OVERVIEW

The past year was another remarkable one for Tufts University School of Engineering (SOE). On June 30, 2011, the university celebrated a successful conclusion to its Beyond Boundaries campaign. Of the more than $1.2 billion raised by the university, the SOE campaign achievement totaled $188 million, exceeding its capital campaign goal by more than 25 percent. In addition to the substantial gains realized in student support and unrestricted endowment, this campaign achievement reflects an increase in the number of endowed SOE professorships from one to seven.

This was a record year for admissions, with both undergraduate and Ph.D. applications up significantly. The incoming undergraduate class of 2015 is the largest and most selective in the school’s history. We launched a new and highly successful engineering summer bridge program to increase our underrepresented and first-generation student population. Our Ph.D. cohort has also grown substantially, with the number of matriculating students increasing by 40 percent between 2009 and 2010. Expansion of our M.S. program in engineering management has continued as planned, and exciting new cross-disciplinary educational programs, including a minor in music engineering and a joint Ph.D. in computer science and cognitive science, have been launched at both the undergraduate and graduate levels. In addition, we have been extremely successful in garnering new external fellowship support for our graduate students and programs, including a National Science Foundation IGERT Award for a new Ph.D. program in water diplomacy.

It has also been a wonderful year for our faculty. This academic year we welcomed four new full-time tenure/tenure track faculty members and awarded the school’s first Alvin H. Howell Endowed Professorship in Electrical Engineering. We also celebrated many prestigious national and international faculty honors, including a Guggenheim Fellowship, the 2011 IEEE Computer Science and Engineering Undergraduate Teaching Award, the Anita Borg Institute 2011 Women of Vision Award, and three coveted early career awards.

Consistent with the tremendous growth of our research enterprise over the previous five years (approximately 300 percent), research productivity has continued to expand this year, with FY11 research expenditures exceeding...
$13 million. These expenditures were associated with a 17 percent increase in indirect cost recovery and a nearly 30 percent increase in the number of active grants. For the third year in a row, the SOE leads all Tufts schools in technology transfer activity, accounting for 57 percent of all Tufts intellectual property disclosures in FY11. With the award of a significant grant from the National Science Foundation, we have initiated construction of a new environmental sustainability laboratory and have renovated leased space to house an exciting new Interdisciplinary Laboratory for Computation.

In this time of celebration and transition in university leadership, the SOE leadership and faculty engaged in a strategic evaluation of our SOE academic vision statement, revising it to reflect the tremendous progress of the past eight years and to guide the SOE in its growth and strategic planning over the next five years. The new vision statement identifies three cross-cutting strategic areas: Engineering for Human Health, Engineering for Sustainability, and Engineering the Human/Technology Interface.

Details of these and other highlights are provided in the following pages.

**Academic Vision**

The last review of the SOE's academic vision was undertaken more than six years ago. This year, the SOE leadership and faculty engaged in a process to recast the school's academic mission and vision to reflect the tremendous progress of the past eight years and to guide the SOE in its growth and strategic planning over the next five years. The revised vision better articulates the distinctiveness of the Tufts learning environment and incorporates a new mission statement, in which the SOE's educational, research, and leadership roles are clearly delineated. The vision also identifies three cross-cutting strategic areas selected to provide opportunity for significant societal impact, build on faculty expertise and leadership, leverage opportunities for multidisciplinary engagement, and resonate with university priorities: Engineering for Human Health, Engineering for Sustainability, and Engineering the Human/Technology Interface. (For the complete statement, see engineering.tufts.edu/about/mission.htm.)
Faculty Achievements

Fiorenzo Omenetto, professor in the Department of Biomedical Engineering (BME), received a fellowship from the John Simon Guggenheim Memorial Foundation, the only fellowship awarded in engineering for 2011. This prestigious award will support Omenetto’s efforts to demonstrate the first implantable and fully bioresorbable optical and electronic components that seamlessly integrate into living tissue. Professor Omenetto was also invited to give a TED talk on his work on silk-based systems being undertaken with David Kaplan, Stern Family Professor in Engineering and BME chair. The pair continues to make headlines, with the New York Times featuring their silk research as the lead story in the science section and National Public Radio interviewing Kaplan for Science Friday, focusing on their paper in Science. Fortune magazine named Professor Omenetto one of the “50 smartest people in tech.”

Dean Linda M. Abriola was recognized among the top American women in science, appearing in American Women of Science Since 1900, an encyclopedia focused on 500 of the 20th century’s most notable American women scientists. The Anita Borg Institute named Professor Karen Panetta (ECE) the 2011 Women of Vision Award winner in the Social Impact category. She was recognized specifically for her contributions in innovating successful low-cost methods for disseminating engineering and science to youth, parents, educators, and the general public to help recruit young women to the STEM disciplines.

Electrical and Computer Engineering (ECE) Professor Aleksandar Stanković was named the first holder of the Alvin H. Howell Endowed Professorship in Electrical Engineering for his research on electric energy processing for distributed energy systems. This professorship was established with support from a charitable gift by the late Frank Doble, E1911, founder of Doble Engineering. Professor Howell helped foster a longstanding relationship between the university and Doble Engineering, where he served for many years as a director and chair of the board. Doble’s estate plan yielded $136 million to Tufts, the largest individual gift in university history.
Three of our junior faculty members were honored with early career awards this year. Assistant Professor Tom Vandervelde, the John A. and Dorothy M. Adams Faculty Development Professor in the Department of Electrical and Computer Engineering, received two early career awards, a National Science Foundation (NSF) CAREER award and an Air Force Office of Science Research’s Young Investigator Program award for his research on thermophotovoltaics and photodetectors and their impact on a new class of green technologies. In the Department of Computer Science (CS), Assistant Professor Sam Guyer received an NSF CAREER award for his research to improve software performance and reliability. Catherine K. Kuo, assistant professor of biomedical engineering (BME), received the Basil O’Connor Starter Scholar Research Award from the March of Dimes Foundation for her research, which has implications for birth defects therapeutics, as well as regenerative medicine and tissue engineering.

Professor Steven Chapra of the Department of Civil and Environmental Engineering (CEE) was named a fellow of the American Society of Civil Engineers (ASCE) and his colleague Associate Professor Laurie Baise (CEE) was elected to the board of the Seismological Society of America. Computer Science Professor Kathleen Fisher was elected a fellow of the ACM for contributions to programming language design, theory, and practice, and for service to the computing community. The year also marked the awarding of tenure and promotion to two junior faculty members, Associate Professors Valencia Joyner (ECE) and Robert White in the Department of Mechanical Engineering (ME).

