

LEADERSHIP IN A TECHNOLOGICAL WORLD

THE KELLER CENTER
FOR INNOVATION IN ENGINEERING EDUCATION

2008

School of
Engineering
and Applied
Science



PRINCETON

LETTER FROM THE DIRECTOR



Welcome to *Leadership in a Technological World*, the second annual report from Princeton's Keller Center for Innovation in Engineering Education. Founded in 2005, the center continues to develop initiatives to fulfill its mission of preparing students—both those in engineering and those in other disciplines—to be leaders in a technological world.

Through Princeton's own stellar faculty in the School of Engineering and Applied Science as well as the distinguished visiting professors it brings to campus, the center has expanded its offerings of broad interest and interdisciplinary undergraduate courses that bring engineering into the core of the liberal arts curriculum. We continue to support the development of new course material at both the undergraduate and graduate level.

To provide insights into the societal applications of engineering, the center offers opportunities for students to engage in research, community service, and professional internships locally and around the world. In these contexts, students learn valuable problem-solving and leadership skills.

Entrepreneurship presents another avenue for Princeton students' creativity and desire to impact society in a meaningful way. In classes with known innovators, through competitions, with access to local business leaders, students discover models for their own careers.

These efforts are summarized in this report, and we invite you to visit our website to learn more about each of these areas.

Sharad Malik

Director, Keller Center for Innovation in Engineering Education
George Van Ness Lothrop Professor in Engineering

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MESSAGE FROM THE DEAN

In a short period of time, the Keller Center for Innovation in Engineering Education has made great strides in bringing engineering into the heart of a liberal arts education at Princeton, supporting and expanding the work of the School of Engineering and Applied Science.

This spring, the University is celebrating the Keller Center with a dedication event that underscores the urgent and vital nature of the center's mission. Distinguished guests, including alumni and deans from prominent engineering schools, and students will discuss a shared conviction that engineering helps shape the world around us and is therefore a cornerstone of any education for the 21st century.

The Keller Center's emphasis on leadership in a technology-driven world provides students a foundation for understanding and action as the University and the global community work toward building a sustainable society.

H. Vincent Poor *77

Dean, School of Engineering and Applied Science
Michael Henry Strater University Professor of
Electrical Engineering

KELLER CENTER DEDICATION EVENTS

Thursday, April 16, 2009

Keynote by **Norman R. Augustine '57 *59 H07**

Dean's Panel: Engineering and Society, moderated by **H. Vincent Poor *77**

Linda Abriola *79 *83, Dean, School of Engineering, Tufts University

David Munson Jr. *78 *79, Robert J. Vlasic Dean of Engineering,
College of Engineering, University of Michigan

James Plummer, Frederick Emmons Terman Dean, School of Engineering,
Stanford University

Subra Suresh, Dean, School of Engineering, Massachusetts Institute
of Technology

T. Kyle Vanderlick, Dean, School of Engineering and Applied Science,
Yale University

Student Projects: Engineering and a Sustainable Society

ENGINEERING EDUCATION

The Keller Center is committed to preparing all students—both engineers and non-engineers—to be leaders in a complex, technology-driven society. In keeping with this mission, we support the development and teaching of multidisciplinary courses and bring a number of visiting faculty to campus each year. The center also promotes hands-on initiatives to challenge students and complement their academic studies.



NEW EYES FOR THE WORLD: HANDS-ON OPTICAL ENGINEERING

Professor Claire Gmachl
EGR 103 (also ELE 102)



In Claire Gmachl's introductory course on optics, students design sophisticated technology, including optical wireless instant messaging systems, but they are learning much more than engineering.

"Broad knowledge is an essential asset for the global leaders that Princeton aims to educate," said Gmachl, professor of electrical engineering. "Engineering training goes hand-in-hand with problem-solving skills and training in persistence and resourcefulness."

Gmachl likes to begin her first lecture with a brief look at the things that students, including many non-engineers, will take away from "New Eyes for the World: Hands-On Optical Engineering." These range from the personal (it's good to know what to do when the pet hamster has gnawed through the Ethernet cable) to the practical (an understanding of technology is essential for a chief executive working with engineers) and the inspirational (trying something outside one's comfort zone promotes personal growth).

The course, which was designed by former postdoctoral fellow Daniel Wasserman, provides a laboratory-based engineering experience for students from disciplines beyond engineering.

While classics major and valedictorian Zachary Squire '08 did not plan to pursue a career in engineering, he credits the course and Gmachl with influencing his path at Princeton and beyond. After completing the course, Squire spent a summer working with Gmachl in the Mid-Infrared Technologies for Health and the Environment engineering research center. This work, he believes, helped him secure his position as a generalist associate with the investment firm D.E. Shaw & Co.

Phillip Braun '10 has also benefited from the course. A classics major, Braun enrolled in the course as a freshman and spent the following two summers working in Gmachl's lab. He hopes to apply this experience to his future employment.

"Clearly, this was not a path I had foreseen entering Princeton, but I am immensely pleased and appreciative that things have transpired as they have," he said.



ENERGY SOLUTIONS FOR THE NEXT CENTURY

**Professors Jay Benziger
and Yiguang Ju
EGR 228 (also CHE 228/MAE 228)**

Above left:
Jay Benziger
Above, far right:
Yiguang Ju

The global energy crisis presents one of the greatest engineering problems facing society, and “Energy Solutions for the Next Century” is designed to teach students to think critically about potential answers.

The course, which is one of two core courses in the new Program in Sustainable Energy, is taught by chemical engineering professor Jay Benziger and Yiguang Ju, associate professor of mechanical and aerospace engineering and director of the sustainable energy program.

Benziger and Ju begin by introducing students to current energy technology, including how fossil fuels are used for electricity, heat, and transportation, as well as the environmental impact of such practices. This understanding then serves as a springboard to explore the promises and pitfalls of alternative energy sources, including solar power, wind, biomass, and nuclear energy.

