DEAN'S MESSAGE

As engineers and applied scientists, our role is to move dynamically between discovering how the world works and creating practical solutions to its problems. Design is one of our key tools for making that connection, for transforming deep knowledge into steps forward. At Princeton, each of our six engineering departments has at least one capstone course at the junior or senior level in which undergraduates put their accumulated knowledge to the test by designing and building devices and systems (see pages 10-13). As they have for generations, Princeton students carry the principles of design even further in their senior theses and independent work.

Today, the challenges that engineers and scientists are called on to address are more complex than ever. Indeed, in health, energy, environment, and data and information systems, only parts of the needed solutions come directly from science and technology. Accordingly, our conception of design is growing. We now have an exciting array of initiatives in design thinking, a field that emphasizes an empathetic connection to the people and social systems affected by designs (see pages 6 and 8).

Design thinking also is a core part of our new certificate program in entrepreneurship that launched in the fall and already has attracted tremendous student interest. The certificate, a joint venture of the Keller Center and the Princeton Entrepreneurship Council, offers not just a route to starting new ventures but more fundamentally is a means to innovate and serve society.

Coupled with the growing number of makerspaces on campus, these efforts emphasize creativity and teamwork as important skills for lifelong careers. How has design been a part of your career? Please join us on Facebook, Twitter, or in person, and tell us your story.

Emily Carter
Dean
Gerhard R. Andlinger Professor in Energy and the Environment
Professor of Mechanical and Aerospace Engineering and Applied and Computational Mathematics
In the wake of historic destruction wrought by Hurricane Sandy in 2012, residents of New York and other coastal cities were left wondering whether Sandy-scale floods are the new normal.

Now, researchers from Princeton and Rutgers universities and the Woods Hole Oceanographic Institution estimate that storm-related flooding on the New York City coastline, similar to what was seen during Sandy, is likely to become more common in coming decades. The worst-case scenario shows the frequency increasing 17 times by the year 2100, according to predictions published Oct. 10 in the journal *Proceedings of the National Academy of Sciences*.

Beyond this particular prediction, the model provides an important new tool that can predict, more accurately than previously possible, the kinds of storm floods that will threaten coastal cities over the next century. The simulation promises to provide a picture of long-term coastal flood risk by accounting for both sea-level rise and varying storm activity due to climate change. Scientists call flooding associated with coastal storms “surge floods,” referring the rise of coastal water due to storm surge (produced by a storm’s pressure and wind forces) and sea-level rise.

“To effectively prepare for future hurricanes, we need to know what coastal cities will be facing in the coming decades, but past models have not accounted for all of the significant dynamic factors involved in predicting surge floods,” said Ning Lin *10, the lead author of the paper and a Princeton assistant professor of civil and environmental engineering. “You need numbers to plan, and this analysis puts sea-level rise and storm surge climatology together on a quantitative basis.”

In a separate study, a research team led by Lin plumbed data from a survey of Gulf Coast residents and found that the severity of the most recent storm a person weathered tended to determine whether they believed coastal hurricanes were getting worse. Residents’ gender and beliefs about climate change also played a significant role.

Publishing in the *International Journal of Climatology*, the researchers noted that objective measurements such as wind speed, storm-surge height, and economic damage show that hurricanes are stronger than they were even a few decades ago.

“Tapping into the state of current perceptions and what drives them will be critical for governments around the world as the impacts of climate change are increasingly felt,” Lin said. –by Chris Emery
Princeton researchers have examined how individual cells act collectively to form structures called biofilms that often play a critical role in disease and other processes. Shown below is a simulation of the bacteria *Vibrio cholerae* forming a biofilm, with each slightly curved, rod-shaped unit indicating individual bacteria. (Image courtesy of Bonnie Bassler, Howard Stone, Ned Wingreen, and Jing Yan)

Researchers have for the first time revealed the mechanics of how bacteria create slimy masses called biofilms, cell by cell. When encased in biofilms, bacteria are a thousand times less susceptible to antibiotics, making certain infections, such as pneumonia, difficult to treat.

In a collaboration between engineers and biologists, Princeton researchers tracked a single bacterial cell as it grew into a biofilm of 10,000 cells with an ordered architecture. The findings, published in the *Proceedings of the National Academy of Sciences*, could help scientists learn more about bacterial behavior and open new ways to attack biofilms with drugs.

“No one’s ever peered inside a living biofilm and watched it develop cell by cell,” said Bonnie Bassler, a senior author of the paper and the Squibb Professor in Molecular Biology. “With this paper, we can now understand for the first time how communities of bacteria form a biofilm.”

The discovery became possible thanks to a microscopy method pioneered at Princeton by former postdoctoral research associate Knut Drescher that allowed the imaging of single cells.

“We have used a state-of-the-art technique to see into the core of a living, growing biofilm,” said lead author Jing Yan, a postdoctoral researcher. Yan works jointly with Bassler and Howard Stone, the Donald R. Dixon ’69 and Elizabeth W. Dixon Professor of Mechanical and Aerospace Engineering and a senior co-author of the paper.

Additional authors of the paper are Ned Wingreen, the Howard A. Prior Professor of the Life Sciences, and physics major Andrew Sharo ’16.

To study the cells, the researchers genetically modified the bacteria so the cells produced proteins that glow when illuminated by specific colors of light. The team then used a confocal microscope, a device that focuses on a single level of depth within a specimen. By making hundreds of such observations, images can be stacked together to create a three-dimensional image of the entire specimen.

What the Princeton team saw was remarkable. Bacteria spread across a surface but as they multiplied and became squeezed, cells were forced to detach from the surface. The bacterial colony thus went from a flat, two-dimensional mass to an expanding, 3-D blob.

“This paper opens up a world to us that was never before accessible — the inside of biofilms,” said Bassler. “My hope is that other researchers working on biofilms will want to use this technology to rapidly move the field forward.” —by Adam Hadhazy
Malicious websites promoting scams, distributing malware, and collecting phished credentials pervade the web. As quickly as we block or blacklist them, criminals set up new domain names to support their activities. Now a research team has developed a technique to make it more difficult to register new domains for nefarious purposes.

In a paper presented at the 2016 ACM Conference on Computer and Communications Security Oct. 27, the researchers describe a system called PREDATOR that distinguishes between legitimate and malicious purchasers