule called a lipidoid, which can easily merge with the cell membrane and deposit its RNA payload inside.

Anderson, MIT Institute Professor Robert Langer and others in their lab have developed RNA-delivering lipidoids that can shut off 10 genes at once in the livers of mice. They have also had success targeting ovarian cancer. In a study published last year in the Proceedings of the National Academy of Sciences, Anderson and his colleagues showed that by shutting off a gene called claudin-3 in mice with ovarian tumors, they could dramatically reduce tumor growth and metastasis.

Clinical trials with the new lipidoids are probably at least a year away, says Anderson, because the team needs to do some additional animal studies, and needs funding to produce the particles on a large scale.

Lipidoids solve two major problems — getting RNA into cells and then releasing the RNA once it's inside, but there are still issues to be worked out, says Dowdy. Lipidoid particles are extremely large compared to the RNA molecules they're delivering, which can hinder their ability to get into tiny capillaries and reach tumor cells. "It's like delivering a dozen eggs in an 18-wheel truck," he says. "It does a good job of protecting the eggs, but at some point you're going to have to be able to get down some residential side streets." ◊

Research Focus: Targeting Cancer

Articles by Anne Trafton, courtesy of the MIT News Office. For more information, go to *web.mit.edu/cheme/news/*

In the past 40 years, scientists have learned a great deal about how cells become cancerous. Some of that knowledge has translated to new treatments, but most of the time doctors are forced to rely on standard chemotherapy and radiation, which can do nearly as much damage to the patients as they do to the tumors. Targeted treatments are on the horizon, but more needs to be done to make them a reality.

Getting Bacteria to Do a Plant's Job

Researchers engineer microbes for low-cost production of precursor of anticancer drug Taxol and other pharmaceuticals

Throughout human history, plants have been a source of potent medicines, including many cancer drugs discovered over the past few decades. However, it is quite difficult to discover such drugs and obtain them in large quantities from the plants or through chemical synthesis.

MIT researchers and collaborators from Tufts University have now engineered E. coli bacteria to produce large quantities of a critical compound that is a precursor to the cancer drug Taxol, originally isolated from the bark of the Pacific yew tree. The bacteria can produce 1,000 times more of the precursor, known as taxadiene, than any other engineered microbial strain.

The technique, described in the Oct. 1, 2010 issue of *Science*, could bring down the manufacturing costs of Taxol and also help scientists discover potential new drugs for cancer and other diseases such as hypertension and Alzheimer's, said Gregory Stephanopoulos, who led the team of MIT and Tufts researchers and is one of the senior authors of the paper.

"If you can make Taxol a lot cheaper, that's good, but what really gets people excited is the prospect of using our platform to discover other therapeutic compounds in an era of declining new pharmaceutical products and rapidly escalating costs for drug development," said Stephanopoulos, the W.H. Dow Professor of Chemical Engineering at MIT.

Taxol, also known as paclitaxel, is a powerful cell-division inhibitor commonly used to treat ovarian, lung and breast cancers. It is also very expensive — about $10,000 per dose, although the cost of manufacturing that dose is only a few hundred dollars. (Patients usually receive one dose.)

Two to four Pacific yew trees are required to obtain enough Taxol to treat one patient, so in the 1990s, bioengineers came up with a way to produce it in the lab from cultured plant cells, or by extracting key intermediates from plant material like the needles of the decorative yew. These methods generate enough material for patients, but do not produce sufficient quantities for synthesizing variants that may be far more potent for treating cancer and other diseases. Organic chemists have succeeded in synthesizing Taxol in the lab, but these methods involve 35 to 50 steps and have a very low yield, so they are not economical. Also, they follow a different pathway than the plants, which makes it impossible to produce the pathway intermediates and change them to make new, potentially more powerful variations.

"By mimicking nature, we can now begin to produce these intermediates that the plant makes, so people can look at them and see if they have any therapeutic properties," said Stephanopoulos. Moreover, they can synthesize variants of these intermediates that may have therapeutic properties for other diseases.

Improving efficiency

The complex metabolic sequence that produces Taxol involves at least 17 intermediate steps and is not fully understood. The team's goal was to optimize production of the first two Taxol intermediates, taxadiene and taxadien-5-alpha-ol. E. coli does not naturally produce taxadiene, but it does synthesize a compound called IPP, which is two steps away from taxadiene. Those two steps normally occur only in plants. MIT postdoctoral associate Ajikumar Parayil recognized that the key to more efficient production is a well-integrated pathway that does not allow potentially toxic intermediates to accumulate. To accomplish this, researchers took a two-pronged approach in engineering E. coli to produce taxadiene.

First, the team examined the IPP pathway, which has eight steps, and focused on four of those reactions that had been determined to be bottlenecks in the synthesis — that is, there is not enough enzyme at those steps, so the entire process is slowed down. Parayil then engineered the bacteria to express multiple copies of those four genes, eliminating the bottlenecks and speeding up IPP production.

"By mimicking nature, we can now begin to produce intermediates that the plant makes, so people can look at them and see if they have any therapeutic properties."

- Greg Stephanopoulos

To get E. coli to convert IPP to taxadiene, the researchers added two plant genes, modified to function in bacteria, which code for the enzymes needed to perform the reactions. They also varied the number of copies of the genes to find the most efficient combination. These methods allowed the researchers to boost taxadiene production 1,000 times over levels achieved by other researchers using engineered E. coli, and 15,000 times over a control strain of E. coli to which they just added the two necessary plant genes but did not optimize gene expression of either pathway.

Following taxadiene synthesis, researchers advanced the pathway by adding one more critical step toward Taxol synthesis, the conversion of taxadiene to taxadien-5-alpha-ol. This is the first time that taxadien-5-alpha-ol has been produced in microbes. There are still several more steps to go before achieving synthesis of the intermediate baccatin III, from which Taxol can be chemically synthesized. "Though this is only a first step, it is a very promising development and certainly supports this approach and its potential," said Blaine Pfeifer, assistant professor of chemical and biological engineering at Tufts and an author of the Science paper.

Now that the researchers have achieved taxadiene synthesis, there are still another 15 to 20 steps to go before they can generate Taxol. In this study, they showed that they can perform the first of those steps.

Joseph Chappell, professor of plant sciences at the University of Kentucky, says the team's yield of taxadiene is impressive, but the addition of several hydroxyl molecules, which is required to produce baccatin III, will likely prove more difficult. "They're showing one (hydroxylation), but it remains to be seen if they'll be able to couple this with the other hydroxylation events needed to build the baccatin III molecule," he said.

Stephanopoulos and Pfeifer expect that if this technique can eventually be used to manufacture Taxol, it would reduce significantly the cost to produce one gram of the drug. Researchers could also experiment with using these bacteria to create other useful chemicals such as fragrances, flavors and cosmetics, said Pfeifer.

Development of the new technology was funded by the Singapore-MIT Alliance, National Institutes of Health and a Milheim Foundation Grant for Cancer Research. MIT has filed a patent on the technology and new strain of E. coli, and the researchers are considering licensing the technology or starting a new company to commercialize it, said Stephanopoulos. ◊

Other Fall 2010 Course X Research News

- Patrick Doyle's hydrogel barcodes could simplify medical diagnostics
- Paula Hammond's layer-by-layer assembly can help prevent infection from surgery
- Karen Gleason makes a paper-thin solar cell
- Bob Langer develops a nanoparticle to improve cancer drug delivery
- Kristala Prather finds a new way to dramatically boost bacteria's manufacturing abilities

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

Research Focus: Carbon Nanotubes

Articles courtesy of the MIT News Office. For more information, go to *web.mit.edu/cheme/news/*

During the span of one week in September 2010, Professor Michael Strano introduced three distinct new discoveries surrounding the development of carbon nanotube technology, breaking an MIT News Office record. Below are summaries; the full content of the articles can be found at the web address above.

Solar funnel

New antenna made of carbon nanotubes could make photovoltaic cells more efficient by concentrating solar energy.

Solar cells are usually grouped in large arrays, often on rooftops, because each cell can generate only a limited amount of power. However, not every building has enough space for a huge expanse of solar panels.

Using carbon nanotubes (hollow tubes of carbon atoms), MIT chemical engineers have found a way to concentrate solar energy 100 times more than a regular photovoltaic cell. Such nanotubes could form antennas that capture and focus light energy, potentially allowing much smaller and more powerful solar arrays.

“Instead of having your whole roof be a photovoltaic cell, you could have little spots that were tiny photovoltaic cells, with antennas that would drive photons into them,” says Michael Strano, the Charles and Hilda Roddey Associate Professor of Chemical Engineering and leader of the research team.

Strano and his students describe their new carbon nanotube antenna, or “solar funnel,” in the Sept. 12 online edition of the journal Nature Materials. Lead authors of the paper are postdoctoral associate Jae-Hee Han and graduate student Geraldine Paulus.

Their new antennas might also be useful for any other application that requires light to be concentrated, such as night-vision goggles or telescopes. The work was funded by a National Science Foundation Career Award, a Sloan Fellowship, the MIT-Dupont Alliance and the Korea Research Foundation. ◊

Solar cell, heal thyself

New self-assembling photovoltaic technology can keep repairing itself to avoid any loss in performance.

Plants are good at doing what scientists and engineers have been struggling to do for decades: converting sunlight into stored energy, and doing so reliably day after day, year after year. Now some MIT scientists have succeeded in mimicking a key aspect of that process.

One of the problems with harvesting sunlight is that the sun’s rays can be highly destructive to many materials. Sunlight leads to a gradual degradation of many systems developed to harness it. But plants have adopted an interesting strategy to address this issue: They constantly break down their light-capturing molecules and reassemble them from scratch, so the basic structures that capture the sun’s energy are, in effect, always brand new.

That process has now been imitated by Michael Strano, the Charles and Hilda Roddey Associate Professor of Chemical Engineering, and his team of graduate students and researchers. They have created a novel set of self-assembling molecules that can turn sunlight into electricity; the molecules can be repeatedly broken down and then reassembled quickly, just by adding or removing an additional solution. Their paper on the work was published on Sept. 5 in Nature Chemistry.

Strano says the idea first occurred to him when he was reading about plant biology. “I was really impressed by how plant cells have this extremely efficient repair mechanism,” he says. In full summer sunlight, “a leaf on a tree is recycling its proteins about every 45 minutes, even though you might think of it as a static photocell.”

One of Strano’s long-term research goals has been to find ways to imitate principles found in nature using nanocomponents. In the case of the molecules used for photosynthesis in plants, the reactive form of oxygen produced by sunlight causes the proteins to fail in a very precise way. As Strano describes it, the oxygen “unsnaps a tether that keeps the protein together,” but the same proteins are quickly reassembled to restart the process.

This action all takes place inside tiny capsules called chloroplasts that reside inside every plant cell — and which is where photosynthesis happens. The chloroplast is “an amazing machine,” Strano says. “They are remarkable engines that consume carbon dioxide and use light to produce glucose,” a chemical that provides energy for metabolism.

To imitate that process, Strano and his team produced synthetic molecules called phospholipids that form disks; these disks

"At some point in the near future, carbon nanotubes will likely be sold for pennies per pound, as polymers are sold [today]."

- Michael Strano

provide structural support for other molecules that actually respond to light, in structures called reaction centers, which release electrons when struck by particles of light. The disks, carrying the reaction centers, are in a solution where they attach themselves spontaneously to carbon nanotubes — wire-like hollow tubes of carbon atoms that are a few billionths of a meter thick yet stronger than steel and capable of conducting electricity a thousand times better than copper. The nanotubes hold the phospholipid disks in a uniform alignment so that the reaction centers can all be exposed to sunlight at once, and they also act as wires to collect and channel the flow of electrons knocked loose by the reactive molecules.

The system Strano's team produced is made up of seven different compounds, including the carbon nanotubes, the phospholipids, and the proteins that make up the reaction centers, which under the right conditions spontaneously assemble themselves into a light-harvesting structure that produces an electric current. Strano says he believes this sets a record for the complexity of a self-assembling system. When a surfactant — similar in principle to the chemicals that BP has sprayed into the Gulf of Mexico to break apart oil — is added to the mix, the seven components all come apart and form a soupy solution. Then, when the researchers removed the surfactant by pushing the solution through a membrane, the compounds spontaneously assembled once again into a perfectly formed, rejuvenated photocell.

"We're basically imitating tricks that nature has discovered over millions of years" — in particular, "reversibility, the ability to break apart and reassemble," Strano says. The team, which included postdoctoral researcher Moon-Ho Ham and graduate student Ardemis Boghossian, came up with the system based on a theoretical analysis, but then decided to build a prototype cell to test it out. They ran the cell through repeated cycles of assembly and disassembly over a 14-hour period, with no loss of efficiency.

Strano says that in devising novel systems for generating electricity from light, researchers don't often study how the systems change over time. For conventional silicon-based photovoltaic cells, there is little degradation, but with many new systems being developed — either for lower cost, higher efficiency, flexibility or other improved characteristics — the degradation can be very significant. "Often people see, over 60 hours, the efficiency falling to 10 percent of what you initially saw," he says. ◊

Pushing ions through carbon nanotubes

The tiny, multitalented carbon tubes can carry single molecules, one at a time.

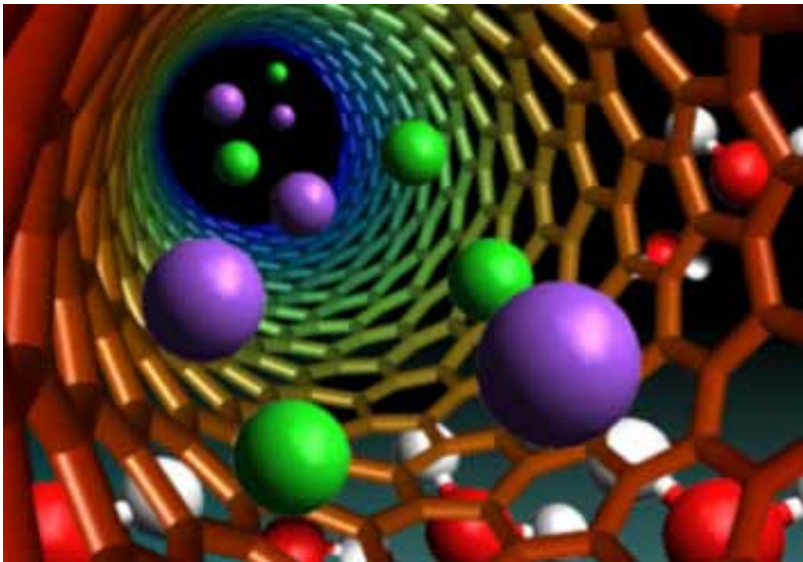
For the first time, a team of MIT chemical engineers has observed single ions marching through a tiny carbon-nanotube channel. Such channels could be used as extremely sensitive detectors or as part of a new water-desalination system. They could also allow scientists to study chemical reactions at the single-molecule level.

