Dear Alumni and Friends,

This has been a year of both good news and bad news for the Department of Mechanical Engineering at Stanford. We will share both with you in this issue of ME News.

The Year in Review
We began the academic year with a celebration of the chairmanship endowed to the Department of Mechanical Engineering by the Robert Bosch Corporation. The highlight of the celebration was a panel discussion entitled “Sustainable Transportation for the Future.” The discussion was moderated by Moira Gunn, host of National Public Radio’s Tech Nation and BioTech Nation and a member of our Advisory Council. Panelists included: Larry Burns, General Motors; Elon Musk, Tesla Motors and SpaceX; Horst Muenzel, Robert Bosch LLC; and, Stanford Professors Christopher Edwards, Department of Mechanical Engineering, and, Stephen Schneider, Department of Biology and Woods Institute for the Environment.

The exhilaration of the Bosch celebration was tempered a few weeks later by the rapid onset of the economic downturn. Like many other schools and departments, we are still feeling its effects. Endowment payouts have been reduced and, accordingly, unrestricted expenditures are down. Then, in March, we lost our good friend and colleague Kosuke Ishii. Professor Ishii’s influence reached an impressive number of people during his careers in industry and academia. He will be greatly missed by the Stanford community and by many others worldwide.

In spite of the current economic climate, we received permission and recently launched a search for a new junior faculty position. This is a broad search which encompasses the following areas: controls, energy systems and sciences, biomechanics and biological transport, propulsion systems and sciences, and nanotechnology. More information is available on our website under faculty open positions.

A few weeks ago, under my colleague Stacey Bent’s (Chemical Engineering) and my leadership, the U.S. Department of Energy granted to Stanford an Energy Frontier Research Center (EFRC) Award for research in the nanostructuring of materials for efficiency in energy conversion. This center brings together Stanford faculty from the departments of Physics, Materials Science, Chemical Engineering and Mechanical Engineering. Through our collaborative efforts, we anticipate that we will advance the field of energy sciences.

Featured Articles
The first three articles in this issue describe programs conceptualized by members of our department’s Design Group: Stanford CarLab, d.school, and Product Realization Network. We are enthusiastic about the collaborative and innovative approaches these programs bring to traditional mechanical engineering activities. The fourth article features Professor Reginald Mitchell’s breakthrough research in making “clean” coal.

Looking Ahead
Despite the setbacks we experienced last year, we are confident that our recent research initiatives will allow the department to retain its strong standing in the engineering and scientific communities. These, combined with new faculty hiring, will ensure that the department is well positioned for the future. In keeping with this forward looking approach, the department has a fresh new look via our website at http://me.stanford.edu. We invite you to visit us on the web to learn more about the exciting things that are happening in the department.

Fritz Prinz
R. H. Adams Professor and Robert Bosch Chair
Silicon Valley might not be the first location that comes to mind when discussing the future of the automobile. However, drive-by-wire technology, autonomous driving, human machine interface, and electric vehicles are just a few examples of how Stanford and the surrounding high tech community are changing traditional automotive thinking.

Combining Automotive Research on Campus and Beyond
The Stanford CarLab came to life in 2007 when founding Professors Chris Gerdes (Mechanical Engineering-Design), Sebastian Thrun (Computer Science), and Cliff Nass (Communication) decided to combine their research in the fields of automotive controls, autonomous driving, and human machine interaction. Their mission is to re-envision the automobile, focusing on safety, performance, sustainability and enjoyment. Pursuing this mission, the Stanford CarLab connects academic researchers with industry experts, and educates students in the field of interdisciplinary automotive thinking.

Stanford CarLab Affiliates Program
In bringing academia and industry together, Stanford CarLab offers industry partners an affiliates program with direct access to automotive research on campus, including lectures, networking events, and research facilities. Currently, Stanford CarLab has six industrial affiliates: Bosch, Honda, Mercedes-Benz, Nissan, Toyota, and Volkswagen. However, this is not the end of Stanford CarLab’s growth potential; there are several local companies that are just starting to engage themselves with the automotive world and would like to partner with established organizations and research facilities.

The main goal of the Stanford CarLab community is to establish collaboration among affiliated companies to demonstrate automotive technology with a distinct Silicon Valley flavor. Sven Beiker, formerly with BMW for 13 years, joined Stanford in 2008 as CarLab’s executive director to manage the research community’s operations.