Ben Hescott, senior lecturer in computer science, was the recipient of the 2011 IEEE Computer Science and Engineering Undergraduate Teaching Award. This international award is given annually by the IEEE Computer Society, the world’s leading organization of computing professionals, to recognize an individual for outstanding contributions to undergraduate education. Hescott received the award “for making computer science accessible to a broad spectrum of students through his energy, enthusiasm, and dedication to teaching.” He was also recently interviewed by the Boston Globe about his teaching methodology and beliefs.
Many of our professors also received teaching and advising awards from Tufts. Hescott received Tufts’ Lerman-Neubauer Prize for outstanding teaching and advising, awarded annually to a faculty member who has had a profound intellectual impact on students, both inside and outside the classroom. Professor of the Practice Eric Hines (CEE) received the Henry and Madeline Fischer Award, awarded annually to a faculty member judged by SOE seniors to be Engineering’s Teacher of the Year. Assistant Professor Matt Panzer (ChBE) was named the Arts, Sciences, and Engineering (AS&E) Gerald R. Gill Professor of the Year for distinguished scholarship, teaching, leadership, and advising. Tom Vandervelde (ECE) received an AS&E Graduate Studies Office Faculty Teaching and Mentoring Award.

Associate Provost and Professor Vincent Manno (ME) was honored with the Seymour Simches Award for Distinguished Teaching and Advising. This award recognizes Professor Manno’s nearly three decades of service to the university. Prior to his appointment as associate provost, he served as chair of the Department of Mechanical Engineering, associate dean of engineering for graduate studies, and dean ad interim of engineering. Dr. Manno has left Tufts for Olin College of Engineering, where he assumed the role of provost and dean of the faculty in July 2011.

School of Engineering Awards

Richard A. Meserve, A66, president of the Carnegie Institution for Science, received the school’s first Vannevar Bush Dean’s Medal. Michelle Williams, EG86, professor in the Department of Epidemiology at the School of Public Health, University of Washington, received the Outstanding Career Achievement Award. Engineering Overseer Robert Haber, E79, E80, CEO and CIO at Haber Trilix Advisors, received the Outstanding Service Award.
Jim Kaklamanos, E08, EG10

2010 Outstanding Graduate Contributor to Engineering Education

For enhancing significantly the education programs of the department (Civil and Environmental Engineering) through teaching-assistant work, voluntary service, and other activities.

My primary area of research is in the field of geotechnical earthquake engineering; in particular, I study the behavior of earthquake ground motions, methods of predicting the amount of ground shaking during an earthquake, and how seismic waves are amplified by near-surface geologic materials. The recent catastrophe in Haiti has reminded the world just how powerful and devastating earthquakes can be. Humans will likely never be able to prevent earthquakes from occurring, but it is possible to design structures that can withstand earthquakes. That’s where my research comes in— I hope that someday my research contributions will influence our understanding of these earthquake phenomena and ultimately help save lives.

I have served as a teaching assistant in introductory engineering courses for the past two years. Most engineering students take the two-course sequence in their first year at Tufts, and it's the first time they are introduced to the fundamental tools used in engineering. Learning to think like an engineer is not an easy task, but it’s so satisfying to have a positive impact and help students achieve this goal. Tufts’ graduate students are trained to be great teachers as well as great researchers.
STUDENT ACHIEVEMENTS

Research related to processing X-ray backscatter images like those collected at airport security checkpoints earned ECE senior Cam Allen a spot at a Gordon research conference. Senior mechanical engineer Matt Kelly, E11, received an NSF Graduate Research Fellowship to pursue his doctorate in robotics at Cornell University. CS senior Shilpa Nadimpalli, A11, also received an NSF Graduate Research Fellowship to pursue her graduate education in computational biology at Princeton University. Electrical engineering and computer science seniors Calvin Hopkins (ECE), Ethan Setnik (CS), and Andrew Purcell (CS) participated in the IEEEXtreme programming competition where their team “LookMaWatchMeCode” placed first in the region and 69th in the world. Three sophomore chemical and biological engineering (ChBE) majors John Abel, Kim Stachenfeld, and Jay Stotsky placed in the top 15 percent of more than 2,000 participating teams in a recent international mathematical modeling competition. BME junior Adhvait Shah won a Tau Beta Pi senior scholarship. The American Heart Association awarded Katherine Tang, E12, a research fellowship to study how the extracellular environment present in injured hearts affects the ability of transplanted stem cells to grow into functional cardiac muscle cells. Emir Magden, E12, won a scholarship in photonics from SPIE, the international society for optics and photonics. As co-captains of the Tufts lacrosse team, seniors D. J. Hessler (BME) and Alec Bialosky (CEE) led the team to its second straight title in the New England Small College Athletic Conference.

Graduate student Allison St. Vincent (CEE) received an EPA STAR Graduate Fellowship and a Scholar Award from the Philanthropic Educational Organization, one of the pioneer societies for women, for her research on ultrafine particles in air pollution. Among our other graduate student award winners, Kostantinos Tsioris (BME) received a Dow Sustainability Innovation Student Challenge award for his research on a biological platform to detect bacterial infections with low-cost, green technology. Jeff Brown, BME doctoral candidate, was awarded the Savio L-Y Woo Young Researcher Award for his work on ligaments and tendons. The International Precious Metals Institute selected doctoral student Matthew Boucher (ChBE) as recipient of the 2011 Johnson Matthey Student award for his work with precious metals as catalysts for the steam reforming of methanol reaction. Tufts’ award winners included former president of the Graduate Student Council, Joanna Xylas (BME), who received the 2011 Robert P. Guertin Graduate Student Leadership Award; Andrew Winslow (CS) and Nan Yi (ChBE), who received Outstanding Graduate Researcher awards for their master’s and doctoral research, respectively; Matthew Toia (TGI), who received the Gordon Institute Outstanding Student Award for superior academic performance and demonstrated technical leadership; and Karen Kosinski (CEE), who was recognized as an Outstanding Graduate Contributor to Engineering Education.
To create robots, it’s necessary to study animals. That’s the belief of postdoctoral engineering associate Huai-ti Lin, Ph.D. For his doctoral thesis, Lin analyzed the movements of the tobacco hornworm, a caterpillar that contracts its body like an accordion when it crawls, to design a simple neural system for a robot that moves in a similar way. From the larva of a mother-of-pearl moth, Lin borrowed the concept of ballistic rolling. This allows the robot to curl into a ball and propel itself forward at high velocity, moving in a matter of milliseconds from a complete standstill to a speed of more than 50 centimeters per second.