Carbon nanotubes — tiny, hollow cylinders whose walls are lattices of carbon atoms — are about 10,000 times thinner than a human hair. Since their discovery nearly 20 years ago, researchers have experimented with them as batteries, transistors, sensors and solar cells, among other applications.

In the Sept. 10 issue of Science, MIT researchers report that charged molecules, such as the sodium and chloride ions that form when salt is dissolved in water, can not only flow rapidly through carbon nanotubes, but also can, under some conditions, do so one at a time, like people taking turns crossing a bridge. The research was led by associate professor Michael Strano.

The new system allows passage of much smaller molecules, over greater distances (up to half a millimeter), than any existing nanochannel. Currently, the most commonly studied nanochannel is a silicon nanopore, made by drilling a hole through a silicon membrane. However, these channels are much shorter than the new nanotube channels (the nanotubes are about 20,000 times longer), so they only permit passage of large molecules such as DNA or polymers — anything smaller would move too quickly to be detected.

"From a molecular perspective, these are exceptionally long distances. This bridging of the gap between nano and the larger world could open up opportunities for harnessing nanoscale phenomena for macroscale applications — from water purification to nanofluidic networks, sensing and fuel cells," says Shekhar Garde, professor of chemical engineering at Rensselaer Polytechnic Institute, who was not involved with the research. ◊



Alumnus Highlight Norman Beecher '44

Norman Beecher '44, current President of the Class of 1944, recounts his experience of being at MIT during World War II:

The class of 1944 entered in the fall of 1940 and saw some significant history. A little over a year later, December 7, 1941, Pearl Harbor was attacked. The war in the Pacific cut the US off from 90% of all rubber supplies. Karl Taylor Compton, MIT President; James B. Conant, President of Harvard; and Bernard M. Baruch were appointed by President Roosevelt to advise on the effort to create synthetic rubber manufacturing, which was accomplished in time to save the nation.

The chemical engineers in our class were studying under some of the founders and early members of the department. Doc Lewis was the greatest and most beloved. On occasion he would put his foot on the front rung of my chair and bend over me trying to extract the right answer to a question. No one was terrified by such conduct. We knew he was trying to help us learn.

There were great people in the department: Gilliland, McAdams, Sherwood, Hottel, and others. These were great human beings, not just great engineers. After the war I was an assistant professor in the department for a few years, and taught courses with both Sherwood and Gilliland.

Almost all of our class served in the war. The military relied heavily on intelligence measurements to assign personnel. MIT students scored high and most became officers. I went overseas in the fall of 1944 as a second lieutenant in the forward ordnance battalion of the 14th Armored Division. We worked very close to the front saving tanks that had been disabled. In one large battle, three of my men received bronze stars for their courageous saving of tanks with their crews in the face of heavy enemy fire.

Lt. Beecher in France, 1944. "I am standing beside the 2-1/2 ton truck in which I was being driven. At that time all officers had a driver. The officer's contribution to the trip was giving directions and the machine gun when necessary. I only used this machine gun once. Mostly I rode in a jeep which had no machine gun."

Norman Beecher today with his wife Nancy.

After the war many of our class did some work on cold war technology. After Sputnik, the US sought desperately to develop a re-entry missile before the Soviets did. The government poured hundreds of millions of dollars into leading firms like General Electric and Avco, both of which got nowhere. The team that invented the re-entry missile was headed by Werner von Braun, the head of the German missile program during the war, who had been brought to the States with some of his staff and worked at Redstone Arsenal in Huntsville, Alabama.

While working for National Research Corporation in Cambridge, I did the heat transfer analysis of the Jupiter missile for von Braun. This is the missile that President Eisenhower showed on TV after its successful re-entry from space. With a parabolic military searchlight, we focused the heat of an arc on a tiny sample of the missile material and used a mass spectrograph to determine what gases were emitted. Computers in this era were far too slow to permit an analysis by repetitive approximation. So we wrote the mathematical equations for all the reactions and boundary layer heat transmission and went to Redstone Arsenal and ran their computers all night every night for three weeks to solve the equations.

2010 Holiday Party

On Friday, December 10, 2010, the faculty, staff, students and their families celebrated the holidays with the traditional day of baking contest, skits, dinner, and caroling.

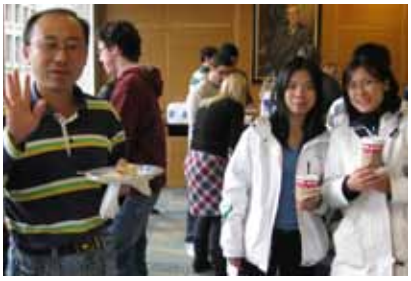












MIT Course X: A Timeline

Chemical engineering is among the disciplines that were truly incubated and created at MIT. From the Institute's earliest days, its engineers were investigating the transformation of molecules into processes and products by chemical and biological means. Many of Course X's earliest advances concerned the petrochemical industry, but chemical engineering research has come to affect nearly every facet of modern life.

Today, Chemical Engineering at MIT explores a broad spectrum of chemical, biological, materials, and energy applications. Course X graduates pursue careers as academics, entrepreneurs, and practicing engineers. The emphasis on molecular engineering continues to play a central role in emerging technologies, including health science and alternative energy.

1888 Lewis Mills Norton establishes Course X, the world's first program in chemical engineering, within the Chemistry Department.

1898 Frank Hall Thorp publishes *Outlines of Industrial Chemistry*, one of the first textbooks in chemical engineering.

1908 William H. Walker establishes the Research Laboratory of Applied Chemistry.

1916 Arthur D. Little, Walker, and Warren K. Lewis cofound the School of Chemical Engineering Practice.

1920 Chemical Engineering separates from Chemistry.

1923 Walker, Lewis, and William H. McAdams publish the textbook *Principles of Chemical Engineering*.

1924 MIT becomes the first university to award a PhD in Chemical Engineering.

1937 Thomas Sherwood publishes *Absorption and Extraction*, the first major textbook in the field of mass transfer, and introduces the "Sherwood number"—a dimensionless figure used in mass-transfer operations.

1938 Hoyt C. Hottel oversees construction of the first solar-heated house in the U.S.

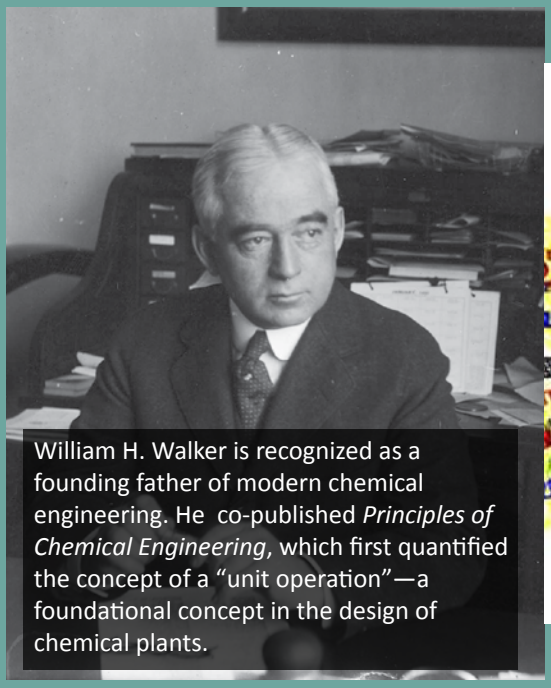
1930s Lewis and Edwin R. Gilliland develop fluidized bed technologies, which prove essential for high-octane fuel production during World War II .

1951 ChemE establishes the Division of Nuclear Engineering.

1958 Nuclear Engineering separates from ChemE to become a separate department.

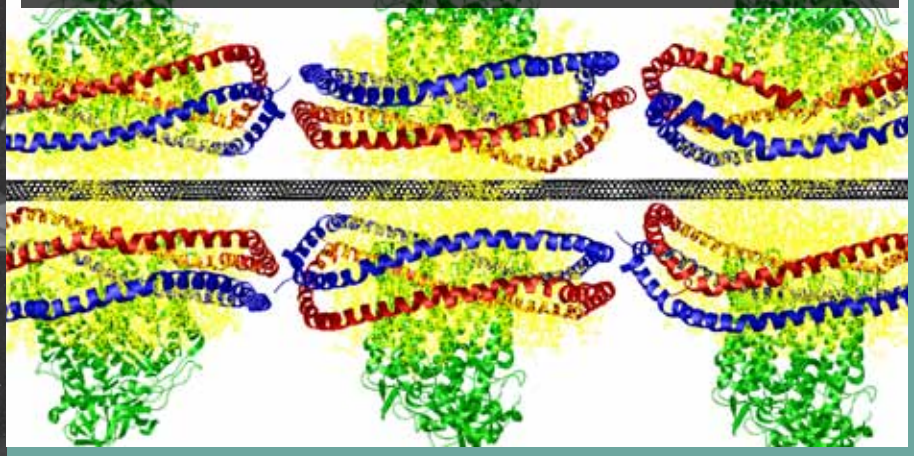
1960s Edward W. Merrill launches the biomedical engineering program.

1965 Edwin R. Gilliland perfects electrodialysis, a process that desalinates brackish water.



William H. Walker is recognized as a founding father of modern chemical engineering. He co-published *Principles of Chemical Engineering*, which first quantified the concept of a "unit operation"—a foundational concept in the design of chemical plants.

Energy research has always been a focus of ChemE, which pioneered early technologies for making gasoline. Today Course X research includes biofuels, gas to liquid technologies, solar technology, and carbon sequestration.



From molecules to manufactured products: MIT's chemical engineers created many of the materials and products that define modern life along with the manufacturing tools and technologies that made them safe and affordable.

Since the 1970s, ChemE has been an incubator of new pharmaceutical technologies: from controlled drug delivery, to therapeutic proteins, to reinventing the processes through which many medications are manufactured.

1975 Robert Langer demonstrates controlled delivery of biopharmaceuticals.

1981 Lawrence Evans partners with the Department of Energy to create ASPEN Technology, which brings computer-aided design and control software to chemical-process manufacturing.

1985 Daniel I.C. Wang founds the NSF Biotechnology Process Engineering Center.

1989 Jefferson W. Tester founds the MIT Energy Lab.

1991 Gregory Stephanopoulos establishes the field of metabolic engineering; a textbook for the field follows in 1998.

1997 Klavs Jensen, with Martin Schmidt (EECS), develops microreactor devices for the optimization of chemical reactions.

1997 Douglas Lauffenburger and Steven Tannenbaum start the Division of Bioengineering and Environmental Health, which becomes Course XX in 2006.

1999 "Directed evolution," an approach pioneered by Dane Wittrup, allows scientists to rapidly generate proteins not found in nature.

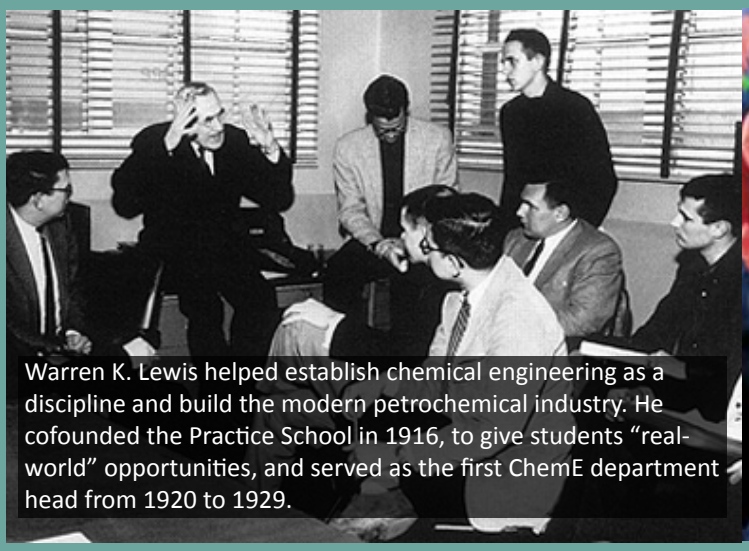
2007 Bernhardt Trout, with colleagues from Chemistry and Chemical Engineering, forms the Novartis-MIT Center for Continuous Manufacturing.

2007 A new Course XB degree on Chemical-Biological Engineering is accredited.

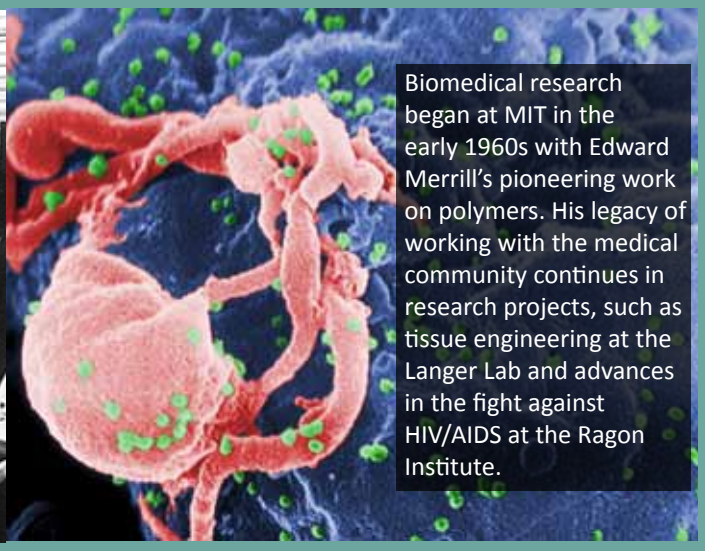
2008 Course X researchers create materials that repel both water and oil, and propose four design rules for creating other "omniphobic" surfaces.