For example, students compare the efficiency of solar cells to biomass for the creation of electricity,

finding that solar cells are almost 10 times more efficient than biomass. Drawing on these types of investigations, the final project challenges students to debate whether a sustainable energy solution is possible, given today’s demographics.

“Now I have some ideas about the challenges facing each renewable energy source’s development and better perceptions of media-induced common myths about global warming and renewable energy,” said Yin Liang ’11, a chemical engineering major from China who is especially interested in how developing regions will cope with the environmental consequences of energy production and use.

Benziger said the goal is to have students leave the course with an understanding of how to evaluate different technologies in systematic, quantitative ways.

**“MY HOPE IS THAT
STUDENTS GO AWAY
KNOWING WHAT
QUESTIONS
TO ASK.”**

—JAY BENZIGER

COURSE DEVELOPMENT

Starting in 2008, the Keller Center initiated a program to provide financial support to faculty in the School of Engineering and Applied Science for the development of new courses and improvement of existing courses. This support enabled undergraduate and graduate students to assist in preparing new course material during the summer months.

MAE 206

Jeremy Kasdin,
Associate Professor,
Mechanical and Aero-
space Engineering



Introduction To Engineering Dynamics

Developing new experiments was a focus for enhancing this course. These experiments will complement a new textbook currently being developed. A model of the equipment was constructed and significant progress was made in developing the lab ideas and writing detailed instructions.

“Support from the Keller Center allowed us to develop new experiments that complement a new textbook that I’m writing for this course,” said Kasdin.

COS 432

Edward Felten,
Professor, Computer
Science and Public
Affairs



Information Security

A new programming component was designed with three main assignments. The first introduced students to Python (a language not required by any other class at Princeton). The second involved partially implementing the SSH transport layer to set up a secure connection between computers. The third involved establishing algorithms and implementing primality testing to generate random numbers.

“These new assignments received positive feedback from students. They enjoyed being able to implement a system (SSH) that they use on a daily basis,” Felten said.

OTHER FUNDED COURSES

Advanced Chemical Reactor Design CHE 504

Stanislav Shvartsman, Associate Professor, Chemical Engineering and the Lewis-Sigler Institute for Integrative Genomics

General Computer Science Algorithms and Data Structures COS 126, COS 226

Kevin Wayne, Senior Lecturer,
Computer Science

Computer Vision COS 429

Fei-Fei Li, Assistant Professor,
Computer Science

Computer Architecture ELE 475

Margaret Martonosi, Professor,
Electrical Engineering

Optimization ORF 307

Alexandre d’Aspremont, Assistant
Professor, Operations Research and
Financial Engineering

WRITING COURSES FOR GRADUATE STUDENTS

Supported by the Keller Center and the Graduate School, the Princeton Writing Program offers several non-credit, short courses in writing in science and engineering. Judith Swan, the assistant director for scientific and technical writing in the Princeton Writing Program, developed the courses. Divided into sections such as engineering, life sciences, and environmental sciences, the courses prepare graduate students for the task of publishing the results of their original work. “Reading and Writing about the Scientific Literature in English” introduces non-native English speakers to scientific literature both as readers and writers, and examines how the articles are constructed and interpreted. Taught by scientists, “Writing an Effective Scientific Research Article” shows students how to mount a persuasive argument while simultaneously communicating to readers precisely what was done, what it might mean, and why it all matters.

VISITING PROFESSORS



Professor John Danner

University of California–Berkeley Haas School of Business

Dean’s Visiting Professor in Entrepreneurship

During fall 2008, Danner taught “Special Topics in Entrepreneurship: Ventures to Address Global Challenges”(see page 15). At the University of California–Berkeley’s Haas School of Business, he teaches the core MBA course on entrepreneurship, as well as other graduate courses on business model innovation and strategies for startups. Danner also launched UC–Berkeley’s campus-wide undergraduate course on entrepreneurship and global poverty.



Professor Julian Lange '65

Babson College

Dean’s Visiting Professor in Entrepreneurship (2007–08)

In this inaugural position, Lange developed and ran a workshop series titled “Harnessing the Power of Entrepreneurship” and taught “Managing High-Growth Entrepreneurial Ventures” in spring 2008, which focused on the opportunities and challenges involved in the management of growth in entrepreneurial settings, both in smaller growing companies and larger corporations.



Louis Padulo

Visiting Lecturer, Mechanical and Aerospace Engineering

Padulo taught a freshman seminar, “Coming Up with New Products: The Art and Science of Product Design,” which presented the basic steps necessary for moving from a “cool idea” to a product sufficiently mature to launch an entrepreneurial startup. Padulo, president emeritus of Philadelphia’s University City Science Center, has helped develop numerous programs and companies, and has been honored for his work guiding many minorities and women into successful careers in engineering, science, and business.



Professor Umesh Vazirani

University of California–Berkeley

William R. Kenan Jr. Visiting Professor for Distinguished Teaching in Engineering and Applied Science

An educational innovator, Vazirani added the course “Quantum Physics, Qubits, and Nanoscience” to the Princeton curriculum. While the class served as an elementary introduction to quantum physics, it also targeted students interested in interdisciplinary areas such as nanoscience and quantum computing. The course covered standards such as tensor products and the Heisenberg uncertainty principle, as well as more advanced topics such as multi-particle systems and spin.



Karl Zaininger

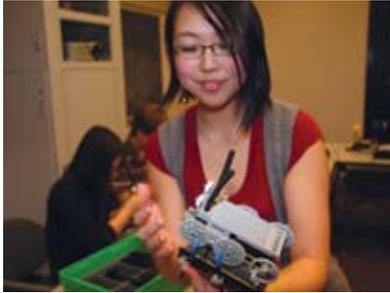
Global Technology Management Partnerships

Visiting Lecturer, Mechanical and Aerospace Engineering

Zaininger taught “Introduction to Innovation Process Management” in fall 2008, which exposed students to fundamental aspects of the technological innovation process: invention/concept development, intellectual property, business plan preparation, competitive intelligence, R&D management, and critical success factors, such as project management and commercialization.

