TUFTS UNIVERSITY CHEMISTRY DEPARTMENT

Chem Notes

on www

SPRING 1995

CHAIRMAN'S CORNER

David Walt

Dramatic changes have occurred since our last newsletter. The Michael Laboratories have been vacated and construction crews have arrived. The Rockwell Library has been relocated to the Pearson Annex and research groups and faculty have been distributed throughout the Pearson Building. As you can imagine, squeezing the entire department into a single building has created some logistical problems and crowding, however, the end result will be worth it. Sometime this fall, the Michael Building will be reopened containing six brand new modern research laboratories with accompanying faculty office and support infrastructure, such as new heating, ventilation, and cooling. If all goes according to plan, it should be a spectacular facility that will enhance the research and teaching effort tremendously. In conjunction with the Michael renovations, Pearson will be getting a new handicapped entrance, new elevator, and receiving area.

Funding for this initial stage of the renovation project has come from a $2 million Challenge Grant from the National Science Foundation. This past summer we launched the Campaign for Chemistry in which we sought matching funding from a variety of foundations, corporations and alumni. I am pleased to announce that the Keck Foundation has contributed $350,000 for the construction of a Materials Research Laboratory as part of the Michael renovations. The DuPont Corporation has contributed $105,000 toward partial construction

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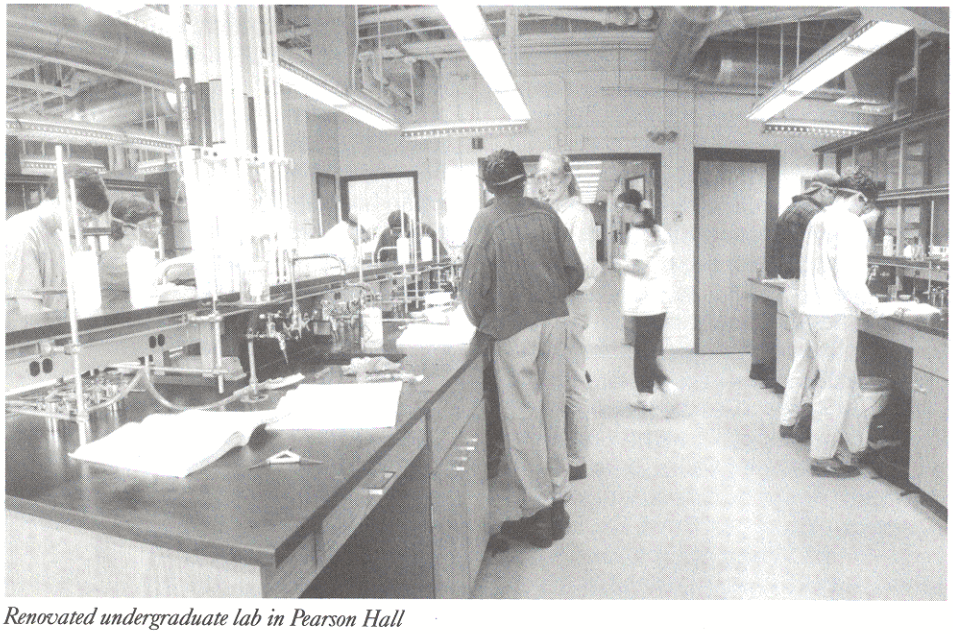

Renovated undergraduate lab in Pearson Hall

Renovation Update

Steven Bryant, Department Manager

The much needed renovation of the Pearson-Michael Chemistry Complex is under way. Phase I of the project was started on April 1, 1995. The initiative for this renovation was begun two years ago with the application for an NSF grant by the Chemistry Department and its Chair, David Walt. The project was set in motion by the granting of a $2 million NSF Academic Infrastructure Challenge Grant in 1993. This grant matches, dollar for dollar, contributions from other individuals, companies, and foundations. In January, 1995 the W. M. Keck Foundation gave $350,000 for the renovation of what will now be the W. M. Keck Foundation Laboratory in Materials Chemistry in the Michael Research Building. The Keck foundation is located in Los Angeles and is among the nation's twenty largest private foundations. It is perhaps best known for its funding for the Keck Telescope in Hawaii. These grants are peer reviewed and highly competitive. This donation will be matched by the NSF challenge grant. The push to secure funding for this project has included personal involvement of President John DiBiaggio and Vice President Mel Bernstein as well as members of the Tufts Chemistry Advising Group.