2008 Michael Strano uses carbon nanotubes to construct the world's smallest sensor for nerve agents. The sensor is also a valuable tool for chemotherapy.

2010 Arup K. Chakraborty discovers that the gene carried by HIV-immune people causes the body to make more powerful T cells—a potentially crucial discovery in the battle against HIV/AIDS.



Warren K. Lewis helped establish chemical engineering as a discipline and build the modern petrochemical industry. He cofounded the Practice School in 1916, to give students "real-world" opportunities, and served as the first ChemE department head from 1920 to 1929.



Biomedical research began at MIT in the early 1960s with Edward Merrill's pioneering work on polymers. His legacy of working with the medical community continues in research projects, such as tissue engineering at the Langer Lab and advances in the fight against HIV/AIDS at the Ragon Institute.

For MIT's 150th anniversary, the School of Engineering will showcase historical timelines of each engineering department at its headquarters; the information on this page is taken from the Chemical Engineering panel that will be displayed. For more information, visit the Office of the Dean of Engineering: Building 1, Room 206.

Upcoming Spring 2011 Lectureships

During the 2011 spring semester, the Chemical Engineering Department will host a distinguished group of academic and industry leaders; highlights are noted below.

Webcasts for all Chemical Engineering major lectures can be accessed at *web.mit.edu/cheme/news/webcast.html.*

10th Frontiers of Biotechnology Lecture (Friday, April 15, 2011, 3pm in 34-101)

"Recent Advances in Yeast Biotechnology - From Humanized Yeast, to Synthetic Immune Systems in Yeast, to ..."

Tillman Gerngross, Professor of Engineering, Dartmouth College

Tillman Gerngross, Ph.D., is a professor of bioengineering at the Thayer School of Engineering at Dartmouth College and an adjunct professor in the Department of Biology and Chemistry at Dartmouth. Gerngross has been an active inventor and to date his work has resulted in the founding of two companies (GlycoFi, Inc. and Adimab, Inc.) and over a dozen U.S. and International patents. His work has been frequently cited in the popular press including The Times (London), CNN, Scientific American, BBC, The Guardian, The Economist, New Scientist, Nature Biotechnology and the Los Angeles Times.

33nd Warren K. Lewis Lecture (Friday, April 29, 2011, 3pm in 66-110)

"Engineering Products and Processes for a Sustainable World"

Gary S. Calabrese, Senior Vice President and Director, Photovoltaic Glass Technologies, Corning, Inc.

Gary Calabrese joined Corning in 2008 as vice president of science & technology and is currently senior vice president and director of Photovoltaic Glass Technologies. A past advisor to *Chemical and Engineering News* and co-chair of the National Academies' Board on Chemical Sciences and Technology, he currently serves as an advisory board member of the Council for Chemical Research, the American Chemical Society, and Lehigh University's Department of Chemical Engineering. Gary is an inventor on 11 patents and has authored over two dozen technical publications. He is also a member of the National Academy of Engineering.

17th Alan S. Michaels Lecture (Friday, May 6, 2011, 3pm in 32-123)

"Regenerative Engineering Paradigms for Musculoskeletal Tissues"

Cato T. Laurencin '87, Chemical Engineering & Dean of School of Medicine, University of Connecticut

Cato T. Laurencin, M.D., Ph.D., a nationally prominent orthopaedic surgeon, bioengineering expert, administrator and professor, is the Vice President for Health Affairs at the University of Connecticut and the seventh dean of the UConn School of Medicine. He is the Van Dusen Endowed Chair Professor in Academic Medicine and is Distinguished Professor of Orthopaedic Surgery and Chemical, Biomolecular and Materials Engineering at the University of Connecticut. Dr. Laurencin is an expert in shoulder and knee surgery and an international leader in tissue engineering research.

President Obama named Dr. Laurencin a 2009 winner of the Presidential Award for Excellence, awarded to science, math and engineering mentors. Additionally, Dr. Laurencin was recently honored by *Scientific American* as one of the top 50 innovators for his groundbreaking technological work in the regeneration of knee tissue. He was also recently named among "100 Chemical Engineers of the Modern Era" by the American Institute of Chemical Engineers, and is the 2009 winner of the Pierre Galletti Award, the American Institute for Medical and Biological Engineering's highest honor.

Fall 2010 Hoyt C. Hottel

On September 22, 2010, Dr. Steven E. Koonin, the Department of Energy's under secretary for science, gave the 25th Annual Hoyt C. Hottel Lecture, discussing "Energy Innovation at Scale." Article by David Chandler, MIT News Office.

A webcast of the lecture can be found at *web.mit.edu/cheme/news/hottel.html.*

Frank Talk on U.S. Energy Innovation

MIT alumnus Steven E. Koonin, DoE under secretary for science, says economics, not technology, is the driver.

As a theoretical physicist by training, Steven E. Koonin PhD '75 might have been expected to focus his talk at MIT on Wednesday, Sept. 22, on the scientific and technological aspects of energy policy. But he made it clear right away that business and economics are the real keys to progress in the energy frontier.

It's the economics that are "absolutely essential if the technologies are going to have an impact," he said at the outset of the annual Hoyt C. Hottel lecture sponsored by the MIT Department of Chemical Engineering, before a packed hall in the Stata Center.

"There is an urgency" about dealing with the problems of energy just from a national security perspective, even apart from the dangers of climate change, he said, pointing out that the United States currently sends about $1 billion a day to other nations to feed our petroleum appetite. That makes us "subject to the actions and fates of centers distant from us," he said.

"But the decisions about building new power plants or investing in major new energy infrastructure are more complex than most people realize," he said. Having spent five years working for BP before assuming his present government post (as the nation's second under secretary for science at the Department of Energy), he says he learned a great deal about that complexity. "I can tell you, it was an eye opener," he said.

"If you want to change the energy industry, you should get to know it," he said. "The energy-supply business is not simple, and the people in it are not troglodytes."

As someone with a long academic background — he spent years as a professor at Caltech and then almost a decade as its provost — he postulated the issue in the form of a simple syllogism:

- Almost the entire energy industry, with only a few exceptions, is in the hands of private industry;
- Industry's primary goal is a legal and predictable profit;
- Therefore, innovation in the energy supply will only reach a significant scale when it is profitable or mandated.

"Industry's goal is not to deploy the most innovative or the greenest technology. The goal is to make money," he said. And the scale of investments in energy is so vast that even the government is not in a position to make much of a dent through direct investment: A single, large oil company spends almost as much on research and development per year as the entire Department of Energy budget, he said.

So to spur innovation and the deployment of new forms of energy, regulation and financial incentives are key, he said. He cited as an example the way installations of new wind turbines in the United States have risen and fallen in lockstep with the back-and-forth passage and repeal of production tax credits for the industry.

But technological innovation still plays an important role, he said. While much of the innovation in energy has already shifted overseas, he said, the US continues to dominate in at least one area that could provide a significant advantage in the development of new energy options: Sophisticated computer simulations, an area of technology initially developed under the DoE to foster research on nuclear weapons without the need for actual nuclear-bomb tests. He noted that such simulations, with DoE's help, made it possible for Goodyear to develop an innovative new line of tires in a fraction of the time such development would normally take — an advance that may have saved the company from the brink of bankruptcy.

"This is a uniquely US capability, and it gives us a competitive advantage," he said. ◊

Alumni News

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

Special note: The alumni donor honor roll for the period of July 1, 2010 through June 30, 2011 will be in the Fall 2011 edition of the alumni news. *We sincerely appreciate everyone who has supported us throughout the year!*

CORRECTION from Fall 2010: *A different John Ross, NOT John Ross'56, published a network administration "how-to" book. John Ross'56 is happily retired; he is "not doing much and it takes a lot of time."*

1935-1951

John H. Howell '35 is a new resident at Arden Wood Christian Science Home in San Francisco – moving from his south Charleston, WV, home in November 2009, where he was retired Associate Director of Chemical Engineering at Union Carbide Corp. (UCC), 1978, now Dow Chemical.

Peter C. Weinert '36 is now living in Michigan, near his two daughters. His five boys are all over the US. He and his wife are still enjoying their association with the local historical society, and their summer cabin and tree farm in northern Wisconsin. "Happy days for Jean and I."

A couple of years ago **David E. Acker '38** moved from a condo on Cape Cod to Brooksby Village "where I still qualify the rating of independent living."

Lewis W. Hull '38 is slowing down some. He is still involved with business activities, children, grandchildren, and great-grandchildren. He flew in a sailplane and an antique Navy P-35 recently.

John J. Phillips, Jr. SB '38 SM '40 is finishing a manuscript for publication soon on medical care in the United States. This is his second book. The first one was called *Suppressed Science*. The new one may be called *Suppressed Medical Science*.

After 95 years of experiencing many parts of our world and always in awe of our vast expanding universe, **Maurice F. Gramville MS '39** is limited, but happily, to a small part of it in mid-coast Maine.

After graduation, **Akbar F. Brinsmade MS '42** (above) was employed by Shell Oil Company at its Houston Refinery, where he worked on Aviation Gasoline production and the development of Catalytic Cracking. There he met Juanita Phillips, a research chemist. They were married during the World War II year 1944. The photo above was taken last year at the Beau Rivage Casino in Biloxi.

Robert Rorschach BS '43 MS '50 is a retired process engineering consultant. He was president of Ajax Investment Co. and general partner at Colonial Royalties L.P. He has six children, including Robert F. Rorschach '70, Course 18. His five grandchildren include Katherine '07, Course 2, daughter of Robert F. His memories are of Lewis, McAdams, Gilliland, Meissner, Sherwood, and Weber, the "Gods of Course 10."

Ben Y. Mason '44 lives with Betty, his wife of 65 years, in a small New Mexico village – in a pine forest at 7200 feet. "We are still fit and well but miss our old MIT friends."

At 88++ career matters for **Randall Nicoll Pratt '44** have become, "Do I want to volunteer for this or that activity?" He writes, "(I have done some math tutoring recently but a serious operation last fall has ended that.) Mostly I like trading stories of our lives with newcomers into my retirement home (Once an elaborate hotel from which Gable and Loretta Young filmed The Call of the Wild) , where I get around mostly on a scooter (post-polio syndrome) or walker. This is my tenth year here. Other than that, reading astronomy, astrology, and number theory, and, of course, solving world problems. Just hope social security isn't cut too badly."

Richard Braendle '45 belonged to Kappa Sigma fraternity on Bay St. Rd. Tuition then was only $600/yr and he had a $200 scholarship. Richard will have been married 66 years in August 2011, and be 88-years-old on June 29, God willing. He was captain of the MIT fencing team and later director of DuPont's Petroleum Chemicals Division.

Lawrence Shutzer '47 has companies producing outerwear for men and ladies. He does extensive overseas traveling. Lawrence is a devoted golfer and fair bridge player. He's been married 61 years

*After 95 years of experiencing many parts of our world and always in awe of our vast expanding universe, **Maurice F. Gramville MS '39** is limited, but happily, to a small part of it in mid-coast Maine.*

and has three children, five grandchildren, and one great-grandchild.

After graduation, **John Yocom '47** spent 3 years in process development at the Battelle Institute. In 1950, he got into environmental work, specializing in air quality , and working for several other research and engineering firms and a regional air quality control agency. In 1969, Yocom co-founded TRC Environmental Consultants. He retired in 1990, but continues to consult and, with a group of volunteer scientists and engineers in CT, "try to pound common sense into a reluctant public by questioning the myth that we humans are the principal cause of global warming."

John Steven Wilson Kellett's SB '47 SM '48's Kellett Foundation fights GLBT discrimination. The foundation's new website is about to launch. John is now Board Member and Nominations Chair of www.bayoucityconcertmusicals.org.

Willis B. Reals SB '47 SM '49 spent forty years with Texaco Inc. in 8 locations. He retired in 1990 as senior VP Texaco Inc. and Chairman Texaco Chemical Co. He married in 1953, and has two children and four grandchildren. Willis was widowed in 1989 and remarried in 1991. He has two homes, one in Lincoln, MA and the other on Cape Cod. In retirement, Willis is chairman of Cape Cod Healthcare, Inc. (two hospitals), President of the Marine Spill Response Corp., and President of the MIT Club of Cape Cod.

Jerry A. Lott '48's entire working career was with Pfizer Inc. He retired in 1985. He was a consultant to the pharmaceutical industry, 1986-1992.

Ralph L. Wentworth '48 joined Prof. W.H. McAdams's MIT project in 1944 to develop a hydrogen generator. He became involved with C.N. Satterfield in hydrogen peroxide research – many theses and the ACS monograph in 1955. After service as Industrial Liaison Officer, he joined W.R. Grace & Co. in papermaking technology. In 1962, he began 27 years at Dynatech R/D Co. undertaking a host of engineering and management assignments. Anaerobic Digestion became a technical specialty.

Antonio Armenante '49 was originally class of '46; he started his second term after World War II. He was phased out of Paterson Bleachery in 2001. He joined Activities Unlimited in town – it is all retired executives, and keeps Fay and him very busy.

Benjamin D. Cowley '49 worked for DuPont for many years in Louisville KY, Montague, MI; Beaumont, TX; Wilmington, DE; and Victoria, TX. He is retired now in Hockessin DE.

Wayman L. Calhoun SM '49 was a process engineer for Reynolds Metals Co. Alumina Plant (AR), did paint research at Stebbins & Roberts, Inc. (AR) and was an instructor at Rose Polytechnic Institute (IN). He did rocket propellant research at Hercules Powder Co. (MD) and physical properties research at Union Carbide Corp. (WV). Wayman retired at the end of 1981 from UCC (23 yrs). He moved to MN at the end of 1996 to live near his daughter (his son lives in NM). He is currently ill from heart and lung surgeries with home care by nurses and his wife, Earline, of 60+ years. He is a life member of Tau Beta Pi, a member of AIChE, and a 60+ member of ACS.

Eugene F. Biek '50 attended Practice School at Bethlehem Steel near Buffalo and Eastern Paper Corp. in Bangor. After graduation from Course 10B in 1950, he married Mary Ellen Casey. They have six outstanding sons, seven grandchildren, and five great grandchildren. He retired in 1989 after 39 years with Kimberly Clark and Simpson Paper in Wisconsin and California. He was deeply involved with the development and production of coated printing and specialty papers. Eugene and Mary Ellen began bicycle touring about 30 years ago and traveled extensively throughout the United States and Europe. They also bicycled in Mexico, Costa Rica, and New Zealand. He has currently logged 157,000 bicycle miles. Eugene now enjoys wine making and duplicate bridge, and plays clarinet in the local community band. They are both in good health (for 82 years) and enjoying life in Northern California.