HANDS-ON LEARNING

The Keller Center supports experiential learning opportunities that supplement classroom learning, enabling students to use their engineering skills in exciting ways and delve deeper into research questions. In 2008, these programs included PEEK, iGEM, and a one-day symposium on Félix Candela.



PEEK PROGRAM REACHES OUT TO SCHOOLS

Princeton Engineering Education for Kids (PEEK) is an undergraduate student group that teaches elementary school children about engineering using engaging activities and teaching aids, including Lego robotics kits. In 2008, PEEK began a two-year pilot program that places undergraduates in classrooms once a week for five weeks to establish connections with the students and provide an extended learning experience. PEEK, advised by Associate Professor of Mechanical and Aerospace Engineering Clarence Rowley '95, also holds additional educational events throughout the year, including an Alumni Day workshop for "little Tigers."

The International Genetically Engineered Machines (iGEM) program is a competition among students at some 40 campuses to engineer biological systems using "building blocks" of DNA. Eight undergraduates and two local high school students spent the summer of 2008 working with Ron Weiss, associate professor of electrical engineering, and postdoctoral research associate Priscilla Purnick. Starting with stem cells, the students designed a nerve cell that fires in response to a specific neurotransmitter. Ultimately, this work could provide a mechanism to create a network of nerve cells used to study learning and memory.

iGEM



CANDELA SYMPOSIUM

In the fall of 2008, students and faculty in the Department of Civil and Environmental Engineering launched a book and museum exhibition at the Princeton University Art Museum featuring models of the work of renowned architect and engineer Félix Candela. In conjunction with the events, a one-day symposium titled "Félix Candela: His Influence for Today and the Future" was held on October 11, featuring undergraduates, graduate students, and distinguished faculty and designers as the speakers.



ENGINEERING AND SOCIETY

THINKING GLOBALLY: INTERNSHIPS IN ASIA TRAIN STUDENTS FOR TODAY'S WORLD

Recognizing the importance of international experiences and perspectives, the Keller Center worked closely with Princeton in Asia to offer engineering internships in China and India in summer 2008.

By presenting undergraduates with technical, business, and personal challenges in this setting, the program aims to prepare them for leadership in a technology-driven, interdependent world.

"International exposure will become increasingly important for our students as technology continues to

eliminate communication and trade barriers across the world," said Keller Center Director Sharad Malik.

At InfoEdge, India's largest e-commerce company, outside New Delhi, **Nic Byrd '08** and **Megan Schoendorf '10** worked to improve the search capabilities used by the company's job search and professional networking sites, Naukri.com and Brijj.com, respectively. In Shanghai, **Gordon Scharf '09** and **Aditya Panda '10** worked on the design of a new Web application for Google.



"Personally, living in India was a huge learning experience. I learned how to handle a whole different set of challenges and problems than you would ever face living in Princeton, N.J."

Megan Schoendorf '10
Electrical Engineering

"...Part of the reason I'm working where I am now is that this became the focal point of my resume and set me up for technical leadership. Employers looked at me and said, 'Well, here's somebody who not only can program, but has the personality and skills to make it in the business world too.'"

Nic Byrd '08, Computer Science, is now in Denver, Colorado, at Tyler Technologies, a manufacturer of software for local governments.



"Working with some of the best young Chinese engineers gave me a much more nuanced understanding of what that country—or a very privileged part of it—is going through. It was also amazing to see just how similar engineers are the world over."

Gordon Scharf '09
Operations Research and Financial Engineering



"Shanghai was a great change. It's vibrant, crowded, bustling, and there's something to see at every street corner. The language and cultural barriers added another layer to the cake."

Aditya Panda '10
Computer Science

Whether they pursue careers in government or academia, business or the not-for-profit arena, tomorrow's leaders must have a profound understanding of technology and an ability to thrive in a globalized, interconnected world. The Keller Center creates and supports a variety of programs, including courses, lectures, internships, and service opportunities, to help prepare students for the challenges they will tackle in the future.

INTERNSHIPS PREPARE STUDENTS TO LEAD

From left: Anita Ma,
Sharon Goswami,
Tiffany Ko



Vorbeck Materials was founded by John Lettow '95 based on technology licensed from Princeton, and the connection with the University does not stop there—in the summer of 2008, three rising seniors completed internships at the company as part of the Keller Center's Preparing to Lead internship program.

"The Preparing to Lead internship program offers students an opportunity to see how a mix of technology and non-technology factors come into play in decision making at the highest levels in corporations," said Keller Center Director Sharad Malik.

Vorbeck, a privately held materials company based in Jessup, Maryland, manufactures and develops applications for graphene—a sheet

of carbon atoms arranged in a honeycomb-like pattern just one atom thick. Graphene can be dispersed in other materials, such as plastics and rubbers, to give them electrical conductivity, incredible strength, and other desirable properties. Vorbeck uses a method developed in the labs of Princeton engineering professors Ilhan Aksay and Robert Prud'homme.

"We hoped that the students would gain exposure to and an appreciation for all aspects of a new venture: technology, finance, sales and marketing, and the excitement of developing a new product without the resources of a large company," Lettow said.

During her internship, **Sharon Goswami '09**, a chemical engineering major, worked on the formulation of graphene-containing conductive inks and also focused on the patent aspects of the work being done at Vorbeck—an experience that guided her post-graduation plans.

"I was considering law school before the internship, but I was convinced after working with the patent agent at Vorbeck," she said. "I now plan to become a patent litigator."