Phase IA of the work includes the complete gutting of the Michael Building and its renovation into a state of the art facility for research. All building infrastructure will be replaced and significantly upgraded, including HVAC, fume hoods and controls, electric, and water service.

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GRADUATE STUDENT CORNER

Richard Breitkopf

Weeks before our last holiday party, our chairman, Professor Walt, issued a challenge to the graduate students. If we could come up with skits satirizing faculty members, he would see to it that a posse of selected faculty return the favor. For weeks the graduate students labored over this task — by putting it off. Finally, nearly a week before the gala event, we concocted an idea whose humor and references could escape no person whose upbringing involved a healthy dosage of vitamin C, milk, and Disney films. The concept involved inserting our favorite professors into the Snow White story as whichever character we saw fit. The wicked queen, a.k.a. David Walt, chided Snow White, a.k.a. Ed Harlan, for drinking in the lab and then tried to poison her by adding methylene blue to her coffee. The dwarfs, dressed in lab coats and safety glasses sang a few "hi-hos" while shaking volumetric flasks. The skit was concluded with Professor Illinger as Prince Charming, not courting Snow White for her apparent beauty, but for her uncanny ability to collaborate with other researchers. The scene ended with the two shaking hands instead of kissing, and part II of the Graduate Student skits began; "gag" holiday gifts were presented to the faculty. Highlights included presentation of a toy dictaphone to Professor Haas so he could remember his appointments — only he forgot to show up at the party! Professor Utz, having gained acclaim for his color slide presentation in his departmental seminar, was given the necessary tools for hours of extensive graphic design, and Crayola was more than happy to provide him with the necessary technology. And if the latest state-of-the-art color graphics was not impressive enough for a room full of chemists, Professor Robbat would receive the most complicated piece of instrumentation ever to grace the halls of Pearson. . .the AL-1000. We advertised it as a GC-FID-AED-AT&T-MS-XRF-ICP-NSF-M&M-FBI-CIA-AL-1000, capable of analyzing any type of sample and analyte to the part per billion level while taking your phone messages, but only Professor Robbat has ever seen it work. We suspect that he is saving this precious system for the Instrumental class in the fall, but we will believe it when we see it!

And so it came time for the professors' parody of the graduate students, and our chair came dressed to kill with an entire overhead presentation. A day in the life of a graduate student was accurately portrayed with many illustrative examples. While all of the laboratory equipment necessary to conduct the diverse research of the graduate student body was displayed, the most important instrument was found right in the front office: the coffee pot! Next, our gourmet eating habits could not be overlooked so credit was given where credit was due — to the vending machines! Lastly, the strict adherence to laboratory safety procedures was acknowledged by showing photographed evidence that a graduate student could in fact balance a cup of coffee in his left hand while running a distillation with his right. This result was deemed powerful, and is currently being written up anonymously to appear in next month's issue of *Journal of the American Chemical Society.*

A good time was had by all, and it was resolved that the entertainment aspect of the party would remain for many department holiday parties to come!

CFAST: A New Center at Tufts Chemistry

Andrea Henderson-Kinney

The problems related to the effective testing and monitoring of chemical compounds in-situ are of such complexity and magnitude as to warrant a partnership approach by industry, academe, and government. Recognizing this the Chemistry Department at Tufts University has expanded its already significant research programs by establishing the Center for Field Analytical Studies and Technology (CFAST). CFAST provides an opportunity for Tufts, other academic institutions, and private and public developers to form cooperatively a vigorous research organization that will address new developments in field analytical technologies and acceptance of that technology by the regulatory and user communities.

CFAST helps to bridge impediments to technology implementations by working with users, government, developers, and other centers of excellence to bring technology forward. CFAST helps developers (public and private) with acceptance of new technology by: 1) helping prepare them to meet the challenges of on-site measurement and 2) correctly positioning their instrumentation through field demonstrations with the appropriate audiences. Users, such as site owners and engineering companies, are provided information on recent developments in new field-based tools through educational programs held at CFAST that emphasize the gains in acceptance the center is making. CFAST understands that government agencies at the State and Federal levels are an important part of the acceptance of new technologies. To address concerns and make government groups aware of new field-based analytical technologies and methods developed by CFAST and collaborative partners, the center