ME 302 – The Future of the Automobile
The new seminar class ME 302 – The Future of the Automobile, educates students in the field of interdisciplinary automotive thinking. This class is open to students in business, law, and the social sciences, as well as to engineering students. In this seminar setting, students discuss automotive topics introduced by lectures from industry experts and academic researchers. At the end of the quarter, students present their own visions of the future of the automobile in a poster session.

Instructors chose the seminar setting to discuss automotive topics as an interdisciplinary group and in order to open the field to industry partners. This allows students to get first-hand experience from automotive experts, and to gain a unique insight into industry’s specific thinking, reasoning, and challenges. In return, industry experts receive value from direct interaction with students, including fresh ideas and unbiased opinions.

In Spring 2009, the topic selected for the class was autonomous driving and how to motivate students to become engaged with that technology. Throughout the quarter, students and industry partners met once a week for discussion sessions and lectures from experts in the field. At the end of the quarter, they met one last time to discuss poster scenarios for autonomous driving and to talk about the future of individual mobility. Relationships established between students and industry partners will continue beyond the class through further workshops and summer internships.

Future Home of Stanford CarLab
One pivotal event that breathed life into Stanford CarLab initially was the $5.75 million research fund donated by Volkswagen. Of this donation, $2 million is directed towards a new research facility that will house the Volkswagen Automotive Innovation Laboratory (vAIL). This state-of-the-art automotive research facility will be equipped with car lifts, mechanical and electrical equipment, a driving simulator, and a seminar room, allowing all automotive research on campus to be housed under one roof. As a result, the Stanford Racing Team (winner of the 2005 DARPA Grand Challenge), the Stanford Solar Car Project, the Dynamic Design Laboratory (DDL) with two drive-by-wire vehicles, and the Communication between Humans and Interactive Media (CHIMe) team will all be located in the same 8,000 sq. ft. building after the grand opening in Fall 2009.
The “d.school”

Bernard Roth

The “d.school,” officially The Hasso Plattner Institute of Design at Stanford, is the brainchild of Mechanical Engineering Professor David Kelley. It was created five years ago by Kelley and George Kembel (BSME ’94, MSE ’97), who is the d.school’s executive director, and an interdisciplinary group of faculty that included strong representation from the Mechanical Engineering Department (Professors Beach, Kelley, Leifer and Roth). The hallmark of the d.school is interdisciplinary collaboration by both faculty and students, and the use of project-based education to actively engage students in the process of learning and creating. Our goal is to teach students who trust their analytical and critical sides to also trust their creative side. We do this by teaching them a methodology that allows for creative leaps to happen and, by experiencing this in multiple projects, they gain confidence in their creative ability.

The d.school offers courses that are taken by mainly graduate students. We have students from all of Stanford’s schools (Business, Earth Sciences, Education, Engineering, Humanities and Sciences, Law, and Medicine). These courses form the elective parts of students’ normal degree programs. However, they often are the transformative experience of a student’s life at Stanford, and it is not uncommon for students to change their career trajectory after a d.school experience.

In our short history, we have already had many outstanding successes in a host of courses. The Entrepreneurial Design for Extreme Affordability student teams have designed products that have improved the lives of hundreds of thousands of people in Myanmar, India, Nepal, Ethiopia, Rwanda and Mexico (http://extreme.stanford.edu). The students in the Creating Infectious Action course have influenced corporate practices at Wal-Mart, Disney, Jet Blue, Cooliris and several financial institutions. The Design Thinking Boot Camp class and the Media + Design class have changed programming at WNYC, New York Public Radio. Due to space limitations, I have mentioned here only some of our courses. The d.school web page (http://dschool.stanford.edu) is a good source for more complete information.

We also run ongoing projects that we call labs. The two largest ones are the K-12 Lab and the Environments Collaborative. The K-12 Lab designs classroom spaces and curricula for teaching design thinking and creative problem solving. We have a strong presence in three schools in the Bay Area and at the Henry Ford Learning Institute in Dearborn, Michigan. We are also building relationships with schools in Bhutan and in India. The Environments Collaborative innovates ways to use physical spaces to run multiple design classes, and designs and builds physical environments to support d.school activities.

Design tends to be a synthesis process that is holistic and iterative rather than reductive and linear. Analytical thinking tends to be reductive and linear. Traditional engineering education tends to educate people in analytic thinking and direct them so that they become specialists. Design thinking and projects can be used to broaden the way students approach problems, and give them new perspectives on the types of problems they can solve.