Electrical engineering major **Tiffany Ko '09** and chemical engineering major **Anita Ma '09** also completed internships at Vorbeck, working on research and development as well as marketing. Additionally, two operations research and financial engineering majors participated in the Preparing to Lead program: **Jennifer Lee '09** interned at Sealed Air, a global packaging company, in Elmwood Park, New Jersey; and **Kimlee Wong '09** worked at e-mail marketing company Return Path in New York City.

REAL LEADERS, REAL INSIGHTS: LECTURE SERIES BRINGS SENIOR EXECs TO CAMPUS

The Keller Center's "Leadership in a Technological World" lecture series brought three leaders from technology-based companies to campus in 2008. The series is underwritten by the William Pierson Field lectureship fund.



Teamwork, trust, and collaboration are key to helping a startup grow in a constantly changing marketplace, **Lynda Clarizio '82** said in her talk, "Advancing a Startup: Becoming a Big Business."

Clarizio holds a bachelor's degree from the Woodrow Wilson School of Public and International Affairs and a law degree from Harvard Law School. She served as chief executive of Advertising.com from 2006 to 2008, preceded by seven years in a variety of senior positions at AOL.

"How do you achieve great results?" she asked. "You have to make sure everyone understands how their work contributes to the success of the business."



Internet media leader **Mark Jung '82** offered insights into the challenges and rewards of entrepreneurship in his talk, "The Entrepreneurial Career."

Jung is currently chairman of the board of Songbird, an open source music player under active development. Jung, who holds a B.S.E. in electrical engineering and an MBA from Stanford Business School, has spent two decades as an entrepreneur. Most recently, he was chief executive of Vudu, a leading provider of digital home entertainment and interactive television services.

"Entrepreneurship, in my opinion, is a profession," he said. "It's a career choice. It's a vocation. When I hear the phrase, 'leadership in a technological world,' I think of entrepreneurship. To me, they are one and the same."



Using examples from his life and career, **Dave Hitz '86** discussed the importance of technology, market, culture, and management in his talk, "How to Engineer Your Way from the Lab to the Boardroom."

Hitz, who earned his B.S.E. in computer science, co-founded the Sunnyvale, California-based computer storage and data management company NetApp in 1992. The company earned the number one spot on *Fortune* magazine's "100 Best Companies to Work For" list in 2009.

Hitz told the audience that an entrepreneurial career has much in common with life on a cattle ranch, where he grew up. In business, as on a ranch, he said, you often face problems that you haven't encountered before, with neither time nor opportunity to seek help from others. In those situations, he said, the answer is often quite simple: "You do it yourself. I think that attitude is so important to startups."

EPICS COURSE COMBINES ENGINEERING AND SERVICE

The Keller Center's Engineering Projects in Community Service (EPICS) course unites student teams with community service organizations to work on technological problems in a mutually beneficial way—the students learn to apply their engineering skills to real-world projects, and the not-for-profit organizations benefit from the skill and technical expertise of the undergraduates.

The EPICS program at Princeton, started at the University by then-Kenan Trust Visiting Professor Edward Coyle '82 in 2006–07 and supported by the Community-Based Learning Initiative, is based on a model pioneered at Purdue University by Coyle and Leah Jamieson '77. EPICS teams are multidisciplinary and diverse, open to freshmen through seniors from all academic departments from across the University.

Two EPICS projects were active at Princeton in 2008: the “time” team, led by Michael Littman, professor of mechanical and aerospace engineering; and the “green retrofitting” team, led by Catherine Peters, associate professor of civil and environmental engineering.

The time team continued its work with the Trenton-based Isles community development organization on a project to restore a tower clock in a historic textile factory currently under redevelopment. In 2008, one group of students on the team worked to rebuild the four clock faces, each six feet in diameter. A second group of students restored a 1920s-era bicycle that will be part of an Isles display of 19th- and early 20th-century mechanical technology. Some students on the team also worked with teachers associated with the

Engineers Club at the John Witherspoon Middle School in Princeton to create activities for team members to teach.

The green retrofit team, known as Greentrotfit™, began 2008 conducting tests on more than 40 homes in the Princeton area to determine their “ventilation rates,” or draftiness, in partnership with the Stony Brook-Millstone Watershed Association in Titusville, New Jersey. The students delivered reports to the homeowners comparing their homes to a national standard and educated them about the tradeoffs between energy conservation and indoor air quality. Members of the team are now working with Isles to conduct repeat analyses of a single home in Trenton to determine the effects of various energy conservation measures.

“EPICS HAS GIVEN ME
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—STEPHANIE BACHAS-DAUNERT '10
CIVIL AND ENVIRONMENTAL
ENGINEERING CONCENTRATOR



Left: Greentrotfit™ team
Below: Time team





**KURTZ FUND
SUPPORTS PROJECTS
OUTSIDE THE CLASSROOM**

In 2008, through the Norman D. Kurtz '58 Fund for Innovation in Engineering Education, the Keller Center provided funds to support “engineering students pursuing projects that offer exposure to engineering applications outside the classroom.” Listed to the right are the projects that received funding.

Project	Students	Adviser
Intelligent Ground Vehicle Competition	Gordon Franken '09, Jonathan Mayer '09, Chris Baldassano '09	Robert Schapire, professor of computer science
Prospect Twelve	Issa Ashwash '09, Derrick Yu '10, Nathan Keyes '11	Alain Kornhauser *71, professor of operations research and financial engineering
Rocket and Lander Competition	David Karp '10, Brendan Mahon '10, Mike Papageorge '10	Luigi Martinelli *87, associate professor of mechanical and aerospace engineering
Princeton Mathematical Contest in Modeling Team	Jeff Tang '09	Robert Calderbank, professor of electrical engineering, mathematics, and applied and computational mathematics
EWB-Princeton Irrigation Project, Kumodo, Ethiopia	Sucharita Ray '10	Peter Jaffe, professor of civil and environmental engineering
Princeton Engineering Education for Kids (PEEK)	Jane Yang '11, Josh Israel '11	Clarence Rowley '95, associate professor of mechanical and aerospace engineering
EWB-Princeton, Water Distribution System in Huamazaña, Peru	Meghan McNulty '10, Hank Song '11	Peter Jaffe, professor of civil and environmental engineering
Elgin Bicycle Restoration	Laura Keay '10, Mariah Min '10, Kenneth Liew '10, Josh Muketha '10, Eric Cady GS, Nelson Chiwara '11	Michael Littman, professor of mechanical and aerospace engineering
Clock Restoration	Mack Pasqual '10, Sara Oon '10, Irene Ndikumwenayo '09, Morgan Fowler '10, Justin Karfo '09	Michael Littman, professor of mechanical and aerospace engineering
EWB-Princeton, Digital Library Initiative in Ghana	Catherine Che '11, Mohit Agrawal '11, Jane Yang '11	Peter Jaffe, professor of civil and environmental engineering