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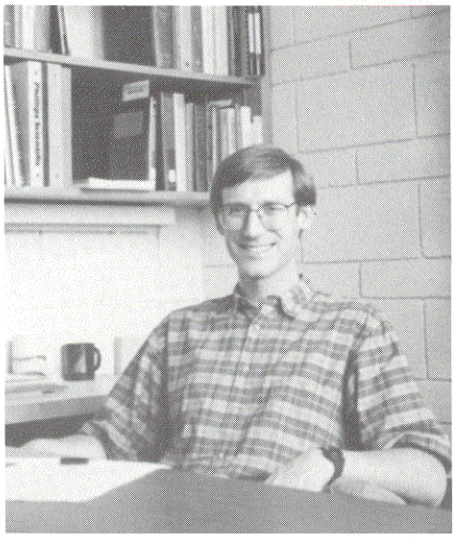
FACULTY PROFILE

Arthur L. Utz, Assistant Professor



Dr. Utz grew up in Illinois and received a B.S. degree from Bradley University. His graduate thesis work with Professor F. F. Crim at the University of Wisconsin-Madison focused on developing and applying time-resolved laser-based spectroscopic techniques to unravel the intramolecular and collisional dynamics of highly vibrationally excited polyatomic molecules. He then moved to the Massachusetts Institute of Technology where he worked with Professor S. T. Ceyer studying the dynamics and mechanisms of catalytic hydrogenation reactions on nickel surfaces. That work uncovered the unique catalytic reactivity of hydrogen dissolved within the catalyst bulk and resolved a decades-old controversy over the source of reactive hydrogen in commercial nickel hydrogenation catalysts. Dr. Utz joins the Tufts Department of Chemistry this fall. His teaching and research interests are in the areas of physical, materials, and surface chemistry.

His research at Tufts will focus on understanding and exploiting the reactivity of vibrationally and translationally energized gas phase molecules incident on a surface. This work impacts on many current and central issues in materials chemistry. Since energetic molecules are frequently the most reactive species in a chemical environment, they play key roles in industrial processes ranging from heterogeneous catalysis to chemical vapor deposition and thin film growth in the microelectronics, optics, and coatings industries. Despite the importance of energized molecules in gas-surface reactions, few studies have quantified their reactivity or identified the key factors that control their reactivity at the molecular level. Such an understanding is crucial not only for the successful modeling of existing processes, but also for predicting reactivity and designing new catalytic and materials deposition processes.

Dr. Utz's research will employ powerful new experimental techniques to uncover the molecular basis for reactivity at a gas-surface interface. A supersonic expansion will create a directed beam of molecules with a narrow, yet tunable, translational energy distribution. Light from an infrared laser intersects this molecular beam and excites many of the molecules to a single vibrational state. These molecules, with their well- defined energies, then pass into an ultrahigh vacuum chamber and interact with the surface of interest. Surface analytical techniques will identify and quantify the gas-surface reaction products. By observing how the reaction probability varies as a function of translational energy and vibrational state, one can infer which nuclear motions most effectively promote reactivity and construct a detailed molecular picture of the reaction mechanism. Initial experimental systems include understanding the rate limiting step in the heterogeneously catalyzed steam reforming of methane, which is the chief industrial preparation for hydrogen gas, and developing techniques that exploit the unique reactivity of energetic gas phase molecules to grow single-crystal diamond thin films epitaxially for use in the optics and microelectronics industry.

Dr. Utz also is actively involved in chemical education. This fall, he will teach an introductory graduate-level quantum mechanics course. He looks forward to developing and teaching other undergraduate- and graduate-level courses in materials and physical chemistry in the future.

Doctoral Degrees Awarded (1994-95)

Venetka Ivanova Agayn (Walt), "Preparation and Application of Fiber-Optic Chemical Sensors for Bioprocess and Environmental Monitoring."

Zhaohui Liu (Kounaves), "Development of an Enzyme Based Biosensor for Organonitriles."

Yi Wang (Brush), "Studies on the Practical Applications and Mechanism of Nitrilase Calalyzed Reactions."