Design thinking, which is a process-oriented way of thinking, is a problem solving modality that is independent of the usual technical specialties. This gives rise to what we call “T” shaped people. The broad horizontal bar in the “T” represents a person’s process ability, which extends far beyond their own depth area, and the vertical bar represents analytical thinking and their area of technical expertise. We find that teams composed of people with these abilities tend to be highly effective regardless of the specific domain of the problem under consideration. Students find working on such teams an empowering experience that gives them confidence in their creative abilities and efficacy in the world; this is what the d.school is all about.

In Memoriam, Kosuke “Kos” Ishii (1957-2009)

Professor Kosuke Ishii died March 2, 2009 after a short stay at Good Samaritan Hospital in Los Gatos, California. He was 51.

After earning his Stanford doctorate in mechanical engineering in 1987, Professor Ishii held a faculty position at Ohio State University until he returned to Stanford to join the ME faculty in 1994. As director of the Manufacturing Modeling Laboratory (MML), Professor Ishii was interested in improving the design and manufacturability of products ranging from airplanes to water pumps. Although based in the Mechanical Engineering Department, MML worked closely with both the Management Science and Engineering Department and the Stanford Graduate School of Business, reflecting Ishii’s interdisciplinary approach. He was perhaps best known among students and colleagues for his course ME317, which presented students with the opportunity to work directly with industry partners across the world to take on real-world design problems.

The course also offered a distance-learning component for non-Stanford students, sponsored by their employers. Through online classes, and supplemented by quarterly visits from Professor Ishii, students in Japan and Mexico worked on their own company’s design challenges. In 1996 and again in 2008, Professor Ishii was awarded the General Motors outstanding Distance Learning Faculty Award. Also in 2008, Professor Ishii was awarded the Ruth and Joel Spira Outstanding Design Educator Award from the American Society of Mechanical Engineers.

From the Stanford Report
The Product Realization Network at Stanford

Dave Beach

Organization
The Product Realization Network (PRN) is a joint organization between the School of Engineering and the Graduate School of Business. We are dedicated to enriching the product development and manufacturing education of Stanford students through innovative courses, a mentorship program, site visits and a certificate program. The PRN has created a network of faculty, staff and industry professionals to educate students interested in creating products and the organizations that make them possible. We are led by faculty directors Dave Beach, Robert C. Carlson and James Patell; and by John Aney, executive director. http://www.stanford.edu/group/prn

New Courses
Mechanical Engineering (ME) 233, Crossing the Entrepreneurial Gap, offers students who bring concepts and prototypes, from any Stanford class, an education in redesign to reduce manufacturing risk, discovery and relationship building with manufacturing vendors, information about protecting intellectual property, and system planning to bring their products to pilot run. Examples of products going to market from ME 233, Autumn 2008, include Peter Frykman’s drip irrigation system for subsistence farm families (design and prototype born in ME 206, Entrepreneurial Design for Extreme Affordability), and Patricia McHale’s combined bicycle fender and seat cover (design and prototype born in ME 203, Design and Manufacturing). ME 233 is the creation of Marc Theeuwes, Consulting Associate Professor in ME. Mr. Theeuwes’ experience includes 15 years of product development and operations at Gracenote, Nokia, Lifechart, OmniCell, J&J/Lifescan, and Syva. He is a Stanford ME alumnus. http://www.stanford.edu/class/me233

Management Science and Engineering (MS&E) 264, Sustainable Product Development and Manufacturing, uses case studies to examine strategic decisions and best practices, and discusses the contribution of sustainable products and operational practices to the firm’s competitive advantage and operational efficiency. Students learn how to integrate traditional product and process development requirements with those of the environment and society using life cycle analysis techniques. They also learn how to account for environmental and resource externalities. MS&E 264 resulted from PRN supported research. The sustainability research team consists of Management Science and Engineering Professors Robert Carlson, Dariush Rafinejad, and Feryal Erthun; and Ph.D. candidates Tim Kraft, and Dan Greenia. MS&E 264 was taught for the first time in Autumn 2008 by Professor Rafinejad.