**EUGENE
WONG '55
FUND
FOR ENGINEERING
AND POLICY**

Through the Eugene Wong '55 Fund for Engineering and Policy, the Keller Center funded the student projects shown at right.

Project	Students	Adviser
The Potential of Carbon Capture and Storage for Petroleum Exporting Nations	Michael Konialian '09	Robert Socolow, professor of mechanical and aerospace engineering
Single Nucleotide Polymorphism Exploration	Sharonmoyee Goswami '09, Nicole Clarke '09	Lee Silver, professor of molecular biology and public affairs
Energy Sector Analysis in the Coquimbo Region, Chile	Dobromir Parushev '10	Catherine Peters, associate professor of civil and environmental engineering

TECHNOLOGICAL SOLUTIONS FOR GLOBAL PROBLEMS

Technology for Developing Regions (TDR) is a multidisciplinary group of researchers working toward the development and deployment of technologies with societal impact. Supported by the Keller Center and the Princeton Institute for International and Regional Studies, TDR sponsored three lectures and granted four graduate student fellowships in 2008.

GENDER, TECHNOLOGY, AND DEVELOPMENT



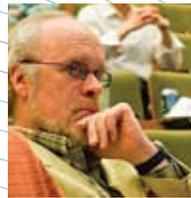
The Advancement through Interactive Radio (AIR) project offers women in the developing world an opportunity to participate in community radio broadcasts as “citizen journalists,” said **S. Revi Sterling**, a doctoral candidate at the ATLAS Institute at the University of Colorado-Boulder, in a talk to a Princeton audience. The goal, she said, is to provide women with opportunities to drive their own development through technical means.

THE TROUBLES WITH AIR QUALITY IN DEVELOPING COMMUNITIES



Poor air quality is responsible for the deaths of millions of children each year, and yet many people are unaware of the devastating effects of this insidious menace, said **Kurt Paterson**, an assistant professor of civil and environmental engineering at Michigan Technological University, in his lecture at Princeton. Using a case study from Ghana, Paterson explored how different measures, such as reducing the concentration of particulates in the air or lessening exposure to the contaminants, might be implemented to reduce the health consequences of air pollution.

VENTURES TO ADDRESS GLOBAL CHALLENGES: DOING WELL BY DOING GOOD



John Danner, the 2008–09 Dean’s Visiting Professor in Entrepreneurship, spoke about an emerging group of entrepreneurs who are tackling global challenges, including poverty and disease, using innovative ventures and technologies to complement more traditional approaches.

“I want to talk today about this basic topic of doing well and doing good,” he said. “A lot of people think that it’s impossible to combine these two. Many entrepreneurs around the world, including here in the United States, are proving them wrong.”

TDR FELLOWSHIPS

Trenton Franz, civil and environmental engineering: studying the consequences of climate and land use change on the water balance in central Kenya

Anirudh Badam, computer science: developing Internet technology for improving network access in developing regions

Baley Fong, chemical engineering: developing novel, economical methods to purify proteins

Tiffany Tong, electrical engineering: helping to improve organic electronic devices and solar cells



Top: Trenton Franz,
Middle: Anirudh
Badam and Baley Fong
Bottom: Tiffany Tong

ENGINEERS WITHOUT BORDERS

The Princeton University chapter of Engineers Without Borders (EWB)-Princeton University was established in 2004 to provide educational opportunities in international development that embody the University's core ideas of academic pragmatism, engaged internationalism, and educational service. Supported by the Keller Center and the Princeton Institute for International and Regional Studies, the group establishes partnerships with developing communities around the globe. Open to students of all academic backgrounds, EWB-Princeton designs and implements sustainable engineering projects approved by EWB-USA.

EWB-Princeton is currently involved in four projects.



Huamazaña, La Libertad, Peru

Huamazaña, La Libertad, Peru

Since forming a partnership with Huamazaña in 2005, EWB-Princeton has installed a community bathroom facility as well as a solar electricity system and battery charging station. In 2008, seven EWB-Princeton students and a professional engineer installed 20 improved stoves, built using locally available materials.

The stoves channel smoke outside of the homes and burn wood more efficiently by concentrating heat in a small combustion chamber, thereby reducing indoor air pollution and conserving a precious natural resource. The team also stressed the social aspect of the project, doing a “first fire” after every build to introduce the homeowner to the technology and encourage them to adopt the new cooking method.



Kumudo, Arsi Negelle, Ethiopia

Kumudo, Arsi Negelle, Ethiopia

EWB-Princeton students spent two weeks in Kumudo in December 2008, installing foot-powered pumps that draw water from a river 90 feet below a community garden to two, 1,000-liter storage tanks. The goal is to enable farmers to grow crops during the dry season, thereby establishing a sustainable food supply year-round. Normally, the farmers are only able to grow crops during the wet season using water from rainfall, but the region is increasingly drought-prone, threatening famine.