It's been a long road and a great career for **James J. Staikos '50**. He started just north of Boston at Monsanto's heavy chemicals plant (anyone remember the huge sulfur pile in Everett?), then a couple of years as a guest of the government at the QM R&D Center in Natick, followed by 35 years with the late, great Arthur D. Little, Inc. working all over the world and variously resident in Cambridge, Algiers, Athens, and London. He is now an annual commuter between homes in North Palm Beach and London, and actively enjoying friends, family and good health.

Robert W. Koch MS '50 and wife Beth live in a retirement community called Longwood at Oakmont. Some of the top golf tournaments are right across the street. They have four children, six grandchildren, and two great-grandchildren. They are active at the local church.

Garth Coombs '51 spent two years in the Army Chemical Corps., then 40

Alumni news continued (1951-1960)

years at Johns Manville Research Center as manager and associate. He is active in AIChE and an elected fellow. He has ten patents and technical articles.

Paul Grady '51 enrolled in Course X on July 5, 1945 to learn from the great professors Gilliland, McAdams, Sherwood, Whitman, and the best lecturer, Doc Lewis, under the administration of Karl Taylor Compton. He joined the US Navy to help win WWII and returned to Course X to graduate and lead his class in June 1951. He studied under Prof. Pigford at Delaware and worked in catalytic cracking processes as taught by Doc Lewis in the petroleum refining industry. He registered as a PE in June 1961 and practiced for 50 years in engineering; he is now enjoying politics in New Jersey and Florida and Sigma Nu fraternity in Virginia and Brookline, MA.

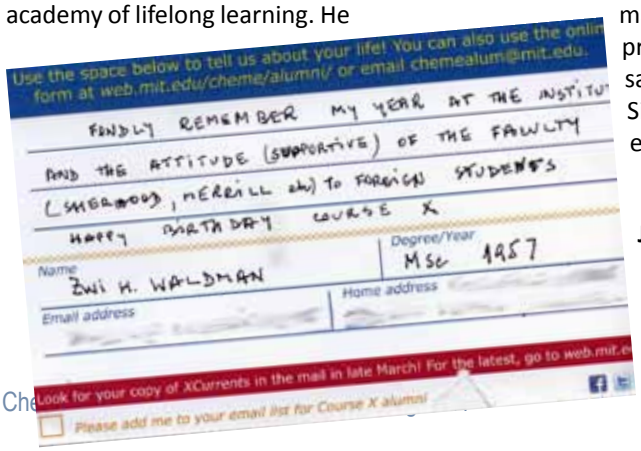
After MIT, **Ronald Greenwald '51** worked for Shell Oil, then in the Civil Engineering Corp of the Navy, and in 1957 returned to California. For many years he owned a small company servicing the food industry. Since retirement, he and his wife have led many foreign international volunteer groups for Habitat for Humanity, and they will now lead a group of volunteers for Fuller Center for Housing to build housing in Haiti.

Eugene B. McCord MS '51: 1945-1947 US Army, one year in Italy; 1947-1950 BS from Johns Hopkins; 1950-51 MIT MS; 1951-1990 ChemEng – DuPont Senior Research Associate; 1990-2005 Retired – house on Chesapeake Bay; 2005-? Retirement Home. He is currently active in the academy of lifelong learning. He runs a duplicate bridge game and sailboat racing program.

The last notable thing **Kenneth H. McCorkle BS '51 MS '53** did relating to ChemE was to get a PhD in ChemE from the University of Tennessee (1966) while working at Oak Ridge National Laboratory. He retired in 1994 and now considers himself "totally obsolete, technically."

After graduation, for two years, **Robert (Bob) Damon '52** was an instructor of tactics, Army Chemical Corps, Ft. McClellan, AL, where he married his wife Barbara, Wellesley '51. In October 1954 he joined Olin Corp, E. Alton, IL (near St. Louis). He became an applications engineer, working with prospective new customers for small gas generators (for missiles large and small) and starter cartridges (for aircraft). He retired after 38 years with Olin; the last three years were in Redmond, WA at a facility (Rocket Research) Olin purchased in 1985. Since retiring in 1992, Bob has trekked in the shadow of Mt. Everest in Nepal, hiked and Volksmarched all around the Pacific Northwest, worked with Habitat for Humanity, and been very active in Rotary and church committees. From age 40 until 66, he was a runner (18 ten-milers in Alton) and did triathlons. He and Bobbie have traveled a good bit, mostly with Elderhostel and to visit family. He has four children and twelve grandchildren. For more news from Bob, please go to web.mit.edu/cheme/alumni/.

William W. (Bill) Dunn '52 received a Stanford MBA in 1956. He worked in the chemical industry from 1956-1976 as market analyst, technical sales, product manager, eastern sales manager, and VP of sales. Since 1976, he has been a real estate investment broker.



Joe Moore '52 was first employed by Humble Oil & Refining Co. at its Baytown, TX refinery near Houston. He designed several refinery units and was asked to explore the potential of computers for refinery technical and economic calculations. In 1956, a colleague, John Bonner (X-50), and he formed Bonner & Moore Associates to consult in computer applications. The company existed for 43 years until being sold in 1999. Joe then retired.

Clifford M. Sayre, Jr. '52 retired from the DuPont Company as VP, Materials, Logistics and Services in 1992. Since that time, he did a little consulting, and lived in California for several years. "Mary and I now live in a Quaker retirement community."

Walter S. Scheib, Jr. '52 has been fully retired since 1990. His wife Jean died February 23, 1994. He spends all of his time working with local charities.

Robert Walsh BS '52 MS '53 retired from Chevron in 1993 as president of Chevron International. Since then, "it's been travel, golf and dealing with MDs."

Robert (Bob) Anslow '54's MIT education has served him well, but not as a chemical engineer. He's been in electronics and electromechanical engineering since 1956, and is still active in making real-time computers as chairman of Dynatem, Inc. in Southern Califoria.

James McCauley '54 was VP of Research and Development Engineering at Crucible Steel 1957-1969, then VP of Engineering and Development at Sharon Steel 1969-1979, and then owner of Emeco Inc. 1979 to 1995.

After retiring from Rhône-Poulenc Inc., **Jean-Paul Jourdan '54** became involved in spirulina culture, a microalgae used in human health and nutrition. There are now many small producers in Africa, India, and also in France (about 70). His site: petites-nouvelles.pagesperso-orange.fr

"I saw Roy "Whitey" Handwerk SM '54 again about a year ago and we called Glenn Armstrong SM '59, both old practice school buddies. Praise to the practice school!"

- Lawrence (Larry) W. Nisbet, Jr. SM '54

Lawrence (Larry) W. Nisbet, Jr. SM '54 has lived in Tampa for over 20 years; he is retired now from working for and with several engineering companies, including his own. He worked with development and process design of over 100 operating facilities here and around the world in petrochem, pharm, and chemical areas. He still now consults. Larry saw Roy "Whitey" Handwerk SM '54 again about a year ago and "we called Glenn Armstrong SM '59, both old practice school buddies. Praise to the practice school!"

H. Rowe Austin, Jr. '55 is retired from Wentworth Institute as professor emeritus. He taught physics and chemistry.

James Thacher BS '55 MS '56 spent 40 years with solid rockets working for Hercules and ATK. He has three sons, is active in the local church, youth program and rescue mission. He's been married to Pauline for 52 years.

John M. Roblin MS '55 is retired and enjoying life.

Werner Glass SM '51 ScD '56 moved to the West Coast and escaped East Coast winters. His lifetime achievement is that he placed 3rd nationally amongst seniors in a Crossword Puzzle Championship (2008).

Edward George Najjar BS '56 MS '57 worked at Esso 1957-1958, then at W.R. Grace (Hampshire Chemical) where he was VP 1963-1983, then president (Organic Chemical) 1984-1992. He was president and CEO of Hampshire Chemical Corp. (Dow Chemical) 1993-1999.

Joe Neville SB '56, SM '65 worked for three different companies and decided to try teaching for a bit. He ended up teaching for 30 years at Wentworth Institute of Technology in Boston as it grew from a two year school to one offering graduate degrees. He enjoyed every minute of it and writes, "Motivating students and preparing experiments were good challenges. Teaching subjects I had never taken, like Metallurgy and Strength of Materials lab, were challenging but made easy by great faculty guidance. It ended up giving me a new hobby – making pewter castings. Sometimes you find it easier to teach something you had to teach yourself first.

I found the four good reasons for being a teacher were May, June, July and August as well as week-long vacations during the year. I 'retired' each summer and did the things I dreamed of, like backpacking through Europe, hiking the Alps and portions of the Appalachian Trail, going on 50-mile canoe trips, touring the US by car for seven weeks nine different times, visiting the famous sites, including sleeping at the bottom of the Grand Canyon and rubber raft rides and being a volunteer at the Catholic Shrine in Lourdes, France, for many summers. Winter trips included coasting four miles down the auto road on Mt. Washington, seeing Niagara Falls frozen and celebrating New Year's Eve in Disneyworld."

Robert Bishop MS '57 has moved to a continuing care retirement village.

Donald A. Cameron MS '57 is still alive, his wife has died. His two children are gone; he has four grandchildren. He's retired from the Electric Boat Gen Dynamics as Chief of Engineering, Strategic Weapons, and LCDR US Navy. He is still sailing, dating, and having fun.

Herbert E. Klei '57 has retired as a professor of chemical engineering from the University of Connecticut. He is currently a potato farmer on family farms in northern Maine.

Joseph E. Leitgeb '57 is in his 19th year of retirement. He enjoyed a great career in process engineering and human resources. Now he is enjoying playing golf and pursuing his hobbies of model trains and astronomy. He fondly remembers taking graduate courses from such chemical engineering icons as Lewis, Gilliland, McAdams and Sherwood.

Robert H. Borgwardt '58 enjoyed a long career as research engineer with the Environmental Protection Agency at Research Triangle Park, NC.

At the age of 75, **Bill Peter MS '58** started a new innovation education business. For details, go to www.worldclassinnovation.com. Technology is only one of the four types of innovation.

Jorge Alfert BS '58 MS '59 retired in 2001 as a corporate officer and head of engineering/manufacturing at Borden Chemical. He and Mayra travel frequently around the world and enjoy the visits from their three children and four grandchildren.

Norman Jacobs MS '59 has served as a business and financial consultant to start-up biotech and medical technology companies, and also as an expert witness in IP litigation, since taking early retirement from Becton Dickinson in 2000. He was remarried on June 27, 2010 to Jane Greenspan of West Hartford, CT, after losing his wife of 46 years in 2005. He and Jane are now dividing time between Boca Raton in the winter and Manhattan in the summer, and would enjoy meeting classmates in either location.

In 1962, **Joseph Cohen '60** received an MS degree in Food Technology from UMass,

Alumni news continued (1960-1975)

Amherst, and married Marianne. He worked for the US Army until retirement in 1999 where he developed microclimate clothing as well as novel ways of preserving food. Marianne passed away suddenly in 2007. Joseph has 3 children and 7 children and spends the warm months in Florida and the cold months in Holliston, MA.

Dave Kellermann '60 got an MBA in economics and finance at the University of Chicago. His employment includes two years in finance at Esso, New York; 25 years in engineering, economics and marketing at Dow Chemical Europe; and then at Financial Services in Zug.

Donald Easson '61 notes that "I now can boast of three generations of Chemical Engineers:

1) Don Easson, 1961, SB ChE MIT

2) David Easson BS ChE USC, SCD BioChemical Engineering from MIT 1988.

3) John Easson, BS ChE Cornell 2010."

Alfred E. Wechsler ScD '61 finally retired (almost) but is always interested in advances in chemical engineering technology. He is still actively participating in AIChE and helping young chemical engineering professionals in their career development.

Inspired in part by Dr. Merrill's blood rheology research in 1962, **Greg Gehred SM '63** changed course (SM in Course 10) and entered medical school in 1963. He worked in Native American health as a family doctor for 25 years, then at UWisc Health for ten. He is now retired and volunteering.

Thomas A. Massaro '63 retired from the University of Virginia School of Medicine after completing 27 years of service there. Upon retirement, he began working at the University of Botswana to start a new medical school there. He is currently Founding Dean of that school. They have admitted two classes into the undergraduate medical program. They have begun post-graduate training (residencies) in six disciplines and expect approval for the Ph.D. program during this academic year. A medical education building is almost completed and construction of a university teaching hospital of 450 beds has begun.

Shintaro Furusaki SM '64 retired in 2008 after having worked in three universities: University of Tokyo, Kyushu University, and Sojo University. Now he is partly doing research on plant cell culture to produce paclitaxel at Kanto-Gakuin University. Recently he wrote a chapter on plant cell bioreactors in "Comprehensive Biotechnology, 2nd ed." which will be published by Elsevier in 2011. He is working as a member of the Science Council of Japan and Engineering Academy of Japan, contributing to the society.

Anthony Benis ScD '64 has fond memories of Practice School in Oak Ridge, TN. He eventually obtained a medical degree and served for many years as director of cardiothoracic intensive care, Mt. Sinai Medical Center in New York.

Richard N. Leslie SB '66 SM '67 states, "My excellent Course X education served me very well in the 4 years after college at Dow Chemical Company, Midland, MI, and then teaching at Tilton School, Tilton, NH. I received an MBA from Dartmouth College in 1977 and spent my 'career' at L.L. Bean in Freeport, ME, in senior management. I found the very strong analytical and problem solving skills served me extremely well at L.L. Bean, allowing me to solve all kinds of business problems. I was in the Practice School in Spring 1967 where we did projects at Oak Ridge National Laboratory, American Cyanamid in Bound Brook, NJ, and 3 or 4 of us did a project at American Cyanamid in Willow Island, WV, living in Marietta, OH. The Practice School work was so intense, but it definitely drilled into us how to do research, how to analyze our work, and how to write it up and present it. My very first college all-nighters occurred at Practice School. Thank you, MIT!