Manufacturing Mentor’s Program
The Manufacturing Mentor’s Program brings together experienced executives and managers with Stanford students interested in learning more about what is involved in taking a design or prototype into production at a pilot or mass production level. Mentors have extensive experience in global manufacturing operations and product design. Peter Muller and Dick Toepfer are representative of our 26 current mentors. Since 1985, Mr. Muller has been president and owner of Interform, an internationally acclaimed product development and design firm. His professional expertise is based on highly diversified international product development and design for major industries in Europe, U.S., most of Asia, and Australia. His clients range from large multinational corporations to start-up companies, including General Motors, General Electric Corporation, Ingersoll Rand, Kodak, LM Ericsson, Steelcase, Philips/CSA and Samsonite. Dick Toepfer has twenty years of engineering management, product development, and program management experience at the Aerospace Corporation, Autonetics, IBM, Measurex, Hewlett Packard, Kubota Graphics and Apple Computer. This includes development of computer systems and software, measurement and control instrumentation, and aerospace vehicle control. The Manufacturing Mentor’s Program is directed by Dr. Richard Reis, former director of the Alliance for Innovative Manufacturing.

Conclusion
The PRN is dedicated to helping students understand how to take their ideas and prototypes through development and manufacturing to the market, in a highly sustainable way. We are a student centric organization whose strength is born of our community. We are a fusion of students, faculty and professionals who are passionate about product design, manufacturing and Stanford University.
Making Clean Coal a Reality

Reginald E. Mitchell

Since coal is the most abundant and cheapest fuel in the world, it is used worldwide as an energy source. The United States has about 27% of all the coal in the world, and more than half of the electricity generated in the United States is produced using coal. Coal is vital to the economy of the United States and is likely to remain so for the next several decades.

Carbon dioxide (CO$_2$) is produced in all coal conversion processes. Since CO$_2$ emissions into the atmosphere exacerbate global warming, it is prudent to develop technologies that use coal in ways that facilitate CO$_2$ capture. Three research projects are underway under Professor Mitchell's supervision that provide for CO$_2$ capture during coal-based electric power generation. The models will be used to determine conditions for optimum DCFC performance.

In chemical looping combustion (CLC) technology, a metal oxide is used to provide the oxygen that reacts with the fuel. As a result, combustion in oxygen can be realized without the energy penalty of an air separation unit. In the CLC scheme being developed, after the metal oxide is reduced via reaction with coal gasification products in a reduction reactor, it is regenerated via reaction with air in an oxidation reactor. Coal conversion species and air never make direct contact in this two-reactor scheme: the gaseous stream leaving the reduction reactor is primarily CO$_2$ and H$_2$O. After energy is removed as heat from the stream and the water is condensed, the stream is ready for sequestration.

Clean coal technologies involving CO$_2$ capture and sequestration are required if global warming is to be abated. The clean coal technologies being investigated in Professor Mitchell's laboratory will permit coal to be used in ways that do not adversely impact the environment. Clean coal technology can become a reality.
Thomas P. Andriacchi  
H. R. Lissner Medal; in recognition for his significant contributions to bioengineering through creative and novel research that has identified relationships between gait biomechanics and joint pathologies which has led to the development of new medical devices and disease prevention strategies, unique bioengineering educational programs and extensive professional activities; Bioengineering Division of American Society of Mechanical Engineers, 2009.

Wei Cai  

Charbel Farhat  

Ronald K. Hanson  
Alfred C. Egerton Gold Medal; in recognition for his pioneering development of new laser-based spectroscopic diagnostics and their application to a variety of basic and practical combustion and propulsion problems, including contributions to fundamental databases of combustion chemistry and molecular spectroscopy; Combustion Institute, August 2008.

David M. Kelley  
Edison Achievement Award; for his pioneering contributions to the design of breakthrough products, services, and experiences for consumers, as well as his development of an innovative culture that has broad impact; Thomas Edison Papers of Rutgers University, April 1, 2009.

Parviz Moin  
Ludwig Prandtl Memorial Lecturer; Society for Applied Mathematics and Mechanics (GAMM), February 2009.  
Elected Fellow; American Institute of Aeronautics and Astronautics, 2009.  
Fluid Dynamics Award; for his outstanding career accomplishments and seminal contributions to turbulence research, particularly the advancement and application of large-eddy and direct simulation, and for leadership in the fluid mechanics community; American Institute of Aeronautics and Astronautics, 2009.  
Einstein Professorship; highest honor offered to overseas scientists; Chinese Academy of Sciences, 2009.

Kenneth J. Waldron  
Robert E. Abbott Award; for his innovative leadership and devoted service to the Division, the international design engineering community and the profession; Design Engineering Division of American Society of Mechanical Engineers, 2008.