As part of his research in neuromechanics of soft-bodied locomotion, Lin also studied nonlinear behaviors of soft materials and worked in the Mechanics of Soft Materials Laboratory at the School of Engineering.

Next on the horizon for this promising researcher: robotic flying vehicles, for which Lin is now exploring animal modes of flight. Real-world applications in biomedical engineering, search-and-rescue operations, and space exploration will be built on Lin’s published findings.
UNDERGRADUATE AND GRADUATE ADMISSIONS

This was another banner year for the School of Engineering, with freshman applications up by more than 13 percent. This represents the SOE’s fifth consecutive record-breaking applicant pool, with a total increase in applications of nearly 50 percent since 2006. With an acceptance rate of 26 percent and an enrolled class of 227, the Class of 2015 is the most selective, and the largest, in SOE history. Consistent with last year’s statistics, financial aid remained strong, with 45 percent of the admitted class receiving Tufts grants. The SOE is also improving its recruitment and enrollment of underrepresented students. Of the enrolled freshmen, Americans of color make up 26 percent (up from 24 percent in 2009) and women make up 28 percent, surpassing the national average of 19 percent. Our students’ academic qualifications continue to raise the bar, with 93 percent in the top 10 percent of their class, a new record high, a mean class high school rank of 4 percent, and SAT-Math scores of 751 (up 10 points from 2008). The middle 50 percent of incoming engineers continue to score between 720 and 780 on the SAT-M. The Class of 2015 includes students from 32 states. Seven percent are foreign citizens, and more than 60 percent of the class come to Tufts SOE from public high schools.

The number of graduate applications continues to climb, increasing nearly 14 percent over last year (from 780 in fall 2010 to 892 in fall 2011), with more applications to both master’s and doctoral programs. The AY10–11 incoming doctoral student cohort, including our first scholar from the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM), was 40 percent larger than last year’s matriculating group, and the incoming 2011 Ph.D. cohort is expected to exceed this record number. More importantly, the quality of our fellowship applicant pool continues to increase. A record number (eight) of our Provost and Dean’s Fellowship offers were accepted, including an award made to the first Clare Boothe Luce Fellow to support women in computer science. In AY11–12, two additional GEM and Luce Fellows will join our engineering doctoral programs. We continue to see an upward trend in the number of doctoral degrees granted with 25 Ph.D.s awarded in 2011, more than twice the number in 2007. Our current students are also receiving important internal fellowships. This year, three of our doctoral students received Tufts Graduate Institute for Teaching (GIFT) fellowships to prepare them to enter academic careers.
Under the leadership of Dr. Robert Hannemann, director of Tufts Gordon Institute (TGI), the institute completed a two-year planned expansion of its M.S. in engineering management (MSEM) program, with enrollment growing by 80 percent over AY08–09. Interest in the MSEM program continues to be strong, and TGI will enroll 60 new students in September 2011, bringing the total MSEM enrollment in AY11–12 to 122. Since the inception of TGI’s Engineering Leadership Studies minor in 2002, the program has grown from an offering of a few courses annually to a thriving academic minor with 12 course sections per semester. Last year, more than 550 students were enrolled in the program and 48 seniors completed the minor.

<table>
<thead>
<tr>
<th>Engineering Program</th>
<th>Fall 2010 Enrollment</th>
<th>Degrees Granted&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS&lt;sup&gt;2&lt;/sup&gt;</td>
<td>ME</td>
</tr>
<tr>
<td>Biomedical Engineering</td>
<td>50</td>
<td>7</td>
</tr>
<tr>
<td>Biotechnology Engineering</td>
<td>—</td>
<td>4</td>
</tr>
<tr>
<td>Bioengineering</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Chemical Engineering&lt;sup&gt;*&lt;/sup&gt;</td>
<td>129</td>
<td>5</td>
</tr>
<tr>
<td>Civil Engineering&lt;sup&gt;*&lt;/sup&gt;</td>
<td>98</td>
<td>9</td>
</tr>
<tr>
<td>Computer Engineering&lt;sup&gt;*&lt;/sup&gt;</td>
<td>27</td>
<td>—</td>
</tr>
<tr>
<td>Computer Science&lt;sup&gt;*&lt;/sup&gt;</td>
<td>55</td>
<td>—</td>
</tr>
<tr>
<td>Electrical Engineering&lt;sup&gt;*&lt;/sup&gt;</td>
<td>76</td>
<td>—</td>
</tr>
<tr>
<td>Engineering Management</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Engineering Physics</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Engineering Psychology/Human Factors</td>
<td>12</td>
<td>—</td>
</tr>
<tr>
<td>Engineering Science</td>
<td>31</td>
<td>—</td>
</tr>
<tr>
<td>Environmental Engineering&lt;sup&gt;*&lt;/sup&gt;</td>
<td>48</td>
<td>—</td>
</tr>
<tr>
<td>Mechanical Engineering&lt;sup&gt;*&lt;/sup&gt;</td>
<td>174</td>
<td>8</td>
</tr>
<tr>
<td>Engineering&lt;sup&gt;**&lt;/sup&gt;</td>
<td>4</td>
<td>—</td>
</tr>
<tr>
<td>No Major Declared</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>TOTAL</td>
<td>710</td>
<td>39</td>
</tr>
</tbody>
</table>

<sup>*Engineering degree programs accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET).</sup>

<sup>**Includes Civil Engineering degrees in Architectural Studies and Environmental Health.</sup>

<sup>1 Enrollment of first majors as of 3/14/11</sup>

<sup>2 Computer Engineering degrees under Electrical Engineering</sup>
The SOE continues to enjoy significant growth and momentum in research productivity. Total annual research expenditures in FY11 were at record highs, exceeding $13M, and FY12 expenditures are projected at similar levels, with a nearly 17 percent growth in indirect cost recovery (ICR) over FY10. Faculty submitted 282 proposals and had 220 active grants (up 28 percent from FY10), with 131 new and supplemental awards. Of the grant funding received, more than 75 percent was balanced among National Science Foundation (NSF), National Institutes of Health (NIH), and Armed Forces grants. These encouraging research trends reflect active involvement of an increasing number of SOE faculty members in research (74 percent of faculty are now funded compared to 46 percent in FY03) and demonstrate the caliber of our recent hires and the success of our strategically focused interdisciplinary research model.