MASTER'S DEGREES AWARDED

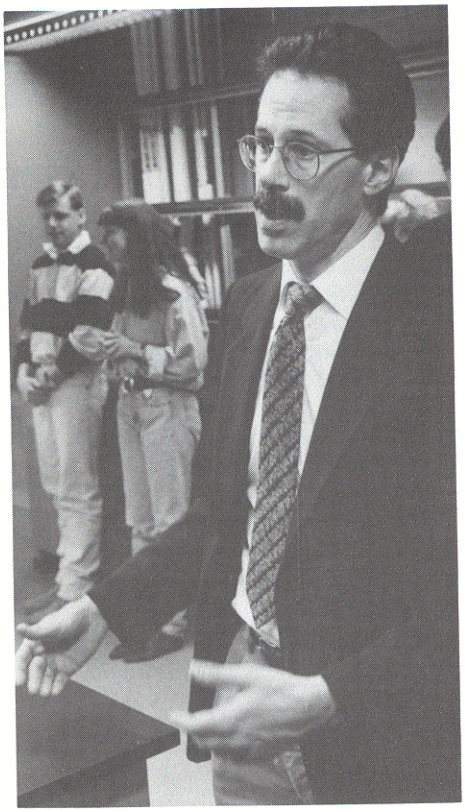
Gavin J. Button
Amy T. Esslinger
Eric S. Farbman
Pamela R. Hallock
Karen J. Jansen
Patricia A. Novelli
Glen R. Pearlstein
Dominique Savinelli

BACHELOR'S DEGREES AWARDED

Valerie AuYeung
Ezra J. Barzilay
Stacey M. Campbaell
Stacy E. Foran
Hyun-Sook J. Lee
Laurel A. Manzelli
Jonathan M. Rheaume
Hrishikesh Srinivasan
Matthew S. Sur
Charles N. Tetzlaff
Tommaso A. Vannelli
Christoph F. Weise

Chairman's Corner: continued from page 1

of an environmental research laboratory. In addition, we have received numerous contributions from many of you as well as other friends of the department (see Contributors List in this newsletter). Although construction is imminent, funding is far from complete. Our original hope was to complete the West Wing of Pearson as part of the initial renovation. This renovation would upgrade our medium-sized lecture room to an electronic classroom and modernize the Physical Chemistry Teaching laboratory, a relic of the Pearson Building — vintage 1926. At this juncture we are truly under the gun in the sense that additional funding must be secured by late spring or the construction project will end with the completion of Michael. Therefore, I encourage all of you who have not contributed to this project to do so as soon as possible so that we can achieve our goal of 100 percent participation from alumni. A variety of naming opportunities exist. The Development Office is also able to structure multi-year gifts that can help alleviate the difficulty of a single contribution. This renovation is a unique opportunity for the department to modernize its facilities. The Chemistry Department has changed dramatically in the last decade with many curriculum innovations, an expanded graduate program and new faculty. Our greatest weakness now is the facility. We hope that each and every one of you will contribute to our effort to provide an improved learning environment for the present and future generations of Tufts Chemistry students.



Professor David Walt

As part of the construction completion we are anticipating a rededication of the Michael Building during Alumni Weekend this coming fall. The department is planning a variety of activities for the dedication including a symposium, poster session, and reception. We hope to see all of you there to meet old friends and colleagues as well as share in the celebration. We will keep you posted as to the schedule of events. Finally, I am extremely pleased to announce that we have hired Dr. Clemens Richert who will be joining the department in fall 1995 as an assistant professor. Dr. Richert received a Ph.D. in Human Biology from the University of Munich and a second Ph.D. in Organic Chemistry from the ETH in Zurich under the direction of Professor Steven Benner. Dr. Richert's research interests lie in the area of biomedical chemistry, one of the developing strategic foci in the department. He will be teaching courses in both Organic Chemistry and Biochemistry.

Tufts Chemistry on the WEB!

The Department of Chemistry now has a home page on the World Wide Web. The World Wide Web, sometimes referred to as "WWW" or even "the Web," is a hypertext form from which one can access most of the Internet through pointers, called "links," to various sites all over the world. To gain access to the Tufts Web Page you need to be connected to the Internet. You also need a Web Browser, software which enables you to access the Web from your computer. There are many types of browsers of which Mosaic is one. The Tufts Chemistry homepage offers department information such as course listings, degree requirements, faculty, the graduate program, links to other chemistry resources, and will soon feature faculty research information as well! The hope is that this resource will not only provide information for prospective graduate students and alumni, but will eventually contain within it, links to other valuable chemistry resources throughout the world. To gain access to the page from a Web browser, use the URL (Uniform Resource Locator)

htpp://www.tufts.edu/departments/chemistry/index.html

The page is currently maintained by Steph Tai, one of our graduate students. For more information or suggestions, you can contact either Steph Tai or Professor Kounaves at the e-mail addresses:

stai@diamond.tufts.edu or kounaves@pearl.tufts.edu

From the Curriculum Committee:

Mary Jane Shultz

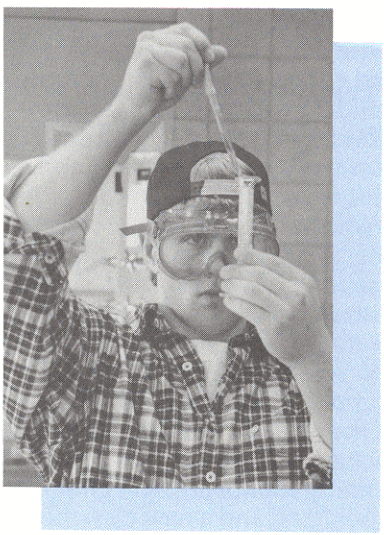
There has been major activity in the department's curriculum since the last newsletter. Some of the highlights:

- The PEW foundation funded two projects, one a challenge program (more about that below) for introductory teaching and the other a bridge project between the department and local high schools.
- We have received a major boost from the National Science Foundation for development and implementation of a new course, *Materials Chemistry* (see separate article in this newsletter).

In addition to this funding activity

- The introductory laboratory facilities have been relocated and received a much needed face lift.
- We have introduced a new major in biochemistry.
- We have totally revised the sequencing of topics in the introductory program and strengthened our advising in this area.

Current efforts are focused on improving instrumentation for introductory students.



Funding

Pew. The major aim of this university-wide program was to promote greater ties between local secondary schools and the university as well as to encourage beginning college students to become involved in science and teaching. Twelve students, three secondary school teachers, and one member of the department were involved in the chemistry portion of the project. This project included a challenge grant for development of an introductory course featuring student involvement. The challenge was met with the successful materials chemistry grant which has brought some much-needed equipment into the beginning courses.

Materials Chemistry. This course relies on modern materials such as thin films, batteries, polymers, superconductors, and solid state devices to teach the fundamental concepts including structure, bonding, electronegativity, and size. The course, funded by the National Science Foundation is running for the first time this spring. The aim was to bring a more relevant course to the engineering students as well as to encourage Arts and Sciences students to take chemistry. The enrollment reflects this mix with two-thirds of the students being engineering majors and one-third arts and sciences students. A separate article in this newsletter contains more details about the course. Keep an eye on this column for reports of further developments.

Other News

Face Lift. The introductory laboratories received a much needed face lift including installation of a greatly expanded ventilation system. The design retains the three module system for greater flexibility in scheduling sections, but adds an openness that makes the room feel spacious and bright. This facility has arrived just in time for our growing enrollments (introductory courses have nearly doubled over the last three years!) and we now have sections running in morning blocks as well as Saturdays. A thank you to all who made this renovation possible!

Biochemistry Major. The chemistry and biology departments have collaborated on the introduction of a new major to Tufts: biochemistry. This is a challenging major which features courses from both departments including organic, physical, and biochemistry in the chemistry department; genetics, molecular biology, and biochemistry in biology. In addition, it requires calculus and physics. Despite the rigor of the major, early indications are that this will be a very popular major which will prepare students for careers in growth areas such as biomedical research and biotechnology as well as more traditional medically-related fields. While other institutions have a biochemistry major, most do not feature the intimate collaboration between chemistry and biology of the Tufts major.

Introductory. We revised our sequencing of material in the introductory courses to reflect a molecular level understanding of interactions and reactions. This revision allows courses such as materials chemistry to replace a more traditionally structured, first-semester course. In keeping with the current national spotlight on introductory teaching, there are numerous creative ideas percolating among the faculty for alternative methods for building a foundation in chemistry. This column will keep you posted on results.

Current Focus. We are currently focusing on improvement of the instrumentation available for our introductory students and welcome any contribution that anyone might make. Many funding programs require or encourage a matching contribution, either financial or in equipment. If you are replacing an older model or shifting direction and no longer need a piece of equipment, contact the department. It could be just what we need.