Afienea, Ghana

Afienea, Ghana

Small groups of students traveled to Ghana twice in 2008 on assessment trips to determine the most effective way to contribute to a development project in Afienea. The groups were jointly led by Gregory van der Vink, a longtime visiting lecturer in geosciences, and a real estate company in Ghana. These trips resulted in the newest EWB-Princeton project, a school library initiative at EP Basic, a school located in Ashaiman, a slum city located 30 minutes outside of Accra, the capital of Ghana. EP Basic has more than 400 elementary and middle school students, but no library facility. EWB-Princeton intends to construct the library using local materials, including blocks made of laterite that has been infused with cement for added strength.

Arial Home

Alumni, students, and other volunteers built an Arial Home—constructed of highly insulated steel panels that fit together like Legos—during Reunions 2008. Tom Pirelli '69, founder of the Arial Home Initiative, said that the goal of the initiative is not simply to build better homes for the poor but to create a viable, new approach toward alleviating the world's housing crisis. EWB-Princeton members are working with the prototype as an on-campus “lab” for the next two years to develop two systems that might be deployed in developing nations: a rainwater catchment and distribution system, and a method to concentrate solar energy and use it to heat oil for cooking.



Arial Home

ENGINEERING AND ENTREPRENEURSHIP

The Keller Center recognizes that the path of entrepreneurship is a way for students to have a meaningful impact on society. Through lectures, courses, and access to experienced entrepreneurs within and beyond the Princeton community, the center fosters the entrepreneurial growth of students from a wide range of disciplines.

VISITORS EXPLORE SPECIAL TOPICS IN ENTREPRENEURSHIP

The Dean's Visiting Professor in Entrepreneurship was established at the Keller Center in 2007–08 to enhance the educational experience of undergraduate and graduate students from across campus. The first two visitors in the role shared their expertise in special courses that complemented existing entrepreneurship offerings.



“Ventures to Address Global Challenges” approached some of the world's most urgent challenges, including the energy crisis and poverty, from an entrepreneur's perspective, exploring sustainable venture solutions that can turn these and other selected problems into opportunities. Using examples from Mumbai, India, to São Paulo, Brazil, the 2008–09 Dean's Visiting Professor in Entrepreneurship John Danner challenged students to examine whether and how entrepreneurial initiatives can complement other, more traditional efforts, such as government programs, private philanthropy, and corporate social responsibility. In one team assignment, students critiqued existing ventures and offered recommendations for success; videos of those presentations can be viewed on YouTube by searching for EGR 495.

“Leaders of tomorrow, regardless of their field, need to understand the broad keyboard of possibilities and

roles available to them if we are to confront and hopefully solve some of our enormous challenges,” said Danner, a senior fellow of the Lester Center for Entrepreneurship and Innovation at the University of California–Berkeley's Haas School of Business. “But this course is not just about solving problems, it's also about recognizing opportunities others haven't seen, which is something successful entrepreneurs, like innovators in other areas, do well.”



Julian Lange '65, focused on the opportunities and challenges involved in the management of growth in entrepreneurial settings. A central part of the course was a sophisticated international simulation exercise known as “The Manufacturing and Service Challenge,” which places students in teams to manage the growth of a multi-product company from a single undifferentiated, imported



product to a portfolio of differentiated products. Management decisions involved strategy, marketing, and finance in a rapidly

changing environment. Lange, a professor of entrepreneurship and public policy at Babson College, is the founder and president of Chatham Associates, a management consulting firm.

For L. Morgan Fowler '10, who is pursuing an independent course of study in energy systems engineering, the course offered an introduction to management and the analysis of business opportunities. In his final project on First Solar, a company that develops solar energy technologies, Fowler “learned the importance of having a roadmap to achieve the company's vision.” Overall, he said, the course provided “a bedrock foundation” for subsequent entrepreneurship courses he has taken, including John Danner's “Ventures to Address Global Challenges.”

“Managing High-Growth Entrepreneurial Ventures,” taught by the 2007–08 Dean's Visiting Professor in Entrepreneurship

**ENTREPRENEURSHIP IN ACTION
PRINCETON-
JUMPSTART
LECTURE SERIES**

An ongoing partnership between the Keller Center and the Jumpstart New Jersey Angel Network of private investors sponsored three events on technology entrepreneurship in 2008. The lectures and forums are designed to appeal to members of the Princeton and local business communities, and the events are followed by informal receptions where entrepreneurs at all stages of their careers meet to discuss ideas and establish new connections.

**INNOVATION
FORUM**



The third annual Innovation Forum featured short presentations describing six commercially ripe ventures that spring from Princeton's science and engineering laboratories. The technologies presented included a new treatment for Alzheimer's and Parkinson's, a sun-powered fuel cell, a targeted chemotherapy delivery system, and optimization software that has the potential to aid a wide range of industries, from energy to finance. "The Innovation Forum has been a great way to build bonds between Princeton's research and entrepreneurial community and the investor community," said Katherine O'Neill, executive director of the Jumpstart New Jersey Angel Network.

Innovation	Presented by
Implantable Multi-Modal Therapeutic Device	Christian Theriault and Wole Soboyejo, Mechanical and Aerospace Engineering
The Dynamic Resource Management System	Warren Powell, Operations Research and Financial Engineering
Mid-Infrared Quantum Cascade Lasers	Scott Howard, Kale Franz, and Anthony Hoffman, Electrical Engineering
A Combined Solar and Water Splitting Cell System	Gerard Dismukes and Rob Brimblecombe, Chemistry
New Antimicrobial Therapies That Target Bacterial Quorum Sensing	Lee Swem, Molecular Biology
Low-Cost, Rapidly Tunable Optical Elements	Craig Arnold and Alexandre Mermillod-Blondin, Mechanical and Aerospace Engineering

**TECHNOLOGY COMMERCIALIZATION
PANEL**

"This is the mission of a university: to create new knowledge, to share new knowledge, and, in addition, to educate people, to nurture and inspire students, who will then become the leaders who take what they have learned and make the world better," said entrepreneur and professor **Ed Zschau '61** in his introduction to a panel discussion on technology transfer.