**Sources of Grant Funding**
Fiscal Year 2011

- NIH 32%
- Armed Forces 24%
- Private & State 14%
- NSF 22%
- MiscFed & USDA 3%
- DOE & EPA 5%
- DHHS 0%

**SOE Proposals Submitted FY 2011**
July 1, 2010–June 30, 2011

- FY 2008: 172
- FY 2009: 268
- FY 2010: 281
- FY 2011: 282
Proposal Submissions by Sponsor FY 2011
(all sponsor categories)

Research Dollars
(in Millions)

Expenditures
Indirect Cost Recovery
The following sections highlight significant achievements in interdisciplinary research and education in SOE strategic areas.

**Engineering for Human Health**

Associate Professor John Durant (CEE) is part of the research team of the Community Assessment of Freeway Exposure and Health (CAFEH) study led by Doug Brugge, professor of public health and community medicine at Tufts University School of Medicine. CAFEH is funded by a $2.5 million grant from the NIH to study pollution in Boston communities near major highways in collaboration with community organizations. Durant recently received additional funding from the U.S. Department of Housing and Urban Development to study highway pollution within homes in these areas.

David Kaplan, BME chair and Stern Family Professor, and Research Professor Barbara Brodsky received funding from the NIH to investigate recombinant bacterial collagens and biomaterial applications, which include providing a biological scaffold to promote bone generation by human stem cells. Brodsky received additional funding from NIH’s National Institute of General Medical Sciences for research into protein folding and collagen deficiency disease. Professor Sergio Fantini and Research Assistant Professor Angelo Sassaroli received NIH funding to further their work on noninvasive functional imaging of the brain. Research Associate Professor Robert Peattie and Associate Professor Luis Dorfmann (CEE) received an NSF grant to develop an integrated approach to analyze abdominal aortic aneurysm biomechanics.

Assistant Professor Blaine Pfeifer (ChBE) and colleagues from MIT have engineered *E. coli* bacteria to produce large quantities of a critical compound that is a precursor to the cancer drug Taxol. The procedure, described in the journal *Science*, could bring down the manufacturing costs of Taxol and also help scientists discover potential new drugs for cancer.

In collaboration with researchers at Brigham and Women’s Hospital, Eric Miller (ECE) is developing a set of algorithms and an associated computational toolbox to improve automation of biomedical imaging of objects such as vasculature or neuronal structures, which currently require significant human interaction to interpret.
Engineering for Sustainability

The Department of Civil and Environmental Engineering received $1.6 million from the NSF to create a state-of-the-art Environmental Sustainability Laboratory (ESL) that will support multidisciplinary experimental and mathematical modeling research to advance the fundamental understanding of the fate, transport, and control of emerging contaminants in multimedia (air, water, and soil) environmental systems.

The water-gas shift (WGS) reaction is a key step in all carbon-based fuel processing aimed at producing and upgrading hydrogen. In the journal *Science*, Haber Professor Maria Flytzani-Stephanopoulos (ChBE) and colleagues at the University of Wisconsin-Madison demonstrated new advances in the design of highly active, stable, and low-cost WGS catalysts, which could be suitable for onboard hydrogen production in fuel-cell-powered vehicles of the future.

Howell Professor Aleksandar Stanković’s (ECE) NSF-funded research looks at developing a better framework to address energy systems. This new model may prove relevant for analysis of failures of power systems connected with other infrastructures, and real-time control to address these issues.

Assistant Professor Jason Rife (ME) received funding from the Federal Aviation Administration to research enhanced navigation capabilities for aircraft, which will ultimately decrease fuel wasted in the takeoff and landing.

A $4.2 million NSF Integrative Graduate Education and Research Traineeship (IGERT) grant was awarded to Professor Shafiqul Islam (CEE) and his colleagues to develop an interdisciplinary doctoral program in water diplomacy. This program leverages our school’s strength in sustainable water research and capitalizes on faculty expertise in the Fletcher School and the School of Arts and Sciences. The program will enroll five students in fall 2011 with varied expertise—from international human rights law to hydrology in developing countries—underscoring the interdisciplinary nature of the program.
The challenge: create opportunities between Middle East nations for cooperative water management that will not only save hundreds of millions of dollars per year, but will also set an example for the entire world. The answer: “It takes a university,” says Professor Richard Vogel, Faculty Committee chair for the Water: Systems, Science, and Society (WSSS) program.

Challenges like this excite the WSSS faculty and students, because the answers and the collaborations are unlimited. Water itself is a complex issue that moves beyond political, environmental, and health-care issues, which is why WSSS encompasses participants from five of Tufts’ graduate schools.

From coastal flooding to natural-disaster prevention to the spread of infectious disease, WSSS is tackling an endless spread of global complexities as students from designated schools are able to achieve a certificate and research experience in water-related issues. John Parker, F12, N12, says his research topic of integrated land and water management came to fruition through weekly WSSS research meetings.

“They allowed me to brainstorm my ideas with a diverse group of faculty members and students representing different disciplines,” says Parker, who was able to carry out his fieldwork in Honduras thanks to funding from a WSSS research fellowship. “It provided a one-of-a-kind opportunity to carry out international water research.”

“WSSS is a fantastic program,” adds Jeffrey Cegan, EG12, another WSSS fellowship recipient, whose research explores efforts to mitigate the adverse effects of climate-induced surprises. “Coming from an economics background and now being an engineer, I really appreciate the inclusiveness of this program—every background and perspective is accepted and valued.”

*WSSS Fellows John Parker, left, and Jeffrey Cegan at the mouth of the Mystic River in Chelsea, Mass.*
Matthias Scheutz holds two Ph.D.s and prior faculty positions in computer science and engineering, cognitive science, and philosophy of science. Currently he is working with other Tufts faculty to develop a joint Ph.D. program in cognitive science. “He challenges students to implement their ideas of what it takes to make robots smart, while asking them to reflect on the ethical and societal implications of technology,” says Carla Brodley, professor and chair of computer science.