I've now enjoyed the Maine lifestyle for almost 34 years. Although I didn't continue in chemical engineering for a career, I really value all that the courses taught us back in the slide rule days. I still remark to people that our final exams often consisted of just one problem - you may get the answer wrong, but if you explained your thinking process you got lots of credit. And working with the Steam Tables - I still can't believe I did those homework problems with a slide rule!"

Richard (Dick) Giberti SM '67 is currently president and CEO of Artisan Industries in Waltham, MA, and will be retiring in October 2011 to the Cape.

Robert W. Heinze SM '68 retired from Cytec Industries in April 2010 after spending the past 35 years in California in the field of composite materials in various manufacturing and quality management positions. He is still married to his wife Betsy, whom he married in 1967 while at MIT. Betsy accompanied Robert to both Practice School stations at Bound Brook, NJ, and Oak Ridge, TN. Before coming to CA, he worked in Oklahoma City for Kerr McGee, Chicago for Amoco, and spent 4 years in Washington DC as an officer in the Naval Reactors program. They have 3 children and 5 grandchildren.

Douglas Cortez SM '66 ScD '69 retired from Fluor Corp. in 2006. He is Managing Director for Hensley Energy Consulting LLC serving the clean energy industry.

Lee P. McMaster ScD '69 retired in 2004 after a 35 year career in the chemical industry. He spent seven years in R&D and the remainder in various business roles.

Debi P. Mukherjee ScD '69 attended the

"The Practice School work was so intense, but it definitely drilled into us how to do research, how to analyze our work, and how to write it up and present it. My very first college all-nighters occurred at Practice School. Thank you, MIT!"

- Richard N. Leslie SB '66 SM '67

50 year reunion of her undergraduate class in Chemical Engineering at Jadavpur University, India, on January 2, 2011.

James Katzer PhD '70 had a great career: (chronologically) teaching chem eng. at Univ. of Delaware, R&D and technology management at Mobil Oil Corp./ ExxonMobil, Visiting Scholar at MIT, Affiliate Prof. at Iowa State, inducted into the NAE and Cosmos Club (DC), and still doing analysis and presenting seminars. He lives in DC and on the Maine coast.

From 1971 to 1997, **Shantaram Govind Kane ScD '71** worked in chemical industry R&D at senior and functional head levels. Since 1997, he has been totally engaged doing research in Ayurveda on his own and also at IIT Bombay. He has invented a simple kitchen process to make super-active extracts of natural products in edible oil. Based on this disruptive invention, he has an 'Affordable Healthcare' proposal. While developing applications of these extracts with the help of volunteers, he became acutely aware of the importance of dietary regulation for the prevention and management of diseases and its current neglect worldwide. He has now written a book *Diet and Lifetyle for Health in the 21st century: A Self-empowerment Guide*. This book is an outcome of the knowledge accumulated and lessons learnt while indulging in his curiosity driven explorations of Ayurveda. For more news from Shantaram, please go to web.mit.edu/cheme/alumni/.

Junichi Miyazaki MS '71 worked 26 years for Chiyoda Corporation, a Japanese contractor, then 12 years for The Foxboro Company, US process controls, and 2 years for Ranco, a Japanese air-conditioning parts manufacturer, then retired in 2007. He is now enjoying fly-fishing, farm works, and travelling Asian countries. He has however have lost all contacts with his MIT friends and ex-classmates. "If I can find them thru this link, I would like to contact them again."

Bradley Billetdeaux '72 spent 20 years of his career working in petroleum refining, specializing in gasoline blending and inventory management. "Here's a neat statistic: the programs I developed blended over 100 billion gallons of products using nonlinear mathematics and techniques that MIT gave me a foundation to understand. My employers were Chevron and ExxonMobil. Now I am in the software business, focusing on web applications. My latest endeavor is a portal used by major energy marketers to keep track of their gasoline exchanges. I just love gasoline!"

Dwight Davis '73 retired two years ago from Lockheed after 29 years working on commercial communications satellites. He moved to Rio Vista, a small town on the California delta.

The company **Paul C. Ahrens SB '73 SM '74** founded 30 years ago, Synthetech, was acquired by W.R. Grace in Nov. 2010. Now, he is developing novel opto-electronic materials at Oregon State University.

Sergio C. Trindade PhD '73 is a Nobel Peace Prize (2007) co-laureate as member of the Intergovernmental Panel on Climate Change – IPCC. He is the former UN Assistant Secretary-General for Science and Technology. He is still working: www.internationalfuel.com.

Since September 2009, **Elsa Kam-Lum SM '74** has been working in organic photovoltaic solar cell technology. She loves "everything about working in this field, from the challenge, to working with bright colleagues, to feeling like I am contributing, even if it is the equivalent of a grain of sand, to help solve the impending energy shortage for our and future generations."

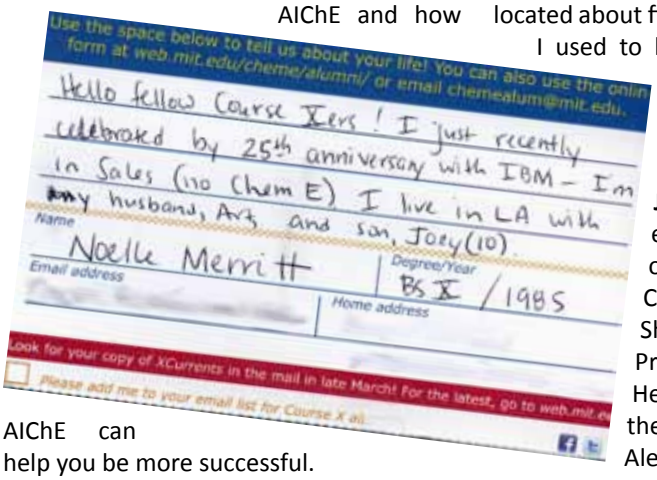
Tim Montgomery SM '74 retired from Chevron in 2007. Since then, he's been building his wine knowledge (and cellar inventory) in addition to traveling. He doesn't miss working one bit.

Gabriel F. Avgerinos MS '75 joined Exxon Chemical in New Jersey in 1975, where he worked for 6 years initially in Paramins Oil Additives and later in the Elastomers Division of Research & Development technology. He received an MBA from NYU and returned to work for Exxon until 1981, when he then joined the energy consulting and brokerage firm Poten & Partners in NYC. He spent 25 years at Poten, initially as Head of the LPG Consulting Dept, then in Special Projects, and later as General Manager of the LNG and Natural Gas Consulting Dept. He focused on new business development in consulting assignments for client companies who were sellers/exporters, trading/shipping companies, or buyers/importers of LNG and LPG via ship transportation worldwide. The advisory work was challenging, the people he met were interesting, and the overall experience was very satisfying. He retired at the end of 2006, due to disability, and now enjoys the company of wife Eileen and the growth, education, and career development of their two wonderful children Christina (23) and Michael (17). For more news from Gabriel, please go to http://web.mit.edu/cheme/alumni/.

Alumni news continued (1977-1993)

Kenneth P. Mortensen '77 is still working in Kansas City in Plastics, Polymers, Water and Water Treatments. He has had several positions over the years. He says "MIT was a wonderful place and still is."

In June 2011, **Scott Berger '78** will celebrate his 10th anniversary working for AIChE. He is currently the Executive Director of AIChE's Center for Chemical Process Safety, and will soon start a new Center focused on manufacturing excellence. He would love to hear from alumni, faculty, and students about what you like best about AIChE and how AIChE can help you be more successful.


Use the space below to tell us about your life! You can also use the onlin form at web.mit.edu/cheme/alumni/ or email chemealum@mit.edu.

Hello fellow Course X'ers! I just recently celebrated by 25th anniversary with IBM - Im in Sales (no Chem E) I live in LA with my husband, Art, and son, Joey (10).

Name: Noelle Merritt

Degree/Year: BS X / 1985

Email address

Home address

Look for your copy of XCurrents in the mail in late March! For the latest, go to web.mit.e

Please add me to your email list for Course X alu

For the last year **Kevin Fallon '78 MS '79** has been Vice President of Technology and Strategy for Badger Licensing LLC, a joint venture between affiliates of ExxonMobil and the Shaw Group. Badger Licensing is a leading process licensor for cumene, BPA, EB, and styrene technology. Personally, he has been busy studying classical piano and preparing for his next concert, as well as conducting a major renovation to his Boston South End townhouse that he bought many years ago.

Brian Maiorella '78 has retired as Vice President of Process Development at Chiron. He now teaches biochemical engineering and pharmaceutical product development at UC Berkeley.

Marc Machbitz MS '78 is living in Texas and working for Deloitte.

David Sudikoff MS '78 writes that after leaving MIT in 1978, after the huge blizzards, for California for a planned one-year stay, he is still there. He is running a software company for industrial control.

Kenneth Wang SM '79 is co-founder of Hybrid Silica Technologies, Inc. (HST). HST is providing nanoscale probes for a clinical trial at Memorial Sloan-Kettering Cancer Center. The collaborative work is described in *Technology Review* (Feb 2011). The company moved from Ithaca, NY to Cambridge, MA in January 2010. "We are located about five blocks away from where I used to live when I attended MIT. Great to be back in the old neighborhood!"

Justine MacDonald '80 is enjoying working for an outstanding Life Science Company: Sigma-Aldrich. She is currently their VP, Procurement & Supply Chain. Her husband Doug is enjoying the empty nest. Her son Alex graduated with a BS in Mechanical Engineering from Washington University in St. Louis, and is now working for a design firm in South Bend, Indiana. His fiance is attending graduate school at Notre Dame working towards a degree in Biomechanical Engineering. Their daughter Vicki is double majoring in marketing and accounting at St. Louis University.

Stephen Kamshun Fok MS '80 has been working for 31 years in a utility company in the areas of power generation, environmental compliance and energy efficiency. He and his wife Nancy are celebrating their 30th anniversary this year. Their older son is attending Tufts Medical School, and the younger son is entering Harvard graduate school this fall.

Selahattin Gültekin PhD '80 is currently the Dean of the Engineering School at Maltepe University, Istanbul.

William Fraizer SM '80 is currently performing a senior project engineering role for Chevron as they complete front end engineering design work on the Wheatstone LNG Project, which will be built in Western Australia. He returned to Houston in mid-2009 after several years working in London, and living in the West End. The MIT alumni club in Houston is an active group with a number of Course X alums involved.

Jasjeet S. Sood BS '79 MS '80 is launching an energy private equity fund to invest in conventional power, renewable energy projects, and related infrastructure.

Valerie Vitale '81 has been in private practice in otolaryngology for the last 17 years in Bristol, CT. Her husband, Armann O. Ciccarelli, MD, FACS (MIT MechE 1981 graduate), is a plastic and reconstructive surgeon also in practice with Valerie. They have three daughters (13, 15, 18).

Ronald Kurnik ScD '81 is currently Principal Engineer II at Roche Molecular Systems in Pleasanton, CA. He has developed innovative algorithms for automated quantitative Polymerase Chain Reaction (PCR) and Melting Assays. His current research is in automated processing of hyperspectral tissue images containing Quantum Dots, with applications in cancer detection. He has 25 issued US patents.

Miren C. Salsamendi PhD '82 is presently the North America Business Director, DTT, at Dupont. She is married to another alumnus and mother of a third, now an ER resident in NYC (Jose M. and Jose R. Torradas (below)).

Jose M. Torradas PhD '82 is a Technical Consultant at DuPont Packaging Business (27 years of service). He is married to and father of MIT alumni (Miren Salsamendi PhD '82 and Jose Ramon Torradas '05).

Scott Berger '78 is currently the Executive Director of AIChE's Center for Chemical Process Safety, and will soon start a new center focused on manufacturing excellence. He would love to hear from alumni, faculty, and students about what you like best about AIChE and how AIChE can help you be more successful.

Howie Rosen SM '82 has been living in the SF Bay Area since graduation and has been semi-retired since 2008. He has kept busy by working with his thesis advisor, Institute Professor Bob Langer, on two start-ups in the Cambridge area: Entrega and Kala Pharmaceuticals. He is also on the Board of Directors of the MIT Club of Northern California, and was elected to the National Academy of Engineering in 2005, based on his work at MIT in drug delivery. He still sees fellow Course 10 alums Horacio Valeiras ChE '83 and Miral Kim-E PhD '85 in SoCal.

Deanna Carroll (Bushendorf) Miller '83 just opened her own veterinary clinic, Rising Sun Animal Care, which specializes in providing the individualized care your pet needs. The website is www.RisingSunAnimalCare.com and facebook page facebook.com/RisingSunAnimalCare.

Lisa Faeth MS '80 ChE '84 has been working at the US Environmental Protection Agency in Washington, DC for the last 26 years.

Arunava Dutta ScD '85 is head of R&D for Solid State Lighting (LED) for the Consumer Lighting division of Osram Sylvania, a Siemens Company. He is based in Danvers, Massachusetts. At Danvers, they develop cutting edge LED lamp designs that are much more energy efficient, have longer life, and are environmentally green compared to the traditional lamp technologies that they will replace. He is also responsible for NAFTA interaction with EU and APAC colleagues for global LED lamp 40 US and EU patents with several more submitted.

Michael Flanagan '85 has begun teaching his kids chemistry and doing labs in their basement, which brings back some memories and is a lot of fun. Covidien bought Aspect Medical Systems and is closing his facility, so he's seeking a new process/product development role, which is not as much fun.

From MIT, **Arthur Lee '85** went to graduate school at Caltech, obtaining his MS, also in chemical engineering. In between, he did a summer internship at 3M working on a new polymer extrusion technology. He then worked for a firm called Directed Technologies, based in Washington, DC and in San Diego at that time, that did classified weapons and propulsion systems type research for DARPA, the Office of Naval Research, and other agencies. He worked at Fluor, then the EPA, where he helped write the first set of regulations for NOx controls for coal-fired power generation in the acid rain provisions of the Clean Air Act, and helped with some of the first provisions tracking the trading of sulfur dioxide allowances trading. Arthur now works with Chevron, and he and his wife Jackie live in the San Francisco Bay area. From 2004-2005, he was a review editor of chapter 5 "underground geologic storage" of the IPCC Special Report on Carbon Dioxide Capture and Storage. He was also an expert reviewer for the IPCC Fourth Assesment Report, focusing on the mitigation technological aspects of the assessment. In 2007, the IPCC shared the Nobel Peace Prize with former US Vice President Al Gore. Along with several hundred others, the IPCC recognized my contributions to the Nobel Peace Prize. For more on Arthur's work and ongoing relationship with MIT, please go to web.mit.edu/cheme/alumni/.