Keep your eye on this column to see what has blossomed and what is brewing next year!

Mary Jane Shultz

NEW CHEMISTRY COURSE

"'Explain all that,' said the mock turtle. 'No, no! The adventures first,' said the gryphon in an impatient tone. 'Explanations take such a dreadful time.'"

Lewis Carroll.

What does Lewis Carroll have to do with chemistry? For one thing, this quotation is the inspiration for the newest curricular innovation in the introductory sequence at Tufts. To arrive at this point, we asked the question: "What makes science so exciting to those of us who are professional scientists?" In many cases, the answer is that it is the discovery, the quest for a consistent understanding. With this insight, it seems very natural that if we want our courses to excite students, we should let them in on this joy. But how? Ah, this is the essence of the problem. We certainly cannot expect students to evolve through the centuries of progress in chemical understanding in a single semester or even a year, yet to build a foundation we feel that they must.

This is the dilemma that Professor Shultz set out to solve when she began to put together our newest course, *Materials Chemistry.* Given a major boost by funding from the National Science Foundation and the Pew Charitable Trusts, Shultz and graduate student Steve Baldelli put together a course which is driven by natural curiosity generated by observation of fascinating material properties. With a little guidance, the instinctive "Why?" question leads students to uncover the images and models that form the base for modern chemistry. For example, the course begins by examining a Ni-Ti alloy called nitinol. This material has the fascinating property that allows it to be easily bent into any shape, but when warmed up returns to its original shape. It has numerous practical applications such as making eyeglass frames, safety valves in showers, or as an artery unclogger. The "memory" is due to a phase transition and the two phases have some very different properties. One is soft and easily bendable, the other hard and very difficult to bend.

Counter intuitively, it is the low temperature phase of nitinol that is soft. Asking why the phases have this hard-soft property leads to an investigation of the bendability of other metals. Concentrating on wires made from metals in the first transition series, we first look at Ni and Ti, the components of nitinol. Ti is hard, Ni soft. Taking a hint from the nitinol memory property being a phase transition, the natural first conjecture is that this difference between Ni and Ti is due to the different crystal structures in the two metals. Examination of Zn, which has the same crystal structure as Ti, shatters that thought since Zn is *very* soft and bendable. Expanding to other first transition series metals reveals that those early in the series are all hard while those later in the series are soft. Voila! It is clear that the structure that underlies the periodic table holds the key to the answer to this question. So students now study atomic structure, but with a goal in mind. In addition to bendability, they investigate more quantifiable properties like conductivity and density. With this investigation, the class "discovers" that all these properties have a periodic pattern. Keeping their eyes on the prize, studying atomic structure becomes very meaningful.

This is the flavor of the course which is running for the first time this spring with forty students in three laboratory sections. Comparative testing and follow up will be used to determine if this more goal-oriented approach leads to a deeper understanding and greater interest in chemistry. Keep an eye on this column; we will update you on the results.

CFAST, continued from page 2

actively participates in various governmental environmental programs that are designed to encourage the use of innovative field technologies. This establishes a relationship between the center and the regulatory community which can be utilized by CFAST members to better understand the environmental marketplace.

CFAST currently is conducting research in fiber optic sensors for a variety of environmental pollutants, electrochemical and TDGC/MS detection of metals and organics in-situ, and rapid on-site field characterization utilizing new approaches for detection of organics and metals portable TDGC-MS, ICP/AE, XRF, and MIP/MS. CFAST collaborates with other Tufts departments to initiate studies on understanding and improving policy that impede technology acceptance by the user communities. This will ultimately bring CFAST technology into wider use for studies that impact human health decisions.

Renovation Update, continued from page 1

Also included in the plans are provisions for substantial energy and water conservation. Central recirculating chilled water and vacuum ejector pumps save thousands of gallons of water a day while advanced fume hood controls save on heating and cooling energy. The completed building will house six research laboratories, a major instrumentation facility, and a support and preparation laboratory for undergraduate laboratory courses. Phase one, to be completed in mid-October, also includes a new main entrance with an accessible ramp and a new heating and cooling plant for the Pearson building. Phase IB is the complete renovation of the west end of the Pearson building. This will include two new research labs, an undergraduate physical chemistry laboratory, and a new classroom. This phase will begin as soon as funding becomes available.