Scheutz’s research is focused on enabling robots to interact with people using natural language. “Conversations, sentence fragments, the kind of spontaneous speech we use: how do we incorporate this language processing into artificial intelligence? It’s very easy for people, but hard for machines,” he says.

“We are moving toward a human-robot society. We already have lots of simple robots like robot vacuum cleaners, robot toys, and rescue robots, but this is only the beginning. For future, more complex robots, the goal is to give them instructions in natural language—so your household robot will be able to prepare dinner for you when you come home at eight. This degree of naturalness won’t be realized any time soon. But what we are learning now sheds light on cognitive processes in humans, on how people talk and interact and understand each other.

“Tufts is small, and people are talking to each other. I was attracted by the prospect of building a graduate program in cognitive science that will bring together expertise in language, philosophy, psychology, biology, and engineering.

“It’s important for undergrads to become involved early on in research, to ask questions and then work on them. I encourage my students in computer science, If you think you have a way to get robots to recognize objects or navigate through the building, then go do it!”

Matthias Scheutz is an associate professor of computer science with a secondary appointment in psychology. He is also the director of the Human-Robot Interaction Laboratory. He is supported by grants from the Richard A. and Susan F. Smith Presidential Initiatives Fund, and the Michael and Christina Gordon Fund.
Engineering the Human-Technology Interface

Professor David Kaplan and collaborators from Arts, Sciences & Engineering, as well as the University of Illinois Urbana-Champaign, received $4.5 million from the U.S. Defense Advanced Research Projects Agency (DARPA) to expand his research into robot systems built from biological sources, encompassing biofuels to power the systems, biopolymer structural parts, reversible bioadhesives to assist walking and climbing, and insect cells to support muscle functions.

Associate Professor Matthias Scheutz’s (CS) research focuses on enabling robots to interact with people using natural language, including sentence fragments, pauses, and exclamations. A grant from the Office of Naval Research will help Scheutz address fundamental problems involving knowledge representation, natural language communication, and human-robot interaction.

Assistant Professor Remco Chang (CS) received NSF funding to use visual analytic techniques to uncover causal mechanisms underlying the intensity of violent political conflict across space and time in order to develop actionable policies to quell such activities. His collaborators, including researchers at the University of North Carolina at Charlotte, specifically seek to understand how government actions, and in particular U.S. government actions, can mitigate the intensification of violent political conflict.

Associate Professor Sameer Sonkusale (ECE) and Assistant Professor Rob White (ME) received research funding for improvements in sensing. White received support from Draper Labs for research on a miniature navigation system to assist in the development of technology for hazardous environment surveillance and safety applications. With collaborators at Boston College, Sonkusale received funding from the NSF to develop an ultrasensitive terahertz spectrometer to capture biomolecular processes in real time.

This year, in collaboration with the School of Arts and Sciences, the SOE developed and launched two new educational initiatives that relate to its human/technology interface strategic theme. A new minor in music engineering will teach students the technologies behind music-making, both traditional and modern, and explore how new technologies can be applied to musical goals. The joint interdisciplinary doctoral program in computer science and cognitive science will focus on language and help strengthen Tufts’ leadership position in the science of the mind. This new joint Ph.D. program complements and strengthens the recently implemented cross-school undergraduate program in cognitive and brain science.
Engineering Education Innovation

A $3.2 million NSF grant was awarded to Chris Rogers, director of the Center for Engineering Education and Outreach (CEEO), and his collaborators to better understand how Massachusetts educators can use literature to teach science, technology, and engineering concepts. Funding from the NSF will help launch Tufts’ Integrating Engineering and Literacy (IEL) project, which uses familiar characters in children’s literature to learn about problem-solving and the engineering design process, as well as critical reading skills. The CEEO will work with more than 100 in-service teachers and their K–5 students in the commonwealth over a period of five years to develop six interdisciplinary engineering and literature curricular units.

Associate Professor Chris Swan (CEE), in association with researchers from the CEEO and four other universities, also received NSF funding to better understand the motivations, obstacles, and strategies for engineering faculty who currently offer learning-through-service (LTS) opportunities and to increase the involvement of engineering faculty engaged in LTS. A growing body of evidence has shown that LTS activities have positive benefits for engineering students, particularly those from underrepresented groups.

Technology Transfer

The Tufts Office of Technology Licensing and Industrial Collaboration reported 51 invention disclosures from across the university in FY11; of these, the SOE leads all Tufts schools, accounting for 57 percent (29). This is the third consecutive year that the SOE has led all other schools in disclosures across the university.
Over the past six years, the SOE has made substantial strides in increasing faculty critical mass and diversity. In AY03–04, the SOE had 54 tenure-track/tenured faculty members, of whom 8 were women and 9 were ethnic minorities. By AY10–11, the size of the faculty has increased to 73, of whom 16 are women and 16 are ethnic minorities. Our percentage of female faculty members (22 percent) continues to be well above the national average of 13.2 percent.

This year, we welcomed new tenure-track faculty members and research faculty who have bolstered our research and teaching programs. In the fall, Professor Elena Naumova (CEE) joined us in a transition from Tufts University School of Medicine. Naumova (Ph.D., Novosibirsk State Technical University in Russia) continues as the director of the Tufts Initiative for the Forecasting and Modeling of Infectious Diseases (InForMID), as well as the director of the Health and the Environment research section of the Tufts Institute of the Environment. Dr. Naumova’s research interests as a biostatistician include the development of analytical tools for time series and longitudinal data analysis as applied to disease surveillance, exposure assessment, environmental epidemiology, and studies of growth.

In spring 2011 we welcomed Kathleen Fisher (Ph.D., Stanford University) to the Department of Computer Science as a full professor. She recently held the position of principal member of the technical staff at AT&T Labs Research and worked as a consulting professor in computer science at Stanford University. She serves on the Computing Research Association Board and is an ACM distinguished scientist and an ACM fellow. Fisher’s research focuses on advancing the theory and practice of programming languages and on applying ideas from the programming language community to the problem of programming with massive amounts of ad hoc data. Fisher will be joining the DARPA in the Information Innovation Office as a program manager for a two-year appointment, further strengthening our school’s connection with this governmental research agency.

