

Fall/Winter Edition 2006

ENGINEERING Ingenuity

A Publication of Brown's Division of Engineering



Brown University Division of Engineering

In this issue:

Giancarlo on globalization

Hazeltine turns 75

Space machine innovations

In this Issue:

- 4 Message from the Dean
- 6 Academic Initiatives
- 8 New Faculty
- 10 Accomplishments
- 12 Campus Outreach
- 14 Celebrations and Updates
- 16 Research Nuggets
- 20 On the Move

Brown University

2

Division of Engineering



Fall/Winter 2006

Engineering Ingenuity is published twice a year to highlight the accomplishments and new developments of the Division of Engineering at Brown University.

Dean of Engineering

Gregory Crawford

Executive Officer

Nancy Congdon

Editors of Ingenuity

Gregory Crawford and Lauren Brennan

Photography and Design

Lauren Brennan

Address Correspondence to:

The Engineering Ingenuity Editors

Division of Engineering

Brown University

Box D

Providence, RI 02912-9104

Fax: (401) 863-1238

Email: Lauren_Brennan@brown.edu



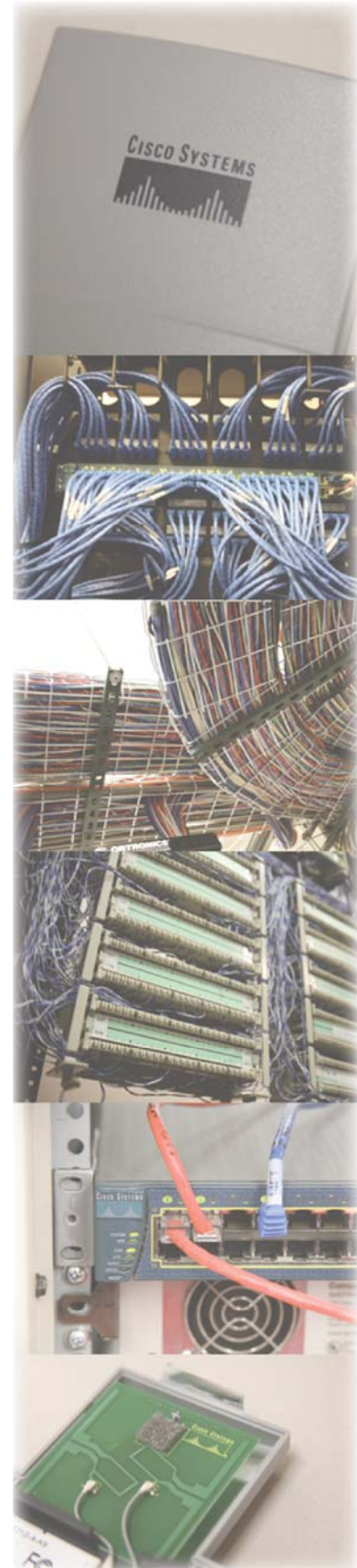


Giancarlo on Globalization

A message from Brown Alumnus and Cisco Chief Technology Officer
 Cisco Systems today employs more than 16,000 engineers around the world, including important development centers in China, India, Israel, and many other locations in Asia, Europe and Africa. At Cisco, we have learned that innovation knows no national or ethnic boundaries, and the Internet has enabled people in every part of the world to collaborate with great efficiency. This new efficiency in the ability to conduct engineering development anywhere around the world is changing the way the world does business and the way American companies and workers compete, especially engineers. American engineers can no longer assume security based upon a large domestic market or unique knowledge. The U.S. market is open, and the Internet spreads knowledge around the world in the blink of an eye.

American engineers need to be able to do two things better than their foreign counterparts to continue to lead the world in innovation. American engineers need to provide more innovation per invested dollar, and they need to be better at collaboration and organization on a global scale. As most engineers have learned throughout their academic and working careers, the better solution often takes far less time to implement than a poorer one. So, in engineering, more hours invested do not necessarily produce the better product. American trained engineers need to consistently provide better, more elegant solutions to more complex problems than engineers overseas. Companies will expect the best from their highest paid employees. Second, because of the globalization of markets and of development itself, American engineers must excel in a globalized environment. American trained engineers and American companies are uniquely positioned to do this because of our natural comfort in a multi-cultural and tolerant society. It is one of our best traits and one of our best assets.

If we focus on elegant solutions to difficult problems, and on maintaining a global mind- and skill-set, American trained engineers will continue to lead innovation around the world. In my days in the University and early career, there was a great fear in the engineering community that the United States had lost its engineering edge to Japan, and that we were headed for a long period of decline. Only 10 years later, we created and witnessed the Internet boom, the creation of Web 1.0, and the biotech revolution. While Japan has a vigorous technology industry, no one fears it will put the United States out of business. Today, there is concern about the rise of India and China as technology powerhouses or as engineering sweatshops. This too, I am sure, will pass. Markets have a way of evening out discontinuities. The United States maintains the best engineering institutions in the world, the most enterprising of populations, the freest market, the most flexible economy, and a multi-cultural heritage. These will enable U.S. engineers and U.S. industry to continue to lead the world in technological innovation.



Dean's Welcome

Brown University

4

Division of Engineering



Message from THE DEAN

It is a great honor to be named the Dean of Engineering at Brown University. The responsibilities are tremendous, and it is highly rewarding knowing my colleagues and the administration are confident in my leadership abilities to continue to grow the Division of Engineering in new and exciting directions. I am taking on this new position with immense energy and enthusiasm, and with high hopes and lofty dreams for the future of Brown Engineering. My goals for the years ahead are grand and will leverage off and expand upon the Division's greatest asset – the collective intellectual capabilities and creativity of the students, faculty, staff, and alumni to cultivate new education and research paradigms. My overarching theme for my tenure as dean is to make Brown Engineering one of the most recognized engineering programs, both nationally and internationally, respected for its tangible contributions to society's health and well being, and for the quality of its graduates and faculty.

One of my goals for the Division is to facilitate new alliances and relationships between students, faculty, staff, alumni, and the community by transcending traditional scholarly disciplines to create a truly innovative and dynamic teaching and research culture. Brown Engineering attracts a vibrant mix of students, from all walks of life and varied backgrounds, who are attracted to Brown for its liberal education. It is time to reflect on our curriculum, enhance the engineering, science, and design components, and implement new and innovative transformations to continue to attract the best and brightest students from around the globe. At the graduate level, I plan to cultivate a growing sense of community and camaraderie among graduate students across our disciplinary programs through innovative activities and coursework. Additionally, I wish to increase the number of Ph.D. graduate students and grow our Sc.M. programs. An example of this growth is the launch of our exciting new Sc.M. Program in Innovation Management and Entrepreneurship (PRIME) Engineering in September. In terms of growing the research enterprise, the cultivation of new relationships and interactions both within engineering and with external partners – other academic departments, national and foreign universities, local hospitals, industry, etc. – is of paramount importance to my plan. I have already begun an aggressive campaign to bring physicians into engineering. My message revolves around a problem-selection paradigm, where physicians identify a need, and engineering faculty identify an expertise and/or technology match. Furthermore, I wish to grow the Division's interaction with industry through close collaborative research partnerships and recruiting relationships. I also wish to expand the Division's visibility in research and education by launching an innovative newsletter and new website, practicing aggressive recruiting methods, and through support of alumni, with the overall goal of significantly improving our rankings and improving our national and international visibility.

Think Big

A message to the Brown engineering students from Dean Crawford

The engineering profession is uniquely positioned to redefine a liberal education. Your engineering education at Brown will instill in you a fundamental and visceral view of unity of knowledge, the power of collective inquiry, the need to challenge the norm, and the ability to apply fundamental knowledge of engineering science and human nature to a plethora of complex problems that face society and the world as a whole. Look to our accomplished alumni and learn from their experience and success. Never forget that good engineers understand the intimate relationship between science and technology, but great engineers also understand people, culture, diversity, and world events. Be passionate about a problem that you wish to solve and have the courage to go places that no other individuals have gone before – and always "Think big."



Professor Clyde L. Briant, former dean of Engineering, is the new vice president for research at Brown University. The vice president for research has senior responsibility for all aspects of research at Brown. Briant will work closely with faculty and the academic administration to foster internal and external academic centers, groupings, and relationships, which will enhance and extend the University's research efforts. He will oversee the University's intellectual property policies, its efforts to identify transferable intellectual property, and its Office of Sponsored Projects. The Division greatly appreciates his accomplishments as dean, initiating many new programs, bringing visibility to Engineering, and growing the faculty size, to name a few. We wish him the best of luck in his new position!

As a faculty member in the Division for the past 10 years, my research program can be summed up in one word – interdisciplinary. As a member of the Electrical Sciences and Computer Engineering group, my research background and expertise combine underlying principles of engineering, physics, and materials science with an impetus on display, photonic, and medical devices that solve a myriad of problems in healthcare, society, and the marketplace. Although known for my interest in applications and my emphasis on innovation, high technology, and entrepreneurship in both the laboratory and classroom, I also engage in very fundamental engineering science studies – most notably my interest in the confinement and imaging of complex fluids. My broad research background has served me well in the Division, an environment without traditional disciplinary boundaries, as I have personally grown in many new directions over the years. I take pride in the fact that I have published papers in archival journals with faculty members in each research group. I will never stop learning. I am continuously challenged by and challenging my colleagues in new ways to open up unique and exciting research and teaching opportunities.

Coming from Xerox PARC 10 years ago, I feel I was fortunate to begin my first professional engineering experience being trained in a truly innovative and intellectually challenging corporate research environment. I strongly believe in and live by the words of Robert Browning, who said, "One's reach should always exceed the grasp," and Vince Lombardi's response to this famous quote, "...Even if you do not reach the moon, you will perhaps grab a star or two." Those who know me well know how passionate I am about entrepreneurship. I have used entrepreneurship as a platform to challenge students to have the courage to step into uncharted territories and the commitment to stay the course even when times get tough. I sometimes feel that I am as much of a coach as a professor. I plan to bring to bear these skills, attitudes, and aspirations to the deanship in shaping the Division's research portfolio, balancing the great synergies between fundamental engineering science and application, and in the design and implementation of unique curricular developments that leverage off the rich liberal arts philosophy of Brown.

The Brown University engineering program provides an atmosphere where students experience an extraordinarily challenging curriculum focused on fundamentals and the

notion of a lifelong commitment to learning, all nestled in a liberal arts campus setting and a beautiful city rich in culture and history. In such a setting, I like to emphasize social responsibility and awareness of purpose, with the underlying philosophy that engineering is a helping profession much like education and medicine. I strongly believe we can ill afford to train engineers in a narrow way. With world demographics undergoing radical changes, and critical debates of our times dominating the headlines, such as those on energy, the environment, healthcare, socio-political conflicts, and catastrophic and man-made disasters, the world will be looking to individuals trained in the fundamental understanding of engineering and human nature to solve complex problems. Engineering of 2020 (National Academy of Engineering) boldly proclaims that the engineering degree will become the liberal arts degree in the future – a notion that I strongly believe in.

I am extraordinarily proud of the Division's alumni; in fact, I am awestruck when I learn about their vast accomplishments around the world – from inventors, educators, professors, consultants, business professionals, entrepreneurs, and philanthropists, to executives in fast growing start-ups and Fortune 500 companies – they have done it all and have impacted the world view. They have been true ambassadors of our program, showing the world the power of a Brown engineering degree. I have sincerely enjoyed my interactions with the alumni over the years, and I look forward to bolstering these future interactions in my new capacity as dean. The Brown Engineering alumni are an inspiring force and resource that should be leveraged and frequently called upon for support and guidance.

I hope this statement gives you a sense of my background, philosophy, and vision. I certainly have my work cut out for me in "filling the shoes" of my predecessors. Over the years I have learned a great deal from their leadership and commitment to this fine University and Division.

I look forward to working with you all in the future.
 Gregory Crawford
 Dean of Engineering
 Brown University
 August 2006



Academic Initiatives

Brown University

6

Division of Engineering

Program in Innovation Management & Entrepreneurship

Innovation in science and engineering has been the dominant source of productivity gains and new enterprises in the United States economy over the last 50 years, accounting for as much as 50 percent of U.S. economic growth. In response to this growing need, the Division of Engineering developed a Masters Program in Innovation Management and Entrepreneurship (PRIME) Engineering, which is composed of an interdisciplinary effort involving science and engineering topics on the cutting edge of technological innovation. PRIME's mission is to provide an innovative learning experience, in which the creation and dissemination of embryonic knowledge and its translation for commercial use and societal benefit becomes a focal point. The aim is to prepare students in this program for a life-long commitment to learning and innovation that complements how we prepare students for other academic and commercial pursuits; what is unique is the commitment to new product and business development. By committing to a one-year masters program after a technology-based undergraduate education, students will receive a set of unique core competencies to lead them in the high technology and global workplace. Interested students can apply through the Brown Graduate School.



Prospective students and their families visited during the Engineering Open House event. Prospective students were introduced to the dean, faculty, and student hosts in Barus and Holley.

Curriculum Innovations

Ready for Blast Off

EN 176 Space Machine Design is an innovative course focused on taking a space mission from concept through a detailed design supported by analysis. The students below are holding a one quarter scale model of the FLASH spacecraft, designed to impact the moon to simulate a meteor strike, achieving a velocity of about 10 km/s (20,000 mph). It will help geologists better understand the makeup and structure of the lunar crust and to better interpret data from natural lunar impacts. The spherical structure and nozzle represent a solid rocket motor used to escape initial orbit around the earth and to embark on translunar trajectory. The mission is being developed with assistance from Professor Peter Schulz of Geo Sciences and in coordination with NASA Ames Research Center in California.



Students (L to R) Dan Manian, Ross Barney, Andrew Lind, Bobby Legge, Greg Sisco and faculty Rick Fleeter. Bobby is holding a quarter scale model of the FLASH spacecraft.

Crossing the Space Chasm

The goal of EN 012, a Division first year seminar, is to broaden freshman understanding of the scope and value of engineering to society. The emphasis is on identification of complex, large scale problems which might be addressed through technology. The students are guided in identification of an issue of interest to them and in researching the state of the solutions that might exist or have been suggested. They then synthesize their own solution, taking into account technical, financial, and political considerations, and present their proposed approach to the class.



Interdisciplinary Team Wins JSID Paper of the Year

Electrical engineering graduate students Matthew Sousa and Sylvain Cloutier, chemistry graduate student Kengqing Jian, and chemical engineering undergraduate students Christopher Chan and Bevan Weissman were led by Professors Robert Hurt and Gregory Crawford in their collaboration on a project involving the synthesis of carbon nanostructures using liquid crystalline materials as carbon precursors. The results of their efforts were published in an article, titled "Pen-writable nanocarbon arrays fabricated using liquid crystalline materials for potential use in displays," appearing in the September 2005 issue of the *Journal of the Society for Information Display (JSID)*, and their work has culminated in the awarding of the inaugural Outstanding JSID Student Paper of the Year to the student authors.



Nascent student entrepreneurs Vivian Fong ('06, right) and Simon Salgado ('07, left) in action, describing the business model of DigiTRx

The Beat is On

DigiTRx, an early-stage biotech startup, emerged in fall 2005 out of Brown University's engineering entrepreneurship courses Entrepreneurship I and II (EN 193/194-S07). DigiTRx has successfully developed a working prototype of a system that enables cardiologists to remotely monitor the rehabilitation progress of heart attack patients and update patients' exercise regimens accordingly. DigiTRx also earned honors as runner-up in the Brown University Business Plan Competition, co-winner of the Brown University Elevator Pitch Competition, runner-up in the Rhode Island Business Plan Competition, and semi-finalist in the National Silicon Valley Baby Boomer Business Plan Competition. The prototypes in the class are partially funded by the National Collegiate Inventors and Innovators Alliance (NCIIA). Working in collaboration with the director of Cardiac Rehabilitation and lead researcher at the Miriam Hospital Center for Cardiac Fitness, Peter Tilkemeier, M.D. and Beth Boch, M.D., respectively. Members of the DigiTRx team include students involved in various disciplines including business, computer science, electrical engineering, and biomedical engineering. While former CFO and marketing directors Kimberly King, Alex Leyzer, and Vivian Fong graduated from Brown in May 2006, CEO Simon Salgado and lead software engineers Chipalo Street and Mike Shim will continue to work on prototype development and fundraising during the 2006-2007 academic year.



The Physician Engineer

Gregory Jay, M.D., Ph.D., an emergency medicine physician and associate chair for Emergency Medicine Research at Rhode Island Hospital, is not your average doctor. A card-carrying engineer by training (B.E. in engineering science), Jay takes great pride in translating new technologies into medical value. When asked, "Why did you pursue medicine?" Jay responded,

"To be a better engineer!" Jay is well integrated into the Division of Engineering through a courtesy appointment and multiple interactions with many engineering faculty. Current projects involve the fundamental study of lubricin, a boundary lubrication of congruent articular surfaces under conditions of high contact pressure and near zero sliding speed, with Professors Kenny Breuer and K.S. Kim, and non-invasive hemoglobin determination, bruise aging, and active skin development for medical simulation mannequins. Jay has also been instrumental in setting up new interactions between engineering faculty and physicians. Because of his efforts, the Division of Engineering has greatly expanded its role with the hospitals. The Division wishes to thank Jay for all of his hard work and efforts in creating a multidisciplinary interface between the hospitals and the Division of Engineering!

New Faculty

Brown University

8

Division of Engineering



Thomas J. Webster addresses the design, synthesis, and evaluation of nanophase materials as more effective biomedical implants. He is an associate professor for the Division of Engineering and the Department of Orthopaedics. Prior to Brown, he was an associate professor at Purdue University. His degrees are in chemical engineering from the University of Pittsburgh (B.S., 1995) and in biomedical engineering from Rensselaer Polytechnic Institute (M.S., 1997; Ph.D., 2000). He is the current director of the Nanomedicine Laboratory and has completed extensive studies on the use of nanophase materials to regenerate tissue.



Karen M. Haberstroh '95 is dedicated to engineering and science education and especially focuses on novel methods of education geared towards increasing the percentages of females and minorities in various physical science fields. She is an assistant professor of research in the Division of Engineering. Prior to joining Brown, she served as an assistant professor in the Weldon School of Biomedical Engineering at Purdue University. Her degrees are in biomedical engineering from Brown University (Sc.B., 1995) and Rensselaer Polytechnic Institute (M.S., 1996; Ph.D., 2000). Her research addresses the use of novel nano-structured polymeric materials in soft tissue engineering applications, including those for bladder tissue replacement.



Rashid Zia '01 returns to the Division of Engineering energized to start his new research program focused upon the unique optical properties of nanostructured materials. He graduated five years ago from Brown University with a combined A.B. in English and American Literature and Sc.B. in Engineering. He then went on to receive both his M.S. and Ph.D. in electrical engineering from Stanford University, where he was the first graduate student in the laboratory of Professor Mark L. Brongersma. Following his graduate studies, Zia spent six months in the Laboratoire de Physique at the Université de Bourgogne (Dijon, France).



Huajian Gao brings expertise in nanomechanics of engineering and biological systems, including mechanical properties and behaviors of bone, gecko, cell, and DNA/protein, as well as carbon nanotubes, thin films, and nanocrystalline materials. He received his B.S. degree from Xian Jiaotong University of China in 1982 and his M.S. and Ph.D. degrees in engineering science from Harvard University in 1984 and 1988, respectively. He served from 1988 to 2002 on the faculty of Stanford University, where he was promoted to associate professor with tenure in 1994 and to full professor in 2000. He was then appointed as director and professor at the Max Planck Institute for Metals Research in Stuttgart, Germany from 2001 to 2006.



Sherief Reda works on the fundamental challenges (e.g., variability and reliability) that are facing the semiconductor industry at technology nodes 65nm and beyond. He will also be developing new design methods for next-generation gene chips. He received his Ph.D. in computer science and engineering from University of California, San Diego and his B.Sc. in electrical and computer engineering from Ain Shams University, Cairo, Egypt. His research areas include design automation techniques for VLSI digital circuits and gene chips, where he has more than 30 publications in premiere journals and conferences. He also has one U.S. patent application with co-inventors at IBM Research.



Jennifer Dworak is pursuing research in new methods of automatic test pattern generation for the detection of manufacturing defects and design errors. The goal of this research is to improve product quality by reducing the number of parts and errors that escape testing and by developing new ways of predicting and quantifying the effectiveness of the test. She graduated from Texas A&M University with a B.S. in electrical engineering in 1998 and earned her M.S. and Ph.D. degrees in 2000 and 2004, respectively. Her broad research interests include computer-aided design of digital circuits and systems with particular emphasis on testing and reliability.

The search is on...

Brown University is currently searching for an assistant professor of solid mechanics and a distinguished senior scholar in engineering to assume the newly-created Barrett Hazeltine University Professorship.

Accomplishments

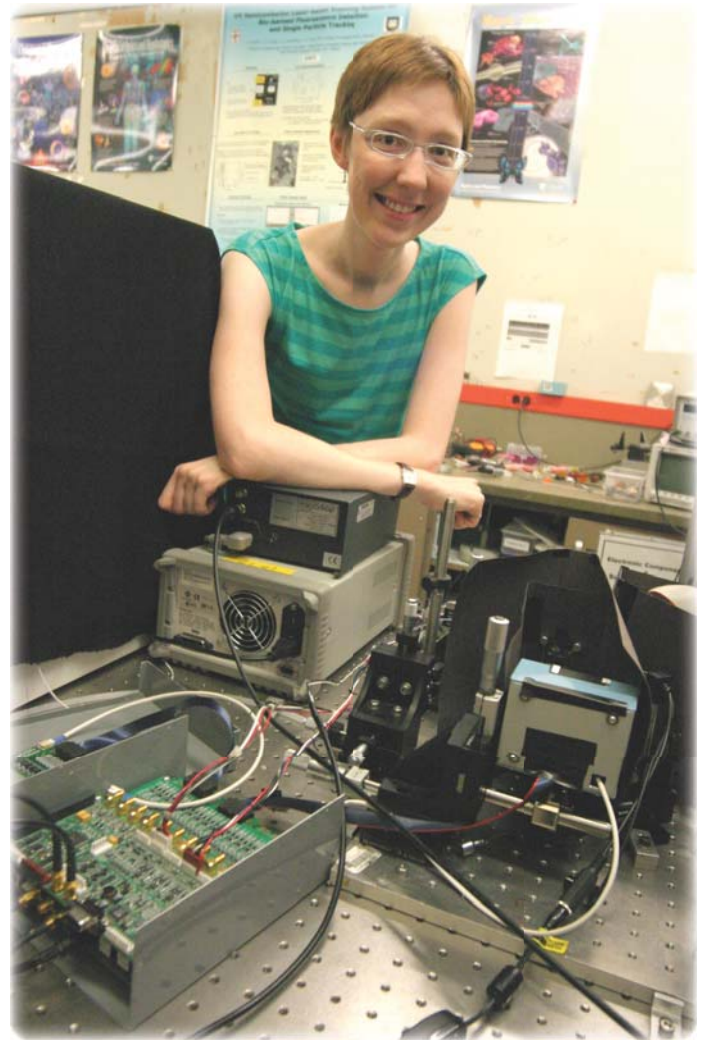
Brown University

10

Division of Engineering

Davitt and Cloutier recognized with Division Outstanding Ph.D. Thesis Awards

Kristina Davitt arrived at Brown in fall 2001 to work under the tutelage of Professor Arto Nurmikko. Last spring she defended her doctoral dissertation, titled "Ultraviolet Light Emitting Diodes and Bio-Aerosol Sensing." Kristina's research had two distinct components: the development and understanding of UV semiconductor materials, in particular the wide bandgap Aluminum Gallium Nitride (AlGaIn) system, and the optical design and assembly of a prototype biological sensor. The former task was accomplished in research collaboration with the Division of Engineering at Yale University and Lumileds Corporation on the West Coast. In the UV, achieving efficient light emission at wavelengths of 340 nm and 280 nm is regarded as a particular milestone. This reflects the need for a UV source in many bio-sensing applications at the absorption peaks of key bio-molecules, but also delineates a threshold of difficulty in current AlGaIn material synthesis. As a part of this work, the team produced both 340 nm and 280 nm wavelength light emitting diodes (LEDs) which represent the state-of-the-art in semiconductor light emitters. The goal of this project, which is funded by the U.S. Department of Defense's SUVOS program, is to build a system capable of detecting the presence of harmful bacteria or bacterial spores in the environment, a task that has had particular motivation in the wake of 9/11.



Kristina Davitt in her lab, where she worked with a team that produced state-of-the-art semiconductor light emitters.

Sylvain Cloutier arrived at Brown University in fall 2002 as an electrical engineering graduate student to work with Professor Jimmy Xu. Sylvain's goal was to combine previous research experiences in photonics with the emerging field of nanotechnologies, and he found the Division to be an ideal place to merge these fields. Sylvain's doctoral dissertation is titled "Unique Properties of Nano-Engineered Optical Materials." A major aspect of Sylvain's work describes how a self-assembled nanopore template is used to nanopattern silicon, which in turn leads to laser action at cryogenic temperatures through isoelectronic trapping and to enhanced room-temperature light emission via phonon localization effects. Additionally, Sylvain's

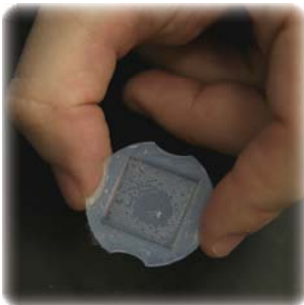
Ph.D. focused on light-matter interactions used to detect the presence of nanoconfined DNA through surface-plasmon induced fluorescence to study nanoconfined liquid crystals using NMR spectroscopy, to probe the structural properties of multi-walled carbon nanotubes and carbon nanostructures, and to study both the plasmonic light-matter interactions in periodic gold nanodot arrays and the structural properties of zinc-oxide semiconductor nanorods grown using these metallic nanodots as catalyst. Sylvain was also a coauthor on the JSID Paper of the Year. (See page 7). Sylvain has moved on to the University of Delaware as an assistant professor of engineering.



Frederick Biga, a Ph.D. candidate in electrical engineering, was awarded a \$19K grant from the NCIIA to develop a flexible conductor technology for portable and flexible displays to be used in inexpensive electronic notebooks for school children in developing countries. The key technology for this device is a stretchable and robust conductive electrode that remains electrically conductive even after being mechanically strained. Biga developed a business plan to compete in the NCIIA competition while taking the EN292-S38 Innovation and Entrepreneurship course in spring 2005. Although Biga's business plan was initially not accepted, his team remained relentless in its pursuit to convince

the awarding committee that this was a very viable project. In the end, their persistence and hard work was rewarded. Biga and his faculty advisors, Alexandar Zaslavsky and Gregory Crawford, along with physics graduate student Dapeng Wang, plan to send a team to Africa to test the market and discover new opportunities for this device. Biga joined Brown University as a graduate student in 2003 after receiving his B.S. in electrical engineering and computer engineering from Florida A&M University. He and his team hope this product will be useful across the globe to help bridge the digital divide and facilitate educational and health programs.

John McMurdy, currently a Ph.D. student in biomedical engineering, was recently awarded \$20K for development of the AnemiCAM, an inexpensive, handheld device to detect anemia in third-world countries plagued by malnutrition and malaria. The GlobaMED Devices team, headed by McMurdy and advised by Gregory Jay, M.D., Dr. Selim Suner, M.D., and Gregory Crawford, was awarded the largest of five NCIIA Advanced E-Team grants to entrepreneurship teams from New England colleges and universities. In 2006 the team will use the funding to both further the device prototype and, with the aid of an external consultant on African trade, initiate contacts with the Nigerian government and ministry of health and discuss collaboration on the AnemiCAM project. Earlier this year, McMurdy was also awarded a \$2,500 runner-up prize in the third annual NCIIA Biomedical Innovation, Design and Entrepreneurship (BMEIdea) competition, given in recognition of student innovation and the commercialization potential of the AnemiCAM. McMurdy began his studies at Brown in September 2004 after graduating with a B.S./M.S. in optics from the University of Rochester and spending one year working for Digilab, an FTIR spectroscopy company.



Anthony Napolitano, a Ph.D. candidate in biomedical engineering, recently won a \$15K award from the NCIIA to develop his patent-pending 3D Petri dish technology that creates 3D micro-tissues for biomedical research. Napolitano and his advisor, Jeffrey Morgan, hope to develop this technology into a commercial product that will ultimately replace the conventional Petri dish. Napolitano believes



that this device will improve drug discovery and biopharmaceutical production, as well as facilitate the development of next generation biomedical applications, such as bioengineered tissues and stem cell therapies. Napolitano received his B.S. and M.S. in biomedical engineering at Columbia University and spent two years working at the biotech start-up Ortec International before joining Brown in 2003.



Education & Outreach

Brown University

12

Division of Engineering

Reaching out in Summer Programs

During the summer of 2006, the MRSEC (Materials Research Science and Engineering Center) at Brown held successful programs for both REU (Research Experience for Undergraduates) and RET (Research Experience for Teachers) participants. The REU program was designed for 10 weeks to allow students from both Brown and other universities to work closely with faculty, post doctorates, and graduate students on various research projects in the area of Materials Science. Seminars, lunches, and events were coordinated for undergraduates to work and socialize. The participants and their home institutions for the summer 2006 program were: George Aninwene II, The University of Maryland-Baltimore; Zachary Beiley, Brown University; Timothy Davis, North Carolina A&T University; Deepa Galaiya, Brown University; Anthony Johnson, Brown University; Elizabeth Mermel, Vassar College; Lenson Pellouchoud, Brown University; Candice Sheldon, Brown University; Michael Task, University of Pittsburgh; and Emmanuel Zoubovsky, Florida State University.

The RET program is a summer program that provides K-12 teachers with an outstanding environment for continued professional development. The goal of the RET program is to give teachers an opportunity to experience: the scientific method in forefront areas of materials research; a hands-on research experience in laboratories and specialized,



Teachers from Hope High School IT Academy and first year participants in the MRSEC RET program, Catharine Slader and Gerome Muriel

advanced MRSEC facilities; the use of materials research instrumentation; and the opportunity and techniques to develop K-12 science lessons based on materials research. The participants and their schools for the six-week summer 2006 program were: Frank (Blinn) Dorsey and Katy Freytag, Gordon School, East Providence, RI; Gerome Muriel and Catharine Slader, Hope High School IT Academy, Providence, RI; and returning as a consultant to the program John Shilko, Goff Junior High School, Pawtucket, RI.

Industrial Visitors

Steven Reznak, Ph.D., vice president of Research and Development at Cabot Corporation, visited the Division on July 21, 2006. Reznak interviewed 10 graduate students during his visit and presented a seminar titled "Fine Particles - From Idea to Material to Business."

Cabot Corporation is the world's leading producer of sub-micro particles, with sales of more than \$2 billion. The major product lines are carbon black; fumed silicon and aluminum oxides; and tantalum and silver metals. Cabot also produces stable dispersions of these particles for such applications as jettable inks, conducting polymer compounds and micro polishing slurries.

Sadeg Faris, Ph.D., chairman, president, and chief executive officer of Reveo, Inc., visited the Division of Engineering on March 14, 2006. During Faris's visit, he interviewed about 15 undergraduate and graduate students and presented a seminar titled "Can the Human Genome Be

Sequenced in 10-Seconds for milli-cents/Genome?" Reveo, Inc. was established in 1991 and employs an entrepreneurship business strategy to develop technologies that represent significant solutions for humanity. To date, Reveo has been issued 330 U.S. and international patents on various technologies, including liquid crystal-based devices, optical thin films, and metal fuel cells.

Ram Nagarajan, Ph.D., innovations specialist, John Penance, innovation process manager, and William Jarvis, director of business development, of FLEXcon visited the Division on August 3, 2006, to meet with faculty and students and learn more about activities in the Division focused on flexible electronics and optical devices. FLEXcon is an ISO 9001-certified manufacturer of pressure-sensitive films and adhesives, offering the largest selection of standard off-the-shelf products and specialty, made-to-order products in the world.

From Atoms to Autos: General Motors Extensions

The laboratory for computational materials research at Brown University is one of several collaborative research laboratories established worldwide by General Motors to accelerate the pace of innovation in strategic technology areas. The goal of the laboratory is to develop computer simulations that predict the mechanical properties of materials used in automotive applications, and to use these simulations to help General Motors develop materials with enhanced performance. The computations are guided and verified by experiments. The laboratory has three focus areas: (i) development of aluminum alloys with enhanced room temperature formability; (ii) hot forming of magnesium and aluminum alloys; and (iii) engineered surfaces with improved wear resistance and friction. Notable achievements of the laboratory include: the development of new multi-scale simulation methods to predict the influence of chemical composition on the rate sensitivity of aluminum alloys; new constitutive equations that model the behavior of aluminum during room temperature forming; development and experimental validation of computer simulation methods to predict constitutive behavior and microstructure evolution in aluminum alloys during hot forming; computer simulations of microstructure evolution in aluminum-silicon alloys under development for linerless engines; and the development of novel wear resistant diamond coatings. The laboratory is co-directed by Mark Verbrugge, director, Materials Processes Group at GM, and Professor Allan Bower of Brown. GM researchers and Brown faculty collaborate closely, with faculty, students, and research associates often spending summer months at the GM R&D center in Warren, MI, and with GM staff members spending extended periods at Brown. The laboratory was founded in 2001 and was renewed for a second period of five years in April of this year, at a total funding level of \$5 million from GM, supplemented by joint GM/Brown research grants from government funding agencies.



Reuse in RI: The Superfund

The Superfund Basic Research Program (SBRP) at Brown University entitled "REUSE IN RI: A State-Based Approach to Complex Exposures," was recently funded by the National Institute of Environmental Health Sciences of the National Institutes of Health, in the spring of 2005. The overall objective of the program is to have a major impact on improving the understanding of the human health consequences and management of contaminated sites in Rhode Island, as well as other heavily industrialized states. The SBRP at Brown brings together scientists and engineers from all over campus to work in a cooperative and synergistic enterprise, including Division Professors Joseph Calo, Robert Hurt and Eric Suuberg from the Fluids, Thermal and Chemical Processes (FTCP) group. The biomedical researchers in the Superfund project aim to develop new approaches to evaluating toxicant responses in sensitive and susceptible individuals that can be applied to real world exposure scenarios involving complex mixtures. The engineering researchers are focused on modeling and remediation of complex polluted sites using novel materials and strategies. All Superfund efforts are tied together with a communications expert and team members from the Rhode Island State Departments of Health and Environmental Management to effectively communicate results and make them relevant to various constituents.

Superfund Spouted Bed Electrolytic Reactor (SBER) system for the recovery/removal of heavy metals from contaminated wastewater



Students in India

Twelve Brown undergraduate students worked in India for eight weeks this summer, in Delhi, Mumbai, and Calcutta. The companies were all Indian, most of them with global operations, and their activities ranged from telecommunications to real estate (Apeejay Group, Mukand Industries, Jubilant, Reliance Industries, Bharti TeleVentures, Mukand Industries, Sonagroup, and Bharti TeleVentures). The students had supervisors and mentors and were assigned specific performance goals, but were often exposed to an array of activities in the company. Early feedback from returning students describes some of their experiences in India as invaluable, eye-opening, and enriching in both, professional and personal areas.

Students Neil Rajan (L) and Elisabeth Kruger (R) in India, and Reliance Industries



Celebrations and Updates

Professor Barrett Hazeltine turns 75



Photo taken from Division recruitment slide-show of Hazeltine teaching circa 1961.

With Mary Hazeltine's support, several alumni - including Randy Haykin ('85), My-Tien Vo ('87) and Annette Lidawer ('79) - have spearheaded an effort to celebrate Professor Barrett Hazeltine's 75th birthday and express their admiration, love, and gratitude for his unwavering commitment, generosity, and devotion to his students through many generations. (His 50th year at Brown will be 2009!) The alumni planned two birthday parties, one in San Francisco on Sept. 9 and one in Providence on Oct. 21. The California celebration was hosted by Conrad Herrmann ('82) and his wife Dianna. The Providence reception was hosted by Gregory Crawford, dean of Engineering. Hazeltine continues to teach the engineering management courses Engin 9 and Engin 90, as well as a new course in social entrepreneurship. His birthday is Nov. 7.

Ginny Novak retires

After 47 years of service to Brown University and the Division of Engineering, Virginia (Ginny) Novak has retired as manager of the Office of Student Affairs. There are not enough words to describe the deep and heart-felt appreciation for her efforts over the past 47 years. She did it all, from student affairs to the organization of the many Division events. We all miss you, Ginny!



Support Engineering

The Division of Engineering has identified a set of funding priorities that is part of the university-wide Plan for Academic Enrichment. Engineering wants to add new faculty positions over the next few years and continue to reach out across campus to make new and exciting interdisciplinary connections. To ensure the success of this effort, Engineering seeks to raise \$25 million through the support and generosity of alumni, parents, and friends.

Engineering has two overarching needs:

- ◆ Supporting excellence in teaching, research, and scholarship through expanded opportunities for Brown's faculty and students.
- ◆ Renovating space in the Barus and Holley Building to accommodate group study and faculty-student interaction outside the classroom and the lab.

If you would like to contribute to the Division of Engineering's fundraising initiatives, please visit

<http://www.gifts.brown.edu> or contact: Neil Steinberg, Office of University Advancement,

Brown University, Box 1893, Providence, RI, 02912, USA Telephone: (401)863-3101 Email: Neil_Steinberg@Brown.edu

Career Initiative

Help Us Connect Students with Corporate Work Experiences

The Division of Engineering often has requests from engineering students, both undergraduate and graduate, for outside contacts for possible internships, both paid and unpaid, and summer work opportunities. The Brown Engineering student is highly motivated, well-grounded in engineering science, highly analytical and organized, and very creative. In addition to engineering experiences, many students are also interested in start-up companies, business, consulting, law, finance, venture and angel financing, and banking. Their quantitative training in engineering and rich liberal arts exposure serves them well in these professions.

Our goal is to develop a data bank of possible opportunities for our students and faculty. If you wish to be part of the Division of Engineering's data bank, please email Lauren Brennan (Lauren_Brennan@Brown.Edu) your company name, company contact (website, address, phone, fax, and email), and a short blurb on your company and the opportunities available.



A message to Hazeltine

Your dedication and devotion to the Division of Engineering for so many years has been truly inspirational. You enthusiastically brought technology management, innovation, and entrepreneurship to the engineering curriculum long before other educators recognized their importance in the training of young engineers. Extending your influence beyond the careers of many engineering students at Brown, your teaching efforts, which you undertake with great vigor, are truly interdisciplinary, attracting students from every concentration on campus. Your forward-thinking attitude on engineering pedagogy has put Brown at the forefront of technology management and entrepreneurship education. Because of your efforts and achievements, our peer institutions look to Brown for direction in this field. Over the years, your mentorship and friendship has genuinely affected so many in the Division, from research, to teaching, to outreach. We do not know how you do it, day after day, semester after semester, year after year; your bottomless reservoir of energy, enthusiasm, passion, and conviction for teaching and mentoring is truly admirable. At the grass roots level, we refer to you as Barrett Hazeltine, but, bearing in mind all of your accomplishments, I think a more appropriate title for you is "Father" of technology management and entrepreneurship pedagogy. Not content with all of your triumphs, you continue to apply your inventiveness in new ways, such as the teaching of social entrepreneurship and appropriate technologies. Despite your extremely busy life as an educator, you have proven your willingness to freely give your time for the benefit of students, faculty, the Division of Engineering, and Brown University. It is with great pleasure, Barrett, that I thank you personally and on behalf of the Division of Engineering for the immense benefits you have brought us over the years. You have combined your skills as an engineer and an educator with your own passion, personal vision, and awareness to open the world up to many young minds. On this occasion of your 75th birthday, we wish you well and express our hopes for the continuation of your productivity in the years to come.

Happy Birthday, Barrett. Gregory Crawford, Dean of Engineering



Tribute to Merv Sibulkin

It is with deep sadness that we inform you of the passing of Professor Merwin Sibulkin. He passed away on July 14, 2006; he was a faculty member in the Division of Engineering 1963-1991.

A World War II Navy Veteran and graduate of New York University, the University of Maryland and the California Institute of Technology, Sibulkin held several research positions in the fluid dynamics area prior to joining the Division of Engineering: the Supersonic Propulsions Division NACA; Naval Ordnance Laboratory; Jet Propulsion Laboratory; and Convair Scientific Research Laboratory. In 1963, Sibulkin was appointed associate professor in the Division of Engineering at Brown. Sibulkin was a member of the Fluids, Thermal and Chemical Processes (FTCP) group, and a member of Sigma Xi and Tau Beta Pi. He authored more than 70 journal articles during his career in the areas of fluid mechanics (boundary layers, vortex flows), heat transfer (convection, radiation), and combustion (fire research, flammability limits). After 28 years of service to Brown, Sibulkin retired in 1991. As professor emeritus, he remained active in research. In 2001, he published a paper on the switching dynamics of anisotropic polymer spheres subjected to electric fields in viscous fluids. During his retirement Sibulkin also pursued his many other interests in history, music and ethics. He will be sadly missed.

Outreach Connections

Heather Johnson (left) joined the Center for Advanced Materials Research (CAMR) in February 2006 as program coordinator. She will be responsible for coordinating various activities of the Center, most importantly the activities of NSF's Materials Research Science and Engineering Center (MRSEC) Program at Brown. Heather earned her Bachelor of Arts degree from Wheaton College in Norton, MA, and her M.B.A. from Salve Regina University in Newport, RI. She has worked in various private sectors, as well as previously at Brown in the Office of the Dean of Medicine. She has served on the Board of Directors for both the State Ballet of R.I. and the Miss R.I. Scholarship Program.

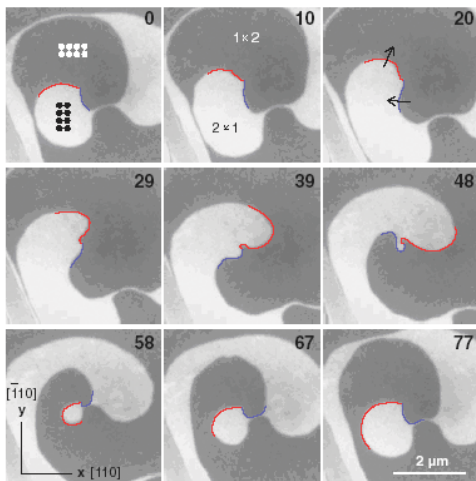
Lauren Brennan (right) joined the Office of Student Affairs in August 2006 as manager. She will be responsible for both undergraduate and graduate affairs related to student services. Lauren earned her Bachelor of Science dual degrees in business administration and psychology from Mary Washington College in Fredericksburg, VA, and her Master of Arts in higher education administration from the University of Arizona in Tucson, AZ. She has worked in various university settings, including admissions, career development, and advising services. She also works as a professional photographer.

Research Nuggets

Brown University

16

Division of Engineering



Motion of surface steps around the core of a dislocation impinging the Si(001) surface.

Step Dances on Silicon Surfaces

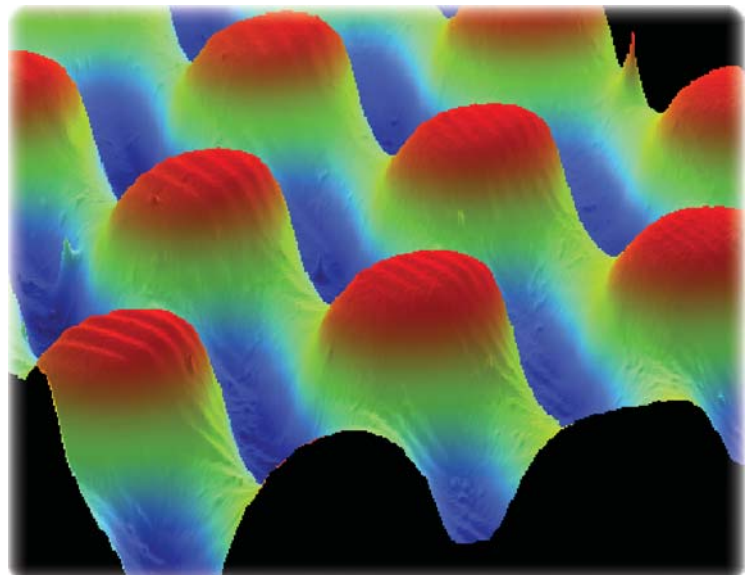
Professor Vivek Shenoy (Solids), in collaboration with researchers at IBM Research Division in Yorktown Heights, Hannon and Schwarz, has shown that during spiral growth form dislocations, surface steps on Si (001), the most commonly used substrate in the semiconductor industry, move around the core of the dislocations in very complicated yet periodic fashion. The observed growth phenomena is very different from the predictions of classic theoretical models, in that the steps execute a concerted dance in response to the strain field of the dislocation, unlike the simple spiral motion expected from well-established theory. This work suggests that step motion can be used to measure strain variations with a resolution of 10 nm, a regime not accessible to current experimental techniques. The paper has appeared in *Science* [313, 1266 (2006)].

Biomimetic Structures: Walking on Walls

Professor Pradeep Guduru has recently been awarded an NSF CAREER Award, which focuses on the mechanics of biologically inspired adhesion, friction and engineered surfaces. The ability of small animals such as insects, flies, and geckos to climb up vertical walls and to walk upside down on ceilings has been a subject of active research in biology for many centuries. There are a variety of mechanisms employed by these animals, including tiny claws, adhesive secretions, smooth and hairy adhesive pads, etc. Following the accumulation of a large body of anatomical and functional data on various natural adhesion systems, in the last few years biologists and engineers have been working together to develop a quantitative understanding of various natural adhesion and friction systems. This is a growing field of research with a rich set of challenging problems at the interface between biology, applied mechanics and micro/nanofabrication, with potentially significant benefits if we can understand and mimic some of nature's optimized solutions to develop useful technologies. The focus of Guduru's research is on engineering the topography of surfaces at micrometer and nanometer scales to understand the mechanics of biological adhesion and friction systems, and to develop biomimetic strategies which implement nature's mechanisms for adhesion and friction. Such a study naturally leads to several basic mechanics problems in rough surface adhesion and friction of soft materials.

Isotropic "Islands" in a Cholesteric "Sea"

Electrical Sciences graduate student Matt Sousa, now a postdoctoral researcher at Case Western Reserve University, and Professors Lambert Freund (Solids) and Gregory Crawford (Electrical Science), in collaboration with researchers in the Netherlands, Kees Bastiaansen, associate professor of chemical engineering at the Technical University of Eindhoven, and Dick Broer, vice president of research at Philips Research, developed a unique way to pattern ordered polymers on substrates to create a film with locally different thermal expansion properties. The films are thermally sensitive and present a myriad of unique surface topologies when thermally addressed; a finite element model was used to sort out the underpinning basic phenomena. The work recently appeared in *Advanced Materials*, "Isotropic 'Islands' in a Cholesteric 'Sea': Patterned Thermal Expansion Coefficients for Responsive Surface Topologies" [18, 1842 (2006)].



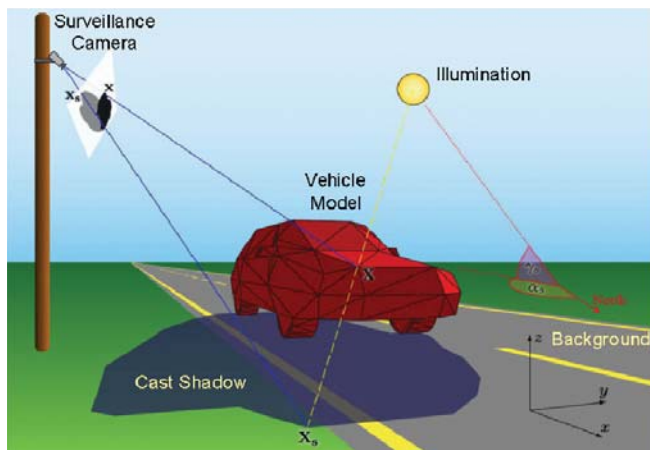


Farewell Bacteria - Nanostructured Implant Surfaces

Approximately 766,100 Americans underwent surgery for hip, knee and shoulder replacements in 2002. In some cases the implant becomes infected. The most common culprit: staphylococcus epidermidis. Found on skin or in mucous membranes, *S. epidermidis* can enter a surgical wound and adhere to an implant. The bacteria multiply, causing a slimy layer, or biofilm, to form around the implant. The result is a need for additional surgery to clean the implant or replace it outright. Professor Thomas Webster (Materials, Biomedical Engineering and Orthopaedics), and former students at Purdue University Gabriel Colon and Brian Ward have created a nano-structured implant surface similar to that of natural bone, which aids in bone growth to better anchor the implant in the body, ultimately extending its useful life. The work recently appeared in *Journal of Biomedical Materials Research*, "Increased Osteoblast and Decreased Staphylococcus Epidermidis Functions on Nanophase ZnO and TiO₂," [78A, 595 (2006)].

Highly Maneuverable Bats in Motion

In the quest to build Micro Air Vehicles (MAVs) with agile and efficient performance, engineers have been looking increasingly at nature for inspiration on highly maneuverable flight. Although the natural world has countless examples of creatures with extraordinary flight capabilities, bats have evolved with truly extraordinary aerodynamic capabilities. Bats possess specialized features that may contribute to their flight performance, including thousands of tiny hair sensors distributed over their wing surface as well as a series of muscles embedded in the wing membrane, whose function appears to be the active control of camber during flight. A multidisciplinary research team at Brown, lead by Professors Kenny Breuer in Engineering and Sharon Swartz in Evolutionary Biology, is embarking on a project to characterize these unique flight capabilities and to understand the roles the bats' bones, skin, and wing motion all play in enabling this behavior. In support of these biological flight experiments, Breuer and Swartz are also performing wind tunnel tests on model wings that mimic those observed in nature, as well as material tests on bat bones and wing membranes. Their research team comprises both engineers and biologists, and they have developed collaborations with others, including mathematicians and computer scientists performing numerical simulations of bat flight and developing techniques for advanced scientific visualization of the complex data sets that are generated by this multidimensional research project. This project is cited in X. Tian, et al. "Bioinspiration and Biomimetics" (in press, 2006).



Far Left: Bats are used in wind tunnel research to develop new Micro Air Vehicles (MAVs)

Right: 3-D world model for the appearance of vehicles in video sequences.

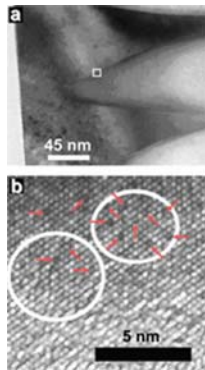
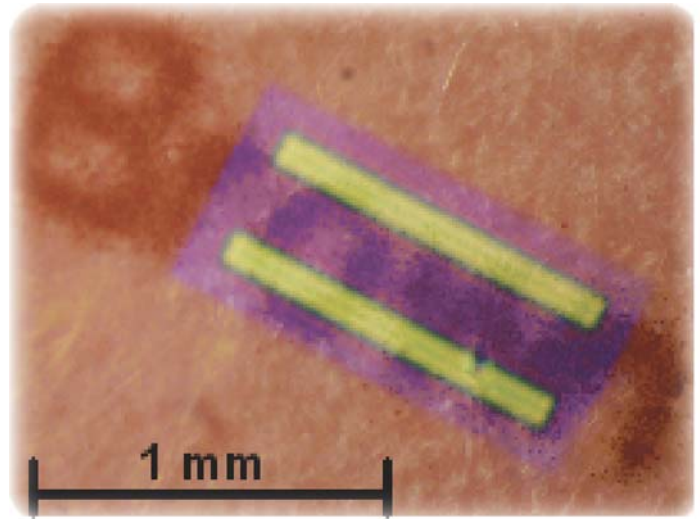
Shadow of a Doubt

The Division's computer vision group, comprised of a collaboration between Professors Joseph Mundy, David Cooper, Benjamin Kimia, and Gabriel Taubin, is carrying out extensive research in automatic recognition of generic vehicle classes for security monitoring. A key problem in visual recognition is the segmentation of the vehicle from the background and from the cast shadow of the vehicle. This model enables the segmentation of vehicle images into three regions: background, vehicle surface, and cast shadow. An algorithm based on this model has been developed by Matthew Leotta, a graduate student in the vision lab. This segmentation will support further research in vehicle classification.

Research Nuggets

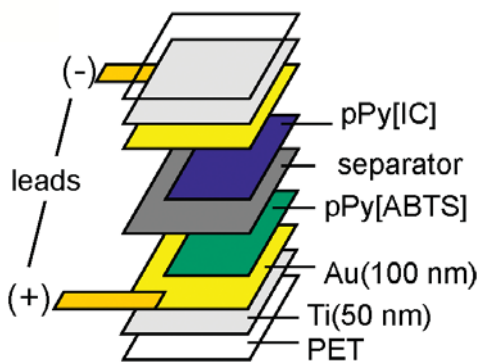
Invisible Electronics

Professor David Paine's group (Materials) has been creating transparent thin film transistors on glass using transparent components that allow the fabrication of active electronic devices (transistors) using a simple large area process – suitable for use in display, sensor, and other large area electronics applications. The semiconductor, metallization (contacts and interconnects), and insulators for these devices are all oxide-based and are therefore visually transparent. Remarkably, though deposited at room temperature, the performance of these amorphous indium zinc oxide thin film transistors is superior to that of the conventional amorphous Si alternatives that are currently in use in flat panel display applications. The work, High-Mobility Amorphous In_2O_3 -10wt% ZnO Thin Film Transistors, will be published in the near future in *Applied Physics Letters*.



Breaking the Rules

Electrical Sciences graduate students Sylvain Cloutier and C. H. Hsu, postdoctoral associate Pavel Kossyrev, and Professor Jimmy Xu (Electrical Sciences) have disclosed strong phonon localization effects in nano-engineered silicon structures, leading to a breaking of the phonon-selection rule in bulk silicon and to enhanced radiative recombination and light emission at room temperature. The work recently appeared in *Advanced Materials*, "Enhancement of Radiative Recombination in Silicon via Phonon Localization and Selection-Rule Breaking" [18, 841 (2006)].

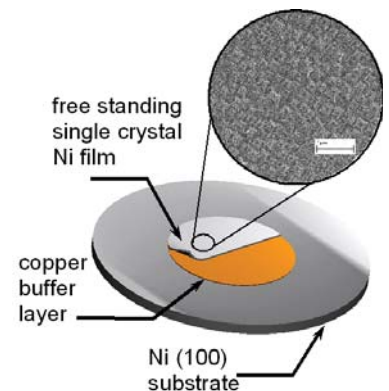


There's a Great Future in Plastics

Postdoctoral researcher Hyun-Kon Song, now a research scientist at LG Electronics, and Associate Professor Tayhas Palmore (Materials Science and Biomedical Engineering) developed a new plastic battery based on the conducting polymer, polypyrrole. The researchers electrodeposited polypyrrole and a redox-active compound onto a plastic strip coated with nanometer-thick films of gold and titanium. Using a second plastic strip, they repeated the process with a different redox-active compound. They then took a paper membrane and sandwiched it between the two strips. The result was a battery prototype with twice the storage capacity of an electric-double layer capacitor and more than 100 times the power of an alkaline battery. The work recently appeared in *Advanced Materials*, "Redox-Active Polypyrrole: Toward Polymer-Based Batteries" [18, 1764, (2006)].

Next Step Reel-to-Reel?

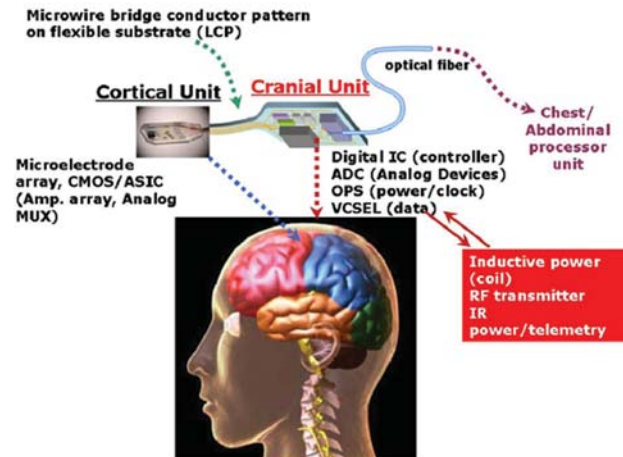
Materials Science graduate student Jae Wook Shin, undergraduate student Adam Standley and Professor Eric Chason (Materials) have developed a novel process for creating thin films that consist of a single crystal. Using a combination of electro-deposition and etching, the method produces free-standing films from a template material, enabling the template to be used again. This deposition process is being used to develop a method to produce arbitrarily long ribbons of single crystal films without breaks. Because the films will have a single orientation and no grain boundaries, they have potential applications as substrates for superconducting tapes or sheets of solar cells, or other applications where crystalline alignment is required.





Implantable Microelectronics for the Brain

An Electrical Sciences team composed of Assistant Professor (Research) Yoon-Kyu Song, senior engineers and lecturers William Patterson and Chris Bull, and graduate and undergraduate students in Arto Nurmikko's group are developing a compact implantable neural recording chip for wireless extraction of signals from the brain. The work is conducted in collaboration with Professor John Donoghue, Department of Neuroscience, a pioneer in the field of brain sciences. The electrical engineering group has developed a novel neural signal sensor where specialized microelectronic chips are integrated with multielectrode cortical probe arrays. With the inclusion of an on-board infrared source for telemetry, the ultimate aim of the team is to implement a high speed digital neural signal communication system from the brain. In initial engineering tests the new microsystem shows ability for high-fidelity recording of neural "spikes" from anesthetized rats. The eventual goal of the research is to offer severely paralyzed people advanced means for operating external devices by direct command signals from the brain.



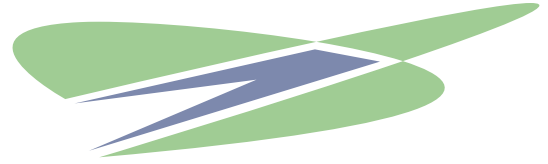
Engineering Optical Spectra Using the Binary Supergrating

Stanford Graduate Fellow Daniel Levner, former Electrical Sciences graduate student Martin Fay and Professor Jimmy Xu (Electrical Sciences) recently presented their work on the Binary Supergrating (BSG), a new technology platform that permits the near-arbitrary control of optical spectra. Using a simple and robust structure that resembles a barcode, the BSG encodes an optical program that defines device function. Through suitable programming, the BSG can address a wide range of applications, which span the fields of optical telecommunication, spectroscopy, and chemical/biological sensing. The research appears in the *IEEE Journal of Quantum Electronics*, "Programmable Spectral Response Using a Simple Bragg-diffractive Structure" [42, 410 (2006)].



Engineering and Design: A Powerful Combination

Undergraduate and graduate engineering students from Brown University are teamed with industrial design students from Rhode Island School of Design (RISD) and faculty who are practicing engineers, industrial designers and researchers to make a truly interdisciplinary engineering design experience for students. The studio experience was taught by adjunct professors of engineering Trey Crisco (Department of Orthopaedics, Rhode Island Hospital) and David Durfee (co-founder and president, Bay Computer Associates), RISD part-time faculty member Matt Cottam (co-founder, Telart), and adjunct faculty Jasper Speicher (senior product engineer, Tellart). Short lectures and critiques were used throughout the semester to reinforce aspects of the engineering and design process necessary to produce competent product designers and engineers who can bring a new product to market on time. Students worked in a team environment in the value creation and product engineering and design process. Process stages included opportunity identification, product concept, research, concept development and requirements definition, design and design documentation, and design for manufacturing, as well as scheduling and planning. This course aims to assimilate the engineering and industrial design "cultures" to better prepare both types of design students for professional careers. The student and faculty team looked for the most pressing latent needs and developed a solution through several iterations to high-fidelity prototypes.



Alums on the Move

Brown University

20

Division of Engineering



Seth Coe-Sullivan graduated in the Brown class of 1999 with an Sc.B. in electrical engineering. He then spent one year as a staff engineer at the Boston-based research company Foster-Miller, Inc., in the Emerging Technology division of the Materials Technology Group. This experience inspired his desire to pursue a Ph.D., which he started at Mas-

sachusetts Institute of Technology in July of 2000. While at MIT, Coe-Sullivan's research focused on incorporating quantum dots into hybrid organic/inorganic LEDs. This led to work on new fabrication techniques, and a basic proof of concept that nanocrystal based LEDs could be a disruptive flat panel display technology. Towards the end of his time at MIT, Coe-Sullivan founded QD Vision, and with the help of his co-founders in May 2005 successfully raised venture capital, licensed the fundamental intellectual property out of MIT, and received his Ph.D. Since then, he has served in a variety of roles including interim CEO, director of devices and director of chemistry, and is currently a member of the Board of Directors and chief technology officer. QD Vision, located in Watertown, MA, has grown to 20 full-time staff and has reported the first demonstration of a QD Display. Coe-Sullivan is proud of the fun and intellectually stimulating work environment at QD Vision, and he is always interested in hearing from Brown engineering graduates who are looking for an exciting place to work (Email him at scoe-sullivan@qdvision.com.)



Above: Distinguished scholars Needleman and Tvergaard
Below: The Division's National Academy of Engineering Members, (left to right) Professors Freund, Needleman, and Clifton

Needleman-Tvergaard Symposium

Nearly 100 participants, including top engineering scientists in the field of solid mechanics, gathered to celebrate the 60th birthday of Professors Alan Needleman and Viggo Tvergaard for the Needleman-Tvergaard symposium held on the Brown campus Aug. 16 - 18, 2006. The theme of the symposium was "Bridging scales in mechanics - 'Where are the bottom and the top?'" Brown's Professor Needleman and Professor Tvergaard of the Technical University of Denmark (DTU) are long-time companions of research who coauthored numerous papers together in the area of mechanics and physics of solids. During the symposium Needleman, Florence Pirce Grant University Professor and professor of engineering at Brown, was honored by the American Society for Mechanical Engineering for his seminal contributions in the area of nonlinear mechanical response and failure of solids, structures, and materials, receiving the Society's Daniel C. Drucker Medal. The medal, established in 1997, is conferred for distinguished contributions to the field of applied mechanics and mechanical engineering over a substantial period of time. Early in the week of the symposium, he also received the William Prager Medal in solid mechanics from the Society of Engineering Science.