Noelle Merritt '85 recently celebrated her 25th anniversary with IBM. She is in Sales (not ChemE). She lives in LA with her husband, Art, and son Joey (10).

Fariba Fischel Ghodsian MS '85 is happily married (since 1984) with 3 wonderful children, David, Daniella and Daphna. They live in Los Angeles and she is co-managing a healthcare fund, DAFNA Capital Management, that invests in biotech and medical devices.

Bernard L. Palowitch, Jr. ScD '87 says, "Hi, everyone. I'm living and working in the Princeton area. I founded Iknow LLC, a knowledge management consulting and systems integration firm in April 2001 and we're quickly approaching our 10-year anniversary. Some of the interesting work we're doing is in the areas of knowledge modeling and representation, cognitive neuroscience architectures, semantic processing, and sensemaking. On the personal side, my three sons are growing up too fast, with the second one entering college in this fall."

Stewart Hen '91 is living in NYC with his wife and two kids (ages 5, 1.5). That has been great fun. He recently started his own investment firm focused on health care companies. He doesn't get to use his chemical engineering knowledge much but at least he tells people that he once knew how to do it.

In 2008, after 16 years of working in sterile dosage form development at Schering-Plough and living in New York City, **Douglas Kline PhD '93** packed up and moved to Berlin with his partner Julien, who accepted a job with the Berlin State Museums. He started a pharmaceutical development consulting firm, Douglas Kline UG, and currently has several US-based clients. Most of the work is done via Internet and telephone and is really enjoyable. His base in Berlin has allowed him to be the "man in the plant" for some critical project activities at European sites. While he does miss the face-to-face contact with co-workers, working out of his home office has its advantages (especially the commute). It has also allowed them to adopt a six-year-old rescue dog (Ella) who

Alumni news continued (1993-2009)

is a real sweetheart. Berlin is exciting and the quality of life there is very good. Unlike in NYC, they have a huge apartment with a guest room (visitors are always welcome!) and a balcony that is a riot of flowers in the summer. "Of course the language is always a challenge and the Berlin winters are long, dark, and cloudy, but living abroad has been a fantastic experience that I never thought I would get the chance to have at this point in life."

William (Bill) Arnold '94 is still a member of the environmental engineering faculty at the University of Minnesota in the Department of Civil Engineering. He was promoted to full professor last year, and now holds the Joseph T. and Rose S. Ling Professorship. His research focuses on the fate and transformation of pollutants in aquatic systems. His group has recently focused on identifying unexpected pollution problems caused by common household chemicals. He and his wife (Lori) have their hands full with two active boys, Alex (9) and Ben (7).

Chonghun Han ScD '94 was selected as the recipient of 2011 Young Engineer Award by the National Academy of Engineering of Korea (NAEK), equivalent to the National Academy of Engineers in the US. The awards are given to only two engineers who are younger than 50 years old, and have contributed to Korean industry and academia during their lifetime. Chonghun is the third chemical engineer in Korea who received this award so far, and would like to share this honor with other alumni from MIT Course X.

Henry "Rick" Constantino PhD '95 is currently Vice President of Research and Development at Energ2 in Seattle, WA.

In June 2010, **Ivette Johnson '96** packed up her family and moved to Geneva, Switzerland, with Procter & Gamble. She has been with P&G for more than 14 years and currently owns the Digital Reputation efforts for the Company. Her husband Jose, the kids Gabriela (5) and Sebastian (2), and she are all learning the fine art of eating cheese and chocolate on a daily basis (tough life!). They also try to go skiing or ice skating every weekend, and she now realizes her elective French courses at MIT came in really handy after all! They just came back from spending the holidays in Peru so they are trying to hold on to their tans despite the cold Geneva temperatures. If any other MIT grads are currently residing in the Switzerland area, she would love to hear from you.

Steve Rodgers MS '96 is doing clinical research in the Medical Affairs Department at Becton Dickinson in Franklin Lakes, New Jersey.

Kevin Agatstein '97 is married and living in Washington, DC, but moving to Boston in April 2011. He works as a consultant/ temporary executive for healthcare technology firms, with a focus on clinical analytics.

Donna Wrublewski '00 received her PhD from UMass Amherst in 2011. She is now a tenure-track faculty librarian at the University of Florida, working with the chemical sciences disciplines. She misses Senior House, but not the weather.

Jeb Keiper BS '99, MS '00 and **Sonja Sharpe PhD '04** checked in together. They met at the Japan Practice School station in 2000, were married in 2004, and as of today have two boys with a third due anytime now. Both work for pharmaceutical company GlaxoSmithKline outside of Philadelphia. Sonja works in the Chemical Engineering department on crystallization and process scale-up. Jeb left for the 'dark-side' after an MBA and works in R&D-based Business Development.

Anish Goel PhD '02 is now in the government working on foreign policy toward South Asia. It's a bit unconventional after ChemE, but it's constantly fascinating and fun.

Michelle Wu MSCEP '02 and her husband had a beautiful baby girl in January, 2011. She continues to work at Ximedica, a medical device contract company, as a Design Assurance manager.

Jeff I. Abes PhD '03 and wife Laurel just had their first child, Seth. Everyone is well.

Daniel Burkey PhD '03 recently joined the Chemical, Materials, and Biomolecular Engineering Department at the University of Connecticut as the assistant department head and professor-in-residence.

Stephanie Willerth '03 recently joined the faculty at the University of Victoria in British Columbia, where she is a professor of biomedical engineering. Her research involves developing biomaterial scaffolds for directing the differentiation of induced pluripotent stem cells. Her lab website can be found at the following address: http://www.engr.uvic.ca/~willerth/.

After graduating from MIT, **Arushi deFonseca '04** studied medicine at UCLA and is currently completing internal medicine training at Cedars-Sinai in Los Angeles, after which she will be starting a fellowship at UVA this June. She and her husband are excited to be moving to Charlottesville.

After working as a post-doc and staff member at Sandia National Laboratories for five years, **Ahmed Ismail PhD '05** moved to Aachen, Germany last year. Now he is a junior professor in the faculty of Mechanical Engineering at RWTH Aachen University. His research group focuses on using molecular simulations to study the thermodynamic and transport properties of biomass components.

Alexander Borschow '06 is currently a VP on equity derivatives sales desk at BNP Paribas in NYC. He's been in New York for the past 5 years, enjoying everything it has to offer.

"I recently got engaged to Adam Sokolnicki (Tufts ChemE '03) whom I met on one of Professor Hamel's summer internships. Thanks JFH!!"

- Kate Madden '08

Ingrid Lawhorn '06 is a third-year PhD student in Clifford Wang's lab at Stanford… about halfway there! Her first two years post-MIT were spent in the Bronx teaching high school science in TFA.

Andrea Dooley Thompson '06 and her husband live in Ann Arbor, MI, where she is pursuing an MD/PhD at the University of Michigan. They celebrated the birth of their daughter Ava in September 2010.

Ben Fine SM '06 is married to Ronit Ossip, a frequent visitor to Tang Hall residence from Toronto. He is a physician: Resident in Radiology at the University of Toronto.

Patrick Underhill PhD '06, assistant professor in the Department of Chemical and Biological Engineering at Rensselaer Polytechnic Institute, has won a prestigious Faculty Early Career Development Award (CAREER) from the National Science Foundation (NSF).

Bernat Olle PhD '07 was a member of the founding team of Follica Biosciences, a company developing a novel therapy for hair growth. He was also a member of the founding team of Vedanta Biosciences, a company developing a novel class of immunotherapies, where he is currently the acting VP of Operations.

During the 2008 Senior Course X Dinner, **Jessica Lam '08** went up in front of the entire graduating class and Course X faculty to receive a $25 Starbucks gift card for the following 3 superlatives she had won: 1. Most likely to get arrested, 2. Most likely to be late for class, and 3. Most likely to be found all night in Lab the night before a project is due. Since then, she has graduated and is doing a D.Phil. in physical and theoretical chemistry at Oxford, where she is trying to build a quantum computer made of ultra cold molecules.

Kate Madden '08 recently got engaged to Adam Sokolnicki (Tufts ChemE '03) whom she met on one of Professor Hamel's summer internships. Thanks JFH!!

After five years, **Julie Shi '08** is engaged to her fellow classmate and best friend, Sergio Haro (Course 6-2, class of '08). They'll be married in NYC this coming fall.

Ellen Eileen Sojka '08 was recently promoted to Consultant at Stroud Consulting, a management and operations consulting firm.

Brian Mickus PhD '09 is currently working in the Exploratory and Translational Sciences Department at Merck Research Labs in West Point, PA, supporting biologics and vaccines production via molecular profiling. His wife, Kathleen, is a nurse at Grand View Hospital. They are getting used to caring for their house and yard. Brian enjoyed seeing classmates at AIChE in Salt Lake City this last November and generally misses playing Prof. Deen and other roles in the Christmas skits. ◊

Solar Cells on Paper

Professor Karen Gleason '82 (center), with MIT President Susan Hockfield (left), demonstrates Eni-supported research in "paper thin photovoltaics" for Paolo Scaroni, (right) CEO of the Italian energy company Eni following a press conference discussing the work of the Eni-MIT Alliance on the MIT campus on October 18, 2010. Scaroni was at MIT to review the progress of the Eni-MIT Alliance, a 5-year research program focused on advanced solar research and other strategic research central to Eni's core business functions.

Course X Alumni Reception at AIChE

At the annual AIChE meeting in Salt Lake City in November 2010, Course X alumni and friends from around the world gathered to mingle and network.

Donald Easson '61 reflects on his time in Course X

The most valuable aspect of my MIT Education: the confidence and awareness that it gave me regarding my ability to solve problems and to make a difference in each of my positions.

1. When I think of MIT, the particular person or group that most often comes to mind: I think most often of my Chemical Engineering Faculty especially TK Sherwood, a world-class Chemical Engineer that gave me my first exposure to Chemical Engineering, and taught us Chem. Engineering Stoichiometry. Ed Gilliland - my BS thesis advisor, Ed Merrill, Hoyt Hottel, Raymond Baddour, McAdams, Mike Moore, and my occasional encounter with Doc Lewis. An amazing group that made a very significant contribution to our world and the development the chemical engineering profession.
2. The last time I visited MIT: At Fluor in 1979, I initiated a Biotechnology Process Design Group. I came to Tech to meet with Charlie Cooney and Dan Wang. They kicked off this program with a Fermentation course in Greenville for fifteen process engineers. With their guidance, we developed a two year after-hours training curriculum with Clemson University to teach chemical engineers biology, microbiology, and biochemistry. This provided the basis for Fluor's Biotechnology Design Division.
3. I have been to Tech many times since then.
4. I kept in touch with a particular faculty member: In my frequent travels to Cambridge, I would keep in touch with Mike Moore. He was always helpful and provided guidance. I was sad to hear of his passing. I lost a colleague."

Adam Louis (Lou) Shrier SM '60

Alumnus Highlight

I am coming to the end of the first decade in my third career, which I greatly enjoy. As Adjunct Professor of International Affairs at Columbia University, I teach graduate courses on energy geopolitics, energy security, and energy industry to a remarkably diverse student body. I also teach and consult abroad, mostly in emerging economies in Eurasia, East Asia, the Middle East, and Africa. I supplement speaking English with basic French, Russian, and Arabic, and I am trying to work up the determination to learn Chinese.

Lou Shrier (right) in 1959. "A classmate from Columbia visited me in my room in Ashdown. His tie confirms that he had a real, paying job rather than struggling on a fellowship."

After receiving my doctorate in chemical engineering at Yale, I began a 25-year career with Exxon (now ExxonMobil) Corporation, where I held a variety of technical, commercial, and corporate positions. I started at the research and engineering subsidiary, but I decided early on that I needed to produce more than patents and publications, and 40 years ago I moved into operations and never looked back. I subsequently worked in the supply and transportation function, new business development, venture capital, and strategic planning.

My next career was prompted by the dramatic changes in the world economy following the end of the Cold War. I set off on my own and spent a dozen years as an international consultant working in countries in transition from central planning to market systems. This experience involved me in economic reform, privatization, technology transfer, and capacity development. It also provided me with a collection of memorable case studies with which I entertain and (I hope) enlighten my students.

I look back fondly at my experiences at MIT. I entered the graduate Course X program with an awesome group of students. Alongside a few MIT graduates, we were some 75 fresh chemical engineering graduates, each of us (it seemed) having been #1 or #2 at his undergraduate school. I left with newfound confidence and a willingness to take on any technical challenge by the disciplined application of unemotional logic. Over time I have found this much more valuable than the specific technical content of my courses.

Lou Shrier today with his own tie.

The Course X professors who made the greatest impression on me were:

Herman Meissner, who taught us how to systematically simplify and analyze reality. I have applied this thinking to problems ranging from regulating an industry to restructuring a company.

Alan Michaels, who introduced us to the fascinating world of interfacial phenomena. Time and again I have found surface science to be key in understanding physical processes.

Ed Merrill, who showed us the power of simple physical models for analyzing and simulating biological systems. While still doing technical work, I applied this approach as a diversion resulting in several biomedical patents.

Tom Sherwood, whose supervision of my one-semester master's degree project gave me a benchmark for what constitutes good mentoring. Later I found this view was shared by my postdoctoral advisor at Cambridge University, Peter Danckwerts '48, another Course X alum.

Only after leaving MIT did I have the privilege of working with Doc Lewis, who had a longtime consulting contract with Exxon. Over a two-year period I could look forward to stimulating monthly sessions with Doc, at which I could bring up any technical subject and be rewarded a lucid and insightful commentary. A rare treat indeed!

Alumnus Highlight

Michael Modell BS ’60, MS ’61, ScD ’64

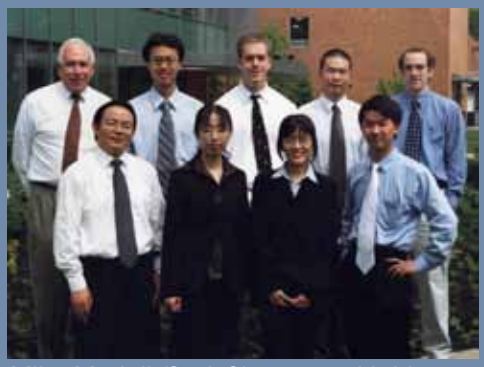
After finishing my BS degree in 3.5 years and completing a semester of Practice School (Oak Ridge National Laboratory), I was assigned to be a teaching assistant to Bob Reid in 10.40, the graduate level course in Thermodynamics, which I had not yet taken. We were using Bob’s notes and Bob’s problems, and I was expected to solve the problems (or see if there was a solution) two weeks before they were assigned to the class. Any problem that I could solve in less than four hours was considered too easy and therefore thrown out. Near the end of the semester, Bob informed me that he expected me to take the PhD qualifiers at the next offering – which was a month away. I objected vigorously since I had taken only three Course X graduate courses. Bob said “not to worry; if you fail, I’ll see to it that you can take them again.” I’m not sure how it happened, but I passed.

The following week, Ed Gilliland (then Department Head) called me in and asked what I expected to do next semester. I said, “search for a PhD thesis and take some more graduate courses.” He asked if I would like to be an instructor. I asked, “how much does it pay?” He said, “$500 per month” and I said, “Yes!” since I was already married and broke. Ed asked, “What would you like to teach?” I replied, “Anything but 10.31” (undergraduate Heat Transfer) since I had not yet taken 10.50 (the graduate level course in Transport Phenomena). Ed said, “good; you’re teaching 10.31; best way to learn it!” Talk about being thrown into the fire. Needless to say, I spent very little time searching for a thesis during that semester.

As I neared completion of my PhD thesis, Ed called me in again and asked if I would like to join the faculty as an assistant professor. It was the Sputnik era and the Gilliland Commission had been appointed by President Kennedy to provide incentives for increasing the nation’s supply of scientists and engineers so that we could get to the moon by 1970. One such incentive was being provided by the Ford Foundation: new PhDs who accepted teaching positions in science or engineering were to be forgiven their student loans at the rate of 20% per year. I had about $10,000 in loans, so the $2,000 per year forgiveness would make the $7,000 teaching salary look very attractive. Although I never intended to make teaching my career, I figured that teaching five years at MIT would be a great stepping stone. However, I didn’t expect it to take 16 years to step out.

My first teaching assignment was Director of the Practice School Station at American Cyanimid, in Bound Brook, NJ. When I returned to the Institute, I had a variety of teaching assignments, but the one I really wanted to reach was 10.60, the graduate course in Catalysis. (My PhD thesis had been in heterogeneous catalysis; I got to teaching it once, when Charlie Satterfield took a sabbatical.)

In 1968, Bob Reid asked if I would like to teach 10.40 (the graduate thermo course that all first year graduate students were required to take) and collaborate on turning his class notes into a graduate level thermo text. It sounded like a great opportunity since everywhere I turned, thermo seemed to play a central role. I figured that I couldn’t get a better chance to learn it thoroughly. Bob finished his half of the chapters in 6 months; it took me 4 years to complete my half. In midstream, Paul Gray, who was Dean of Engineering at the time, asked me to spend 6 months in Washington, working with the National Science Board on a report to Congress on the state of health of engineering. By that time (1971), we had reached the moon, NASA’s budget had been cut, and 3% of engineers were out of work. (The norm for the previous ten years had been virtually zero.) It was during that stay in DC that I decided I would never work for the Government because I couldn’t handle a martini for lunch, let alone the five or six that some of the Assistant Directors of NSF would put away.



Mike Modell (far left) poses with his Practice School Station students in the spring of 2005.

After the thermo book was finished, Bob Reid gave me another great opportunity. He recommended me for a position on the NASA Advisory Committee working on life support systems in space. That group was working on funding development of technologies to recycle water and oxygen on a hypothetical colony of 200 people on the moon. That was my first introduction to thinking green. I was exposed to a very broad variety of environmental technologies, and the arduous process of taking a thought to bench scale and then onto pilot scale.

In 1973, NASA awarded me some funds for an MIT project to do some exploratory research on finding a way to convert human wastes to a useable fuel, namely methane. Ed Gilliland had always said the Fischer-Tropsch process for converting coal to liquid fuels would never be economical because it required a high temperature endotherm (gasification to CO_2 and H_2) while generating a low temperature exotherm (methanation). If ever to make that process practical, one had to find a low temperature, single stage process to go directly from coal to methane.

Together with a superb graduate student, Sanjay Amin ScD ’75, we embarked on a search for that low temperature methanation route. Using my background in catalysis, we devised a bench scale batch system using a high pressure autoclave to try to convert glucose to methane. (The sponsor, NASA, was interested in feces, not coal; we compromised on glucose as a model compound for the carbohydrates that make up 50% of feces.) We added a mixture of heterogeneous catalysts to the autoclave that was partially filled with water, evacuated the air space, heated to a predefined temperature, and then injected a solution of glucose in water. We started at 50° C and found no

reaction. We continued increasing temperature until we began to observe reaction, which occurred at about 150° C. The major reaction was char formation; the catalysts had very little effect. As we increased temperature, we began to observe some liquid and gaseous products, but the rate of char formation increased considerably. By 300° C (still a low temperature by Gilliland's definition), 50% of the glucose was converted to char, 40% to organic liquids, and 10% to gases (CO_2, CO, H_2, CH_4, C_2H_6) within 5 minutes. The results of the next experiment, at 350° C, were startling. The amount of char had decreased significantly!

I had written the chapter on criticality for the thermo text and had studied a number of processes with supercritical CO_2. I knew that we were approaching the critical temperature of water and that the properties of water were changing rapidly with increasing temperature, so we decided to make the next run at 375° C, right around the critical temperature of water. We also decided to adjust the initial amount of water in the autoclave so that we would hit the critical pressure as well as the critical temperature (i.e., water would be a supercritical fluid). Low and behold, the products contained no char. Sanjay ran a broad spectrum of organics, including cellulose, maple sawdust, and polyethylene. In no case did we observe any char. MIT patented the process in 1977. That work subsequently led to the invention of a process for oxidizing waste under the conditions where water is a supercritical fluid, which I named SCWO for Supercritical Water Oxidation.

In 1980, I took a leave of absence from MIT to start a company to develop the SCWO process (against the advice of Jim Wei, the Department Head at the time, who thought I should take a sabbatical and write another book). By 1999, the last time I looked, there were about 500 papers per year on some aspect of SCWO. Although there are only a few installations of commercial scale SCWO plants that have been built to date, the effort to commercialize SCWO continues today – but that is another story for another time. ◊

Support Staff Retirement

In the fall of 2010, after 32 years of supporting the faculty and students of MIT Chemical Engineering, **Craig Abernethy** retired. Since his start in 1978, Craig has worked with Professors Satterfield, Manning, Armstrong, Barton, McRae, Griffith, and Love, along with enumerable students and researchers. He found his work "stressful but positive," and will miss working day to day with Course X students.

What Craig said he will not miss is the 2.5 hour daily commute to Cambridge from his home in Providence.

A veteran of the US Navy, Craig recalled typing Ed Merrill's *Polymer Science* book and Charles Satterfield's *Heterogeneous Catalysis in Practice* on an IBM Selectric typewriter.

Craig's retirement plans included a month's worth of sleep, then some volunteering. His advice to those of us still working is to "live long and retire early." ◊

Alumnus Highlight

Warren K. Lewis ‘05

Warren K. “Doc” Lewis came to MIT in 1901 as an early student of the new program in chemical engineering. He received his PhD in Physical Chemistry from the University of Breslau, Germany in 1908. Doc joined MIT as an assistant professor in 1910, and was promoted to professor in 1914. He was the first head of the newly formed Chemical Engineering Department from 1920 to 1929. After this, he devoted himself to teaching, research, and consulting, and remained an influential member of the department until his death in 1975 at the age of 92.

Doc Lewis was a superb educator. His text, Principles of Chemical Engineering, written with William Walker and William McAdams in 1923, first defined the discipline and provided the basis for quantitative calculations of unit operations. His lectures are legendary for their combination of beautifully organized material and Socratic exchanges with his students. As an inventor, he contributed to the fields of industrial stoichiometry and industrial chemistry with over 80 patents. He also pioneered the use of the fluidized bed, which led to catalytic cracking processes in refining.

Doc’s numerous honors and awards include the President’s Medal of Science, the President’s Medal of Merit, and the John Fritz Medal. He was honored by the AIChE with the establishment of the Warren K. Lewis Award, which recognizes outstanding educators in chemical engineering.

Alumni remember “Doc” Lewis

A giant of the chemical engineering field was also larger than life in the classroom

Bert Grosselfinger SB ’38 SM ’39
In my sophomore class in 1935, Doc Lewis wrote “One Liter Air” on the board. He declined to give any additional information and , “What do I have?” Nobody had an acceptable answer: one liter N_2 and one liter O_2, etc.

John D. McGrew ’51
After 60 years, my remembrances of life at MIT are somewhat fuzzy, but one scene I see like it was yesterday.

Dr. Warren K. Lewis was on emeritus status but still teaching a few classes (Stoiciometry). I was in a class being conducted by Professor Merrill when the classroom door suddenly opened and in came Dr. Lewis, unannounced. He strode to the head of the class, pointed to an unfortunate student and asked, “You, why do you believe in the atomic theory?” After a short pause, the student selected stammered, “The atomic bomb.”

Wrong answer, definitely wrong. The correct answer, per Dr. Lewis, is the Law of Combining Weights. After this brief outburst, Professor Lewis retired as suddenly as he had arrived and Professor Merrill continued with his lecture.

Cliff Sayre ’52
BRESLAU
Doc told some of us one time about how he came to teach at MIT. As a student, shortly before he was to graduate, the head of the department stopped him in the hall. “Warren, what are you going to do after you graduate?”

Doc responded, “Well, I think I will probably go home and help work the family farm.”

“Warren, you know there is a scholarship for study in Germany that I and many of the faculty think you might want to apply for.”

Doc hesitated. The head went on, “Why don’t you write your father and see what he thinks?” Doc did and his father advised him to apply and if he got it fine. If not, he could always come home.

"They don't make them like Warren K. Lewis anymore."
- John D. McGrew '51

"Well", Doc said, "You know me. If I try for something I want to get it. So I learned the names of all the committee members that awarded that scholarship along with their likes and dislikes. Every chance I got I would buttonhole one of them and chat him up. Sure enough I got the scholarship. I went to Breslau got my doctorate and came back and started teaching at MIT and have been here ever since."

Doc went on. "Several years later I found myself on the committee that awarded the scholarship. I could not resist. I looked back over the minutes of their previous meetings. Sure enough, there it was, the entry on the day that I was awarded that scholarship. It read 'Today the Breslau scholarship is awarded to Warren Kendall Lewis, he being the only applicant.'"

LEWIS AND GILLILAND

I was sitting in Doc's office. Ed Merrill came to the door. He said, "I have something I want to run by Gilliland and he suggested that you might want to join us." Doc turned to me and said, "Sayre, come along. Keep your eyes and ears open and your mouth shut and you might learn something." We went into Gilliland's office and Merrill went to the board and wrote a couple of lines describing his problem. Almost before he had finished talking Gilliland got up and took the chalk from him and wrote about three brief lines on the board with a solution. We all got up and filed out of the office and as we did Doc put his arm around my shoulders and loud enough for all to hear said, "You know, Sayre, sometimes I think there is such a thing as being too goddam smart." I could hardly disagree. Ed Gilliland was one of the smartest men I have ever known.

Curt Beck MS '53

When I asked Doc Lewis to explain a concept, he frowned at me, called me "Old Horse," and answered my question.

Harlan M. Walker '55

I had a class with Doc Lewis in my junior year. When Doc asked Frank Leitz to explain something, and he spieled, Doc said, "Leitz, you're just fartin' a gale of wind!"

Joe Neville SB '56, SM '65

One lecture I remember was given by Doc Lewis when he showed up as a surprise guest in my class in 1956. We were about to graduate and figuring out which job offer to accept. Doc came in to offer some guidance and declared we should not accept a job as a salesman as it would be a waste of our education. He was very firm on this point and spent the whole lecture contrasting the good things we could do as compared to being a salesman. It was not until some of us got together afterwards that we realized his whole lecture consisted of him trying to sell us the idea of going to Practice School. I have to admit he was a good salesman.

Bill Peter MS '58

In one of the classes I had with Warren K. Lewis, he wrote on the blackboard: "Part of it + the rest of it = all of it." ◊

Course X: The Next Generation

Victor, the one-year-old son of Jason Kralj PhD '06 and wife Marianne Terrot PhD '07, reviews the fall 2010 edition of MIT Chemical Engineering Alumni News.

In Memoriam

James L. Baird ’40

1917-2010

James L. Baird, age 93, of Concord, Mass. passed away suddenly on Tuesday, Dec. 7, 2010 at his residence. Born in Richmond, NH on Nov. 9, 1917, he was the son of the late Howard L. and Marion (Homan) Baird. Educated in Richmond and Winchester, NH, he attended and graduated from MIT, earning a bachelor of science degree in chemical engineering in 1940. During his time at MIT, Jim was active in crew, was a member of Alpha Tau Omega Fraternity and was selected by the faculty of MIT in his sophomore year to be a member of Epsilon Pi Tau, a worldwide academic honorary engineering society (72 years later his granddaughter Margaret was also selected to join the elite ranks of that same society). From his time at MIT, Jim became passionate about education. Jim’s life was transformed by his opportunity to attend MIT as a student. He generously gave back to MIT and other educational institutions in gratitude and recognition that education can be an enduring legacy of blessing to the world. He also generously supported the education of his grandchildren.