Two new assistant professors, Shuchin Aeron (Ph.D., Boston University) and Usman Khan (Ph.D., Carnegie Mellon) joined the Department of Electrical and Computer Engineering. Aeron comes to the SOE from his research scientist position with Schlumberger-Doll Research in Cambridge, Mass. His research interests lie in network information theory, sensor networks, compressed sensing, and statistical signal processing. Khan comes to Tufts from his postdoctoral research position at the University of Pennsylvania’s School of Engineering and Applied Sciences, where he has conducted research on power systems modeling and estimation using sensor networks.
John F. Hodgman (TGI) was appointed as the first Professor of the Practice in TGI’s Entrepreneurial Leadership Studies faculty. Hodgman is former president and CEO of the Massachusetts Technology Development Corporation (MTDC) and the Howard Foley Professor for High Tech Workforce Development at the School of Engineering at the University of Massachusetts. This year, Hodgman was also elected to the board of directors of the Massachusetts Biotechnology Education Foundation, an organization that seeks to support science and biotechnology education in Massachusetts through school programs and workforce training.

We also welcomed a number of new research faculty members. Itza Mendoza-Sanchez (Ph.D., Texas A&M University) joined SOE in the winter as a research assistant professor in the CEE department. Her research centers on abiotic and biotic processes that relate to the prevention and mitigation of soil and groundwater contamination. Other new CEE research assistant professors include David Small (Ph.D., University of Cincinnati) whose work focuses on global hydrologic processes and environmental impacts of climate change and Eric Thompson (Ph.D., Tufts University) whose research areas include modeling of soil behavior and incorporating the effects of soil response on seismic hazard maps. The ME department welcomed Research Associate Professors Shu Ching Quek (Ph.D., University of Michigan) whose research focuses on wind energy engineering, and Pratap Misra (Ph.D., University of California) who is developing navigation systems that combine multiple sensors, databases, and communication networks. In ECE, Research Assistant Professor Brian Tracey (Ph.D., MIT) joined the faculty with expertise in image processing and computational acoustics, Research Assistant Professor Alan Hoskinson (Ph.D., University of Wisconsin-Madison) with research interests relating to applications for high-pressure plasmas, and Research Professor Mary Beth Ruskai (Ph.D., University of Wisconsin-Madison) with research interests in quantum computing and quantum information theory.
ADVANCEMENT

Tufts saw the end of its Beyond Boundaries campaign this year, exceeding its $1.2 billion goal. The SOE completed its campaign with $188 million in achievement, exceeding its $150 million goal by more than 25 percent. In fiscal year 2011, alumni, friends, parents, and organizations gave the SOE $7.3 million for endowment, capital plant, and current-use support. Highlights included a fully endowed scholarship, the Devejian Family Scholarship for needy students, created by the estate of Robert Devejian, E44, and a pledge by SOE Board of Overseers Chair Steven Karol, A76, A04P, A13P, and his wife, Michelle, A04P, A13P, to fund the Karol Family Professorship. This latter professorship will be the sixth SOE professorship to be funded in the Beyond Boundaries campaign, increasing the total endowed positions in the school to seven. (A listing of major gifts to the school begins on the next page.)

In February 2011, Cynthia LuBien joined the SOE leadership team as our new senior director of development. Most recently, LuBien was the director of campaign and major gifts at the Perkins School for the Blind. Prior to that position, she worked at MIT in several different capacities, including senior director for strategic initiatives in the Office of the Associate Provost and the Center for Cancer Research, assistant dean for development in the School of Science, and director of development in the Harvard-MIT Division of Health Sciences and Technology. Dr. LuBien holds B.S. and Ph.D. degrees in chemistry (from Purdue University and MIT, respectively) and an M.B.A. from Southern Methodist University.

One highlight of the Corporate and Foundation Relations activity in the past year was the receipt of two Clare Booth Luce Graduate Fellowships from the Luce Foundation. These prestigious fellowships will be awarded to exceptional women students entering doctoral studies in computer science. We also competed successfully for an additional Draper Laboratory Fellowship; Tufts SOE is now one of Draper’s “preferred partners.” The outstanding research in biomedical engineering was recognized with a number of large gifts, including one from F. Hoffman-LaRoche to Department Chair David Kaplan. The Verizon Foundation awarded a grant of $60,000 to the CEEO’s Student Teacher Outreach Mentorship Program. Senior Vice President of Customer Care and Operations for Verizon Business, Engineering Overseer, and Tufts University Trustee Jeannie Diefenderfer, E84, and Stephanie Lee, Verizon’s director of external affairs, visited Tufts to present the check.
We are grateful to all of the alumni, friends, and organizations who have supported the School of Engineering. Gifts of $10,000 or more in the past fiscal year are listed below.*

**Gifts and Payments to Existing Funds**

- Estate of Dorothy M. Adams in support of the Doble Lab
- Mr. Fahd A. Alireza, E80, in support of the School of Engineering
- Mr. Charles F. Auster, A73, in support of the Entrepreneurial Leadership Program
- Mr. Ivan Xavier Baquerizo, E89, in support of the School of Engineering
- Dr. Robert H. Bedoukian, E70, A02P, and Bedoukian Research in support of the School of Engineering
- Mr. Frederic Berger, A69, and Ms. Elizabeth Brannan, J69, in support of the Dean of Engineering Discretionary Fund and Engineering Without Borders
- Mr. Jordan Birger, E43, in support of the Dean of Engineering Discretionary Fund
- Mr. Kenneth Bloom, E85, A14P, and Mrs. Debra Bloom, J85, A14P, in support of the Kenneth L. and Debra L. Bloom Endowed Scholarship Fund
- Mr. James Burstein, A76, J77, A05P, A08P, and Mrs. Linda Burstein, J77, A05P, A08P, and Admiral Metals Inc. in support of the Entrepreneurial Leadership Program
- Dr. Stanley E. Charm, E79P, J82P, D85P, in support of the Department of Chemical Engineering
- Mr. Richard John Coar, E42, in support of Engineering Financial Aid
- Mr. Robert Coutts, E72, and Mrs. Ingrid Coutts, J74, in support of the School of Engineering
- Mr. Jonathan Curtis, E69, EG72, AG05P, in support of the Zeta Psi Class of 1969 Scholarship in Memory of Paul Montle
- Ms. Jeannie H. Diefenderfer, E84, in support of the Jeannie H. Diefenderfer Endowed Scholarship Fund
- Mr. Abraham Dranetz, E44, J84P, and Mrs. Marianna Dranetz, J84P, in support of the Abraham and Marianna Dranetz Endowed Scholarship Fund and the Director’s Fund for Library Excellence
- Dr. Jeffrey Drazen, A68, and Mrs. Erica L. Drazen, E68, in support of the School of Engineering
- Mr. Jonathan D. Durst, E78, A12P, and Mrs. Michaelene Durst, A12P, in support of the Steve Tisch Sports and Fitness Center
- Mr. John H. Foster, E52, E82P, in support of the Watershed Center
- Mr. Frederick J. Emmett Jr., E66, and Mrs. Marcia Emmett in support of the Emmett Scholarship Fund
- Mr. Andrew J. Frommer, E79, in support of the School of Engineering
- Ms. Neva Goodwin in support of the Center for Regional Sustainability
- Mrs. Kimberly A. Hartman, J85, in support of the Entrepreneurial Leadership Program
- Estate of Ernest N. Hellberg, E49, in support of the School of Engineering
- Mr. Gary Johnson, E76 and Vertrue Inc. in support of the Entrepreneurial Leadership Program Business Plan Competition
- Mr. Lance Johnson, E69, J95P, and Mrs. Susan Johnson, J95P, in support of the School of Engineering