The conversation, moderated by Zschau, provided diverse perspectives on the commercialization of university research, featuring: **Paul Prucnal**, professor of electrical engineering, Princeton University; **Jeffrey Rosedale '86**, patent attorney, Woodcock Washburn; **Laura Schoppe *88**, president, Fuentek, LLC; **John Lettow '95**, co-founder and president, Vorbeck Materials; and **Ralph Taylor-Smith *94**, partner, Battelle Ventures.



**THE JOURNEY
FROM
INVENTION TO
INNOVATION**



The ability to innovate is not a skill limited to an elite few—it is something everyone can learn to do, said **Curtis Carlson**, president and chief executive of SRI, an independent, nonprofit research institute, in a talk to a Princeton audience. Furthermore, it is something more people must do if our society is to prosper and become sustainable.

"The good news is that we live in a world of abundance, not scarcity," he said, speaking not of material things, but human ability. "There are no limits to ideas and creativity in the knowledge age."

ENTREPRENEURSHIP IN THE U.S.-INDIA CORRIDOR



An October 16 networking event titled “Entrepreneurship in the U.S.-India Corridor,” co-sponsored by the Keller Center, the MIT Club of Princeton, and The Indus Entrepreneurs (TiE) of New Jersey and Philadelphia, drew about 200 aspiring entrepreneurs to campus. While discussing the opportunities and challenges of doing business in India, the guest lecturers and an expert panel offered advice on what sectors of the Indian economy are set to grow in coming years and suggestions on breaking into these emerging markets. New Jersey Congressman Rush Holt and the managing director of the Massachusetts Institute of Technology’s Center for Entrepreneurship, Kenneth Morse, were among the guest speakers. The panelists included Sumit Ganguli, the executive vice president of iGATE Global Solutions; Rajiv Khanna, president of the India-America Chamber of Commerce; Navjot Singh, a principal at the global management consulting firm McKinsey and Company; and Ravi Srinivasan ’93, a co-founder of Office Tiger.

ENTREPRENEURSHIP CLUB



The Keller Center supports the student-run Entrepreneurship Club, an active forum

that sponsors TigerLaunch and Princeton Pitch, two business competitions for undergraduate and graduate students.

Seth Priebatsch ’11 took first place in TigerLaunch 2008, the University’s student-run \$10,000 business plan competition, supported by **Howard Cox ’64**. Priebatsch’s winning idea: SCVNGR, a company that designs software to enable high-tech scavenger hunts by sending text messages to participants’ cell phones.

Princeton Pitch 2008 challenged students to present their business ideas in 90 seconds to a panel of five venture capitalists, angel investors, and entrepreneurs for a grand prize of \$1,000. The winner was **Tony Xiao ’12** and his was pitch for AirCrumble Technologies, a company that would develop automobile protection devices that predict collisions and deploy external airbags in front of vehicle bumpers moments before impact.



GREG OLSEN ENTREPRENEUR-IN- RESIDENCE

Greg Olsen, the Keller Center’s entrepreneur-in-residence, offered researchers and students at Princeton the opportunity to benefit from his extensive experience throughout 2008.

In addition to offering one-on-one advice regarding potential entrepreneurial endeavors during his office hours, Olsen had discussions with students on “Societal Impact through Entrepreneurship” at Rockefeller and Whitman residential colleges.

Olsen’s previous entrepreneurial successes include the co-founding and later sale of Sensors Unlimited, a near-infrared camera manufacturer, in 1992. During this period he worked with Princeton researchers and graduate students.

Olsen was also the third private citizen to orbit the Earth on the International Space Station.

He is also president of GHO Ventures in Princeton, where he manages his “angel” investments, a South African winery, and a Montana ranch, and performs numerous speaking engagements to encourage children, especially minorities and females, to consider careers in science and engineering. He is active in the New Jersey Technology Counsel (NJTC), the NJTC Venture Fund, the Institute of Electrical and Electronics Engineers, and the New Jersey Commission on Science and Technology.

SUPPORTERS

The Keller Center for Innovation in Engineering Education is grateful to the following supporters who help to realize the long-term vision of the center:

Dennis J. Keller '63 and Constance Templeton Keller to endow the Keller Center for Innovation in Engineering Education; the gift will support and strengthen programs that will enable future generations of students to become leaders in a technological society

Flack + Kurtz, William G. Hamilton '58, and G. Frederick Perkins Jr. '58 to establish the Norman D. Kurtz '58 Fund for Innovation in Engineering Education (which is in addition to contributions from Mrs. Norman D. Kurtz, Peter and Fern Nadel P88, Irwin W. Silverberg '58, and Dr. Garrett J. Thrasher '58 to endow the Norman D. Kurtz '58 Scholarship Fund); the Kurtz Fund supports students who are pursuing projects that offer exposure to engineering applications outside the classroom

Eugene Wong '55, to establish the Eugene Wong '55 Fund for Engineering and Policy, which supports engineering students who are pursuing projects or internships that combine engineering and policy

Kimberly Ritrievi '80, to establish the Kimberly E. Ritrievi '80 Fund for Innovation in Engineering Education, which supports excellence in innovation in engineering education

Anonymous, Dennis J. Keller '63, Peter Kellner '91, and Ed Zschau '61 to endow the Dean's Visiting Professor in Entrepreneurship

The William Pierson Field lectureship to support the Leadership in a Technological World lecture series

Jeff Drazan '80 to establish the Alumni Fund for Innovation in Engineering Education, which supports group projects conducted by students in engineering and applied science

The law firm of Morgan, Lewis & Bockius and the Jumpstart New Jersey Angel Network for their support of the Princeton-Jumpstart Lecture Series on Technology Entrepreneurship

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COURSES

The Keller Center supports courses that have interdisciplinary content integrating engineering, natural sciences, social sciences, and humanities that are of broad interest to students from across the University. Many of these courses have no prerequisites. They are cross-listed in undergraduate course offerings under engineering and bear the label EGR.

EGR 102A, B

**Engineering in the Modern World
(also CEE 102A, B)**

Professors: David Billington, Michael Littman

EGR 103

**New Eyes for the World: Hands-On
Optical Engineering (also ELE 102)**

Professor: Claire Gmachl

EGR 109

**Computers in Our World
(also COS 109)**

Professor: Brian Kernighan

EGR 116

**The Computational Universe
(also COS 116)**

Professor: Sanjeev Arora

EGR 199

**Great Inventions That Changed the
World (also CHE 199)**

Professor: James Wei

EGR 222A, B

**The Computing Age
(also ELE 222A, B)**

Professors: Sharad Malik, James Sturm

EGR 228

**Energy Solutions for the Next Century
(also MAE 228/CHE 228)**

Professors: Jay Benziger, Yiguang Ju

**EGR 250, 251, 350, 351, 450, 451
Engineering Projects in Community
Service (EPICS)**

Professors: Michael Littman, Catherine Peters

EGR 262A, B

**Structures and the Urban Environment
(also ART 262/CEE 222A, B/ARC
262A, B/URB 262A, B)**

Professors: David Billington, Maria Garlock

EGR 328

**Energy for a Greenhouse-Constrained
World (also ENV 328/MAE 328)**

Professor: Robert Socolow

EGR 386

**Cyber Security (also ELE 386)
(also MAE 437)**

Professor: Ruby Lee

EGR 431

**Solar Energy Conversion
(also ELE 431/ENV 431/MAE 431)**

Professors: Emily Carter, Sigurd Wagner

EGR 437

**Introduction to Innovation Process
Management (also MAE 437)**

Professor: Karl Zaininger

EGR 445

**Entrepreneurial Engineering
(also MAE 445)**

Professor: Daniel Nosenchuck

EGR 491

**High-Tech Entrepreneurship
(also ELE 491/ORF 491)**

Professor: Ed Zschau

EGR 493

**Managing High-Growth
Entrepreneurial Ventures**

Professor: Julian Lange

EGR 495

**Special Topics in Entrepreneurship:
Ventures to Address Global
Challenges (also ELE 491/ORF 491)**

Professor: John Danner

Additional EGR courses are those with focused computer science, engineering, or mathematical content. These courses are relevant to students beyond the home department.

EGR 126

**General Computer Science
(also COS 126)**

Professors: Douglas Clark, Donna Gabai, Maia Ginsburg, Robert Sedgewick

EGR 191, 192, 193, 194

**An Integrated Introduction to
Engineering, Mathematics,
and Physics (also MAT 191, 192,
193, 194/PHY 191, 192, 193, 194)**

Professors: Jay Benziger, Frank Calaprice, Ingrid Daubechies, Pablo Debenedetti, Michael Littman, Stephen Lyon, Daniel Marlow, William Massey, Peter Meyers, Jennifer Rexford

EGR 245

**Fundamentals of Engineering
Statistics (also ORF 245)**

Professors: Philippe Rigollet, Hugo Simão

EGR 305

**Mathematics in Engineering
(also MAE 305/MAT 301)**

Professors: Edgar Choueiri, Luigi Martinelli

EGR 307

Optimization (also ORF 307)

Professor: Alexandre d'Aspremont

EGR 309

**Probability and Stochastic Systems
(also ORF 309/MAT 309)**

Professor: Erhan Çinlar

Credits

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SEMINARS AND WORKSHOPS

Leadership in a Technological World Lecture Series

“Advancing a Startup: Becoming a Big Business”
Lynda Clarizio '82, Chief Executive Officer, Advertising.com
February 7, 2008

“The Entrepreneurial Career”
Mark Jung '82, Chairman of the Board, Songbird
November 24, 2008

“How to Engineer Your Way from the Lab to the Boardroom”
Dave Hitz '86, Founder and Executive Vice President, NetApp
December 2, 2008

Technology for Developing Regions Seminar Series

“Gender, Technology, and Development: The AIR Project”
S. Revi Sterling, doctoral candidate at the ATLAS Institute, University of Colorado–Boulder
February 12, 2008

“The Troubles with Air Quality in Developing Communities”
Kurt Paterson, Assistant Professor of Civil and Environmental Engineering, Michigan Technological University
April 29, 2008

“Ventures to Address Global Challenges: Doing Well by Doing Good”
John Danner, Dean's Visiting Professor in Entrepreneurship
November 18, 2008

Princeton-Jumpstart Lecture Series on Technology Entrepreneurship

“The Journey from Invention to Innovation”
Curtis Carlson, President and Chief Executive Officer, SRI
February 13, 2008

Third Annual Innovation Forum
April 9, 2008

“The Commercialization of University Technology”
Panelists: John Lettow '95, Co-founder AND President, Vorbeck Materials; Paul Prucnal, Professor of Electrical Engineering, Princeton University; Jeffrey Rosedale '86, Patent Attorney, Woodcock Washburn; Laura Schoppe *88, President, Fuentek, LLC; Ralph Taylor-Smith *94, Partner, Battelle Ventures
Moderator: Ed Zschau '61, Visiting Lecturer with the Rank of Professor, Electrical Engineering
November 19, 2008

Special Topics in Technology Entrepreneurship

“Entrepreneurship in the U.S.-India Corridor”
Guest Speakers: Rush Holt, U.S. Congressman; Kenneth Morse, Managing Director, Massachusetts Institute of Technology Center for Entrepreneurship, Navjot Singh, Principal, McKinsey & Co.
Panelists: Sumit Ganguli, Executive Vice President, iGATE Global Solutions; Rajiv Khanna, President, India-America Chamber of Commerce; Navjot Singh; Ravi Srinivasan '93, Co-founder, Office Tiger
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