Upon his graduation, Jim began a career as a chemical engineer with Artisan Industries of , Massachusetts. Jim worked as a key member of the Artisan Family for over 70 years, still working on the board of directors and helping to mentor young engineers until he was almost 93-years-old. At the time that Jim stepped down from the board in June of 2010, James Donavan, son of the founder of Artisan Industries wrote of Jim: “Of all the brilliant men who have worked at Artisan, he is still one of the most brilliant and has been of great help to us right up to the present. He will be missed by all who knew him as a gentle and humble man whose brilliance as a scientist and researcher was respected by colleagues and students at Artisan Industries, at MIT, Northeastern and in the worldwide engineering profession. Inventor of numerous patents, many of his contributions to the science and technology fields are still to be calculated. A Fellow of the American Institute of Chemical Engineers and The American Oil Chemical Society, Jim received numerous Life-Time Achievement awards from a variety of Engineering societies and organizations.”

Jim was an active and devoted MIT alumnus. He remained in lifelong contact with many of his colleagues and alumni. He served in leadership positions for his class and chaired the reunion committees, and was an alumni council officer multiple times. He also served as chair of the Cardinal and Gray Society. A generous giver, among other gifts Jim supported the MIT Crew and several graduate fellowships for the Koch School of Chemical Engineering Practice.

He is survived by his children, Thomas L. Baird of Keene, NH; Jayne E. Gilmore of Raymond, NH; Stephen H. Baird of Jamaica Plain, MA; and Rev. David H. Baird of North Grosvenor Dale, CT. He is also survived by eight grandchildren, four great-grandchildren, and a sister Elizabeth Brown. He was pre-deceased by his beloved Melissa and by a grandson, Daniel Baird. For online tribute and guestbook visit www.concordfuneral.com/

Rafael C. Laredo ’44

1920-2010

Rafael Caturla Laredo of Southbury died on Nov. 22, 2010, after suffering a stroke. He was 90. He was born in Havana, Cuba, on May 20, 1920, a son of the late Octavio and Silvia Laredo. He left Cuba at age 15 and was educated in the United States, where he attended Fork Union Military Academy and was a 1944 graduate of MIT in chemical engineering.

Rafael’s career started with Monsanto Chemicals, and then with Liquid Carbonic, where he was responsible for building and managing dry ice plants in Mexico City, Mexico; Havana, Cuba; and Santiago, Chile. He traveled extensively and conducted business throughout the Caribbean and Latin America. In 1964 he moved to the U.S. with George Meyer Co., and then with the Diversey Chemical Corp. A sailor, he loved days on the Long Island Sound in the family catboat.

Rafael is survived by his wife of 64 years, Ann Duncan Laredo; his brother, Octavio Laredo; his daughter, Susan Thompson and her husband, Bill of Westport; his son, Rafael Laredo and his wife, Vicky of Daphne, Ala.; and his son, Andrew Laredo and his wife, Marianne of Westport. He is also survived by his grandchildren, Karolina Laredo of Westport, Christina Muro of Durham, Willie Thompson of Brooklyn, Marisa Beauchemin of Providence; his great-granddaughter, Julia Muro; several nieces and nephews; and by a close Thompson family friend, Sarah St. Jacques and her son, Slade of Providence, RI.

David R. Miller SM ’48

1923-2010

Dr. David Radford Miller died on Sunday, October 24, 2010 at age 87. He was born on September 29, 1923 in Webster Groves, Missouri to parents Hazel and Oliver Miller.

He is survived by his wife of 60 years, Betty Jean Jackson Miller. Surviving children are Susan, Gregory, Jeffrey, and Alison. Susan and husband Mark Fitzwilliam are parents of Ben and Joe, and live in Wheat Ridge, Colorado. Gregory and wife Diana Lee Crumby Miller are parents of Kari (married to James Shepherd), Eric, Grant, and Scott, and live in Houston, Texas. Jeffrey and wife Lilli Ann Barrios Miller are parents of Jonathan, Jennifer, Daniel, Catherine, and Christina, and also live in Houston, Texas. Alison Miller Clay lives with her children Kyle, Bryn, and Kenyan in Vacaville, California. Also surviving David is his sister, Dr. Marian Hamburg of San Diego, California and her two daughters, Jean Hamburg of Marblehead, Massachusetts, and Jackie Hamburg Pepper of Mountain View, California. Gloria Jackson Barcomb is a surviving sister-in-law residing in Nixa, Missouri.

Dr. Miller attended schools in Webster Groves, Missouri, and graduated from Washington University with a degree in Chemical Engineering in 1944. He served during World War II as Lt. JG in the Navy aboard the destroyer USS Robinson. After the war, he obtained a master’s degree in chemical engineering from MIT and went to work at Monsanto Chemical Company in Dayton, Ohio and St. Louis, Missouri. Feeling the need for further education in his research field he obtained a PhD in chemical engineering from Purdue University. He returned to Monsanto’s division of Chemical and Nutritional research in St. Louis for 35 years. Projects he was involved with were: Skydrol, a fire-resistant hydraulic fluid for airplane use and Alimet, a poultry food supplement. After taking early retirement, he became active as a volunteer with the Braille Institute in Kirkwood, Missouri, where he established a website for those who worked with the blind. Also, he developed and maintained a website for his destroyer, the USS Robinson and actively participated in the yearly reunions. Other meaningful activities to Dave during these years were: weekly church meetings as a member of the “Nifty Fifties”- a repair and fix-up group which coupled work with fellowship, monthly meetings with high school buddies, weekly meetings with Monsanto friends, lunch and local trips with a neighborhood group “The Silver Robbins”, made his retirement years pleasant ones. He loved sailing trips to the BVI, and yearly family reunions with his children and grandchildren. He considered his family his greatest blessing and their well-being uppermost in his mind.

John “Jack” T. McKenna, Jr ’50

1927-2010

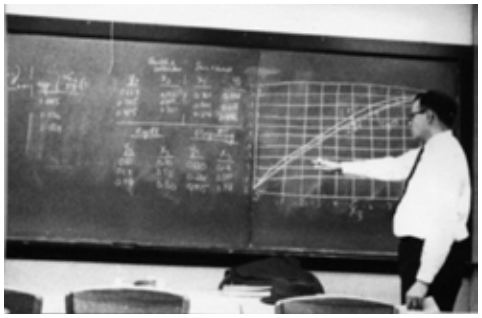
John T. McKenna passed away peacefully on November 29, 2010 at age 83, after a long battle with cancer. He was one of two children born to the late John Thomas Sr. and Agnes McKenna and was the beloved husband of Dorothy (Mahoney) McKenna for 58 years. Jack will forever be remembered by his devoted sister Peggy, loving children Mary Lou, John, Steven, and Carol McKenna, and treasured grandchildren Sean Whalen, Christopher McKenna, and Kaitlyn McKenna. Jack is also mourned by his brother-in-law Russell Quinn and sister-in-law Joan Mahoney, along with countless other friends and family. Notes of comfort and sympathy may be sent to Jack’s family at www.MorrisOConnorBlute.com.

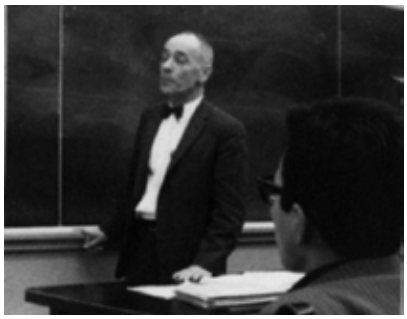
Course X: Then and Now

(left) At the November 8, 2010 MIT Alumni Reception at AIChE’s annual meeting in Salt Lake City, Prof. S. Patrick Walton ScD ’02 found himself on the pages of the fall 2010 edition of *XCurrents*.

Blast from the Past

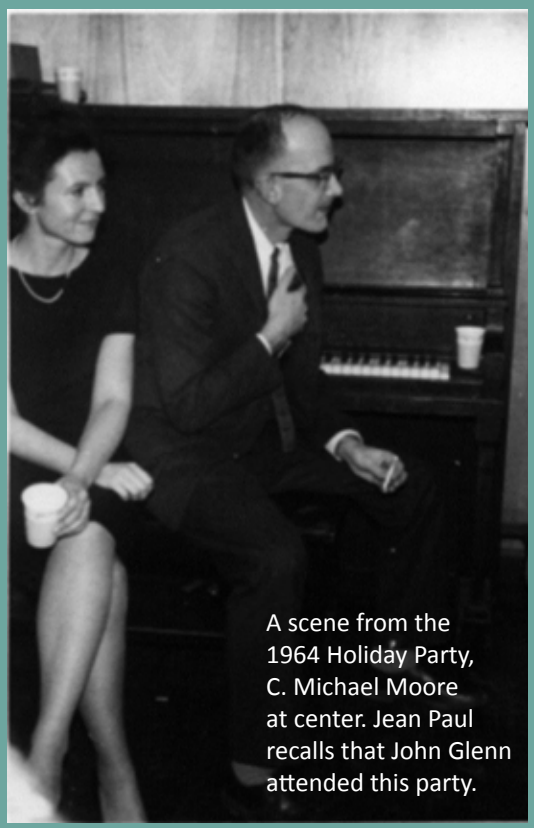
This edition's gallery is courtesy of a fellow alumnus, Jean Paul Viennois SM '65. Are you or anyone you know in them? Or do you have a photo you'd like to share? Email *chemealum@mit.edu*.


Top row and bottom left and right: scenes from a 1964 thermodynamic course with Professor Vieth. Bottom center: 1964 industrial chemistry course with Professor Meissner.

(above) **Jean Paul** also sent in a piece of Practice School history: On this photo taken at Bayway Refinery station in 1965, you can see from left to right: Vinod Jhunjhunwala ("pardon me Vinod if I misspell your name"), Charles Lablonde, Douglas Steele, Jean Paul Viennois, X, Donald Chase, Station director (I do not remember his name), Shailesh Parekh, assistant director Mike Modell.



A scene from the 1964 Holiday Party, C. Michael Moore at center. Jean Paul recalls that John Glenn attended this party.

Thank you to all the sharp-eyed alumni and staff who recognized the photos from the Spring 2010 edition!

(to the right) Bill Schmitt PhD '03 writes: The man in the center with the white shirt is S. Patrick Walton ScD '02. He's an Assistant Professor at Michigan State University and worked for Gregory Stephanopoulos while I was at MIT. He could probably ID the other people in that picture, who look familiar to me.

Janet Fischer, ChemE's former academic administrator and current graduate administrator in EECS remembers well: Top right corner is Timothy Finnegan, Stephanie Stine, Pat Walton, and I can't remember the names of the MSCEP students (the one of the end is Mike something)!

(to the left) Janet Fischer: Top left corner is from a TGIF that I organized for a few years, featuring carnival games.
Throwing the ball is Patrick Gwynne....Joshua Taylor is to the immediate right (always wore the Red Sox hat backwards)!

(to the right) Bill Schmitt PhD '03 writes: The man second from left with the shark on his shirt is Matthew Dyer Ph.D. '00 - he worked for George Stephanopoulos. He surely would know the others in the picture... he was quant developer @ Citadel Investments last I heard.

Janet Fischer: Middle bottom picture...know them all very well and am 100% certain! Joanna Dinaro, Matthew Dyer, Jane Ciebien, and Brian Phenix (in the sweatshirt)

Fred Calhoun MSCEP '95, Ph.D '00 also recognizes friends: The photo has several contemporaries of mine in it. From L to R: Joanna DiNaro (Tester PhD), Matthew Dyer (Barton PhD), Jane Ciebien (Cohen PhD), ??? – I recognize but don't remember the name of the person wearing the Duke sweatshirt. He either entered the graduate program in the fall of 1993 or served as TA for one of the core classes in the fall of 1993. Now that I think more, I think he TAed 10.40 in 1993 and was a member of the Tester group.

Fred Schmidt '61 shares: I recognize the big catalytic cracker in the background. That was in the ESSO (now EXXON) Bayway Refinery just south of Elizabeth, NJ. You can still see it by going to Google Maps / Street View.
I was in NJ from September 1962 to January 1963. I recognize John Sherman as one of the instructors. That class of the Practice School was split in two and we spent half the semester here to experience continuous processing operations and half at a batch processing plant at American Cyanamid in Bound Brook, NJ.
I was placed with three others to share a rather nice duplex in Plainfield, which was about halfway between the two stations. My roommate was Tony Mack'62. The other bedroom was shared by the Koch twins; Bill'62 and Dave'62.
Bill, his twin brother, is famous in the sports world for having won the America's Cup in 1992. When Bill stopped by shortly afterwards to speak to the Washington DC Alumni Club about the technical aspects of that triumph, I took my 2 sons. The 4 of us had a long chat afterwards, which really really impressed my sons. The only downside was that Bill told my sons a couple stories 'out of school' about me for that semester in NJ.

Professor Emeritus Marcus Karel PhD '60 recognized someone as well: In the section "Blasts from the past" on page 33 there is a picture of 8 students, with a request for identification of person 4th from the left, who is believed to be James L.Go Class of 63. Jimmie Go did his thesis with me (Title " Respiration control of bananas by packaging methods.") I saw Jimmie last in 1981 in Manila, where he is CEO of a fairly large industrial "empire" owned largely by his family. My eyesight as well as my memory are not what they used to be, but the person does look like Jimmie.

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Spring 2011 Chemical Engineering Dept. Seminar Schedule

All Seminars are Fridays at 3pm in 66-110, unless otherwise noted.

3/18 Designing Novel Devices with Chemically Vapor Deposited Polymers by Karen K. Gleason, Chemical Engineering, MIT

4/8 Network Dynamics and Intracellular Feedback Control by Christopher V. Rao, University of Illinois at Urbana-Champaign

*4/15 FRONTIERS OF BIOTECHNOLOGY LECTURE by
Tillman U. Gerngross, Engineering, Dartmouth College
(Location: 34-101)

4/22 Multiscale Simulation for Biomolecular Engineering: Protein Allostery and Deconstruction of Cellulose Microfibril by Jhih-Wei Chu, University of California - Berkeley

*4/29 WARREN K. LEWIS LECTURE by
Gary S. Calabrese, Director, Photovoltaic Technologies &
Senior Vice President, Corning, Inc.

*5/6 ALAN S. MICHAELS LECTURE by
Cato T. Laurencin, Chemical Engineering & Dean of School of Medicine, University of Connecticut
(Location 32-123)

**For more information on major lectures, go to page 26.*

Under the Dome: Come Explore MIT!

Saturday, April 30, 2011

a day-long, campus-wide open house that also kicks off the Cambridge Science Festival, which runs from April 30–May 8. For more information, go to http://mit150.mit.edu/open-house