*A full list of our Packard Society and Dean’s Inner Circle donors can be found outside the dean’s office in Anderson Hall. A list of endowed funds and Charles Tufts Society members can also be found inside the Burden Lounge in Anderson Hall.
• Mr. Mark P. Kesslen, E86, and Mrs. Phyllis R. Kesslen, J86, and Lowenstein Sandler in support of the Entrepreneurial Leadership Program

• Mr. John Kokulis, E81, in support of the Entrepreneurial Leadership Program and the Summer Scholars

• Mrs. Ellen J. Kullman, E78, A12P, and Mr. Michael Kullman, A12P, in support of the Steve Tisch Sports and Fitness Center

• Mr. Jon A. Levy, E83, in support of the Reiner Family Term Scholarship

• Ms. Robin S. Liss, A06 in support of the Entrepreneurial Leadership Program

• Dr. and Mrs. John Lutostanski, E08P, in support of the School of Engineering

• Ms. Stacey Coleman Morse, E77, in support of the STOMP program in the Center for Engineering Education and Outreach

• The Normandin Family and Braun’s Express in support of the School of Engineering

• Ms. Carol Lynn Parrella, E85, in support of the Theodore L. & Ruth B. Parrella Endowed Scholarship Fund

• Estate of Miriam and Victor Peterson, E45, in support of the School of Engineering

• Mrs. Erin E. Riecker, E03, AG05, in support of the STOMP program in the Center for Engineering Education and Outreach

• Mrs. Margaret Riker, E12P, in support of the School of Engineering

• Mr. Peter H. Rothschild, E77, and Mrs. Laura Rothschild in support of the Entrepreneurial Leadership Program

• Mr. Matthew Sabel, A97, in support of the Entrepreneurial Leadership Program

• Mr. James Stern, E72, A07P, and Mrs. Jane Stern, A07P, in support of the Steve Tisch Sports and Fitness Center and the School of Engineering

• Mr. and Mrs. Robert Stricker, E69, in support of the Zeta Psi Class of 1969 Scholarship in Memory of Paul Montle

• Mr. James J. Tiampo, E83, A83, and Dr. Kristy F. Tiampo, Ph.D., E83, A83, in support of the School of Engineering

• Mr. Gregory A. White, E78, in support of the Allan H. Clemow Endowed Scholarship Fund and the Entrepreneurial Leadership Program

• Ms. Martha Wyckoff, E77, in support of the School of Engineering

• Mr. Earle Yaffa, E61, and Mrs. Elizabeth Yaffa, J85P, in support of the Entrepreneurial Leadership Program

**Gifts to Establish New Funds**

• Estate of Robert K. Devejian, E44, funded the Devejian Family Scholarship

• Mr. Leonard A. DiLorenzo, E66, funded the Leonard A. DiLorenzo, E66, and Annamarie P. Garceau Endowed Scholarship Fund

• Mr. James B. Flaws, E71, and Ms. Marcia D. Weber, J71, funded the James B. Flaws Endowed Scholarship

• Mr. Stephen Ricci, E67, E88P, J88P, and Mrs. Geraldine Ricci, E88P, J88P, funded the Stephen and Geraldine Ricci Interdisciplinary Prize Fund

• Mr. Ankur A. Sahu, E91, and Mrs. Mari Sahu funded the Ankur and Mari Sahu Endowed Scholarship Fund

• Estate of Gladys Swartwood funded the Gerald L. Swartwood, E46, Endowed Scholarship Fund for Engineering

• Mr. Robert Tate, E46, and Mrs. Joyce Tate, J46, funded the Robert L. and Joyce Tate Term Scholarship
New Pledges and Bequest Intentions

- Mr. William W. Edgerton, E70, pledged to fund the Edgerton Graduate Student Fund
- Mr. Robert Ellis, E46, created a gift in his estate plans for the School of Engineering
- Mr. Steven Karol, A76, A04P, A13P, and Mrs. Michelle Karol, A04P, A13P, pledged to fund the Karol Family Professorship
- Mr. Edward A. White, E47, created a gift in his estate plans for the School of Engineering

Corporate and Foundation Giving

- Cambridge Consultants in support of the Human Factors Program
- Catalyst Foundation in support of research in the Joyner Laboratory
- Clare Booth Luce Program in support of the Luce Fellowships
- Draper Laboratories in support of the Draper Fellowships
- F. Hoffmann-La Roche Ltd. in support of research in the Kaplan Laboratory
- The Kodosky Foundation in support of the Program for Engineers as Teachers
- March of Dimes in support of research in the Kuo Laboratory
- The Mathworks Inc. in support of the Nerd Girls Program
- The James S. McDonnell Foundation in support of the Center for Engineering Education and Outreach
- The National GEM Consortium in support of the GEM Ph.D. Fellowship
- Verizon Foundation in support of the STOMP program in the Center for Engineering Education and Outreach

Dean’s Inner Circle

Honoring Leaders in Giving. Supporting the Engineering Leaders of Tomorrow.

In 2007, Dean Linda Abriola instituted the Engineering Dean's Inner Circle to recognize and celebrate the outstanding contributions of our most dedicated supporters. The Inner Circle honors those alumni who give $100 x the number of years since their graduation. It also recognizes the many generous friends and parents who donate $1,500 or more.

Outside the dean’s office in Anderson Hall, a recognition wall proudly displays the names of our Dean’s Inner Circle. The dean commissions a unique coin each year as a keepsake for members. This year, 97 members make up the Dean’s Inner Circle. They contributed $645,000 during fiscal year 2011!

It’s critical that we recognize the many dedicated alumni and friends who consistently support the School of Engineering, growing with us as we take the school to the next level. The support of our Dean’s Inner Circle reinforces the momentum we have gained in recent years with excellent new faculty members and increased activity in interdisciplinary research. Not only does this program reinforce the significance of giving, but it’s important to me, as dean, to celebrate the individuals who truly are our inner circle of friends.

— Dean Linda Abriola
OUTREACH

Under the leadership of Jonathan Kaplan, A96, alumni relations associate director, our alumni outreach program hosted its fifth annual Boston area reception on integrating LEGO into STEM education, featuring Professor Chris Rogers (ME, CCEO). In the fall, Dean Abriola and James Stern, E72, A07P, chair of the Board of Trustees, hosted a New York area reception on alternative energy, with speakers Tim Lannin, E11, and Professor Aleksandar Stanković. In December, Dean Abriola hosted an American Geophysical Union Conference alumni event on the West Coast with a water sustainability theme. Pamela McNamara, E81, a new member of the Board of Overseers and former president of Cambridge Consultants, gave the fall Lyon & Bendheim Alumni Lecture. Michael Granoff, A91, head of oil independence policies for Better Place, delivered the spring Lyon & Bendheim Alumni Lecture. Focused on energy security, Better Place is developing market-driven, scalable alternatives to gasoline vehicles by production of battery switch stations and charge spots for electric vehicles in Israel, Australia, and Denmark. For the inaugural Alan Shapiro Entrepreneurial Lecture, CTO and co-founder of KAYAK Paul English discussed the criteria for successful entrepreneurs as well as his own path to forming one of the largest Internet travel sites. Former Dean and current Tufts Alumni Trustee Ioannis Miaoulis, E83, AG86, EG87, E12P, A15P, received the Light on the Hill Award, the highest honor bestowed upon an alumnus by the Tufts student body. At the sixth annual Engineering Alumni Weekend Reception, graduates and guests gathered to see a Viswall demonstration by Assistant Professor Remco Chang (CS) and to learn about our structural engineers’ participation in the annual steel bridge contest.

Under the leadership of Robin Kahan, J80, associate director of career services, more than 600 SOE students and alumni had individual consultations with career advisors. The job market for engineering graduates improved significantly this year, as demonstrated by a 137 percent increase in entry-level job listings for engineering/computer science majors. Internship postings were up 29 percent. SOE students received 197 interviews for full-time and intern positions through on-campus and virtual recruiting, almost double the number in 2010. Graduating seniors reported job offers from top companies, including AECOM, CB&I, Dow Chemical, Draper, GE, Genzyme, Goldman Sachs, Microsoft, Navigant, and Woodard and Curran. Employer numbers at career fairs increased with 108 companies (13 percent increase over 2009) participating in the fall Career Fair, 35 percent of whom were specifically seeking engineering/computer science students. Additionally, 47 companies
attended the spring Sci-Tech Fair (36 percent increase) seeking interns and full-time hires from engineering, science, math, and computer science; 17 new companies participated in a virtual consortium career fair.

DIVERSITY

The Center for STEM (Science, Technology, Engineering, and Math) Diversity had another successful year under the leadership of Program Manager Dr. Travis Brown. Of particular note is the Bridge to Engineering Success at Tufts (BEST) program, developed and launched in summer 2010, in conjunction with the Office of Undergraduate Admissions, to increase retention of students from underrepresented groups. BEST had a fantastic first year, with six of the eight participating first-year students making the dean’s list at least one semester during AY10–11. The program continues to expand and a new BEST cohort (11 students) arrived on campus in summer 2011. This year, the Center for STEM Diversity also collaborated with the Center for the Enhancement for Learning and Teaching (CELT) to offer two workshops for faculty and administrators on implicit assumption and bias that may marginalize underrepresented students. Efforts to increase and diversify our undergraduate application pool have expanded with visits to local high schools, including East Boston, Brighton, John D. O’Bryant, and Match Charter School, to talk about STEM fields.
INFRASTRUCTURE DEVELOPMENT

The SOE continues to improve existing space and to lease new space to support its mission. Over the past seven years, we have invested more than $6 million to renovate space in our buildings. Our current inventory of buildings on campus are 4 Colby Street (Sci Tech), Anderson Hall, Halligan Hall, Bray Hall, and Curtis Hall. We lease space at 200 Boston Avenue and 196 Boston Avenue, and soon will be adding space on the first floor of 550 Boston Avenue.

This year, we renovated space at 4 Colby Street for the Unit Ops undergraduate teaching lab for ChBE, and began planning the NSF-sponsored Environmental Sustainability Laboratory (ESL) in Anderson Hall. The latter will encompass renovation of more than 6,000 square feet of CEE’s current research and teaching space.

Absent plans for new capital construction for engineering, we are working with the Office of the Vice President for Facilities and Planning to develop a space master plan for the SOE to ensure that the school continues to provide high-quality academic and research facilities. With the scheduled completion of the Steve Tisch Sports and Fitness Center in summer 2012, the athletics department will be vacating its space in Halligan Hall, allowing us to plan for Halligan’s renewal/renovation. In addition, we are exploring new leasing opportunities. This year, in leased space at 196 Boston Avenue, we have created an Interdisciplinary Laboratory for Computation, housing researchers from CS, ECE, and CEE, working in such areas as visualization, artificial intelligence, signal processing, statistics, and machine learning. This 10,000-square-foot space represents another collaborative environment to advance our research in our strategic areas.
In this visualization of a dataset from a three-month simulation of political violence in present-day Thailand, each node represents a power hierarchy of 31 different socio-political identities with a single dominant identity. The edge colors represent different runs of the simulation that have been aggregated together. The graph has been organized so that hierarchies that share a dominant identity are clustered together, revealing interesting patterns of sociopolitical change (e.g., the consistent power struggle between identity 7 (top center) and identity 25 (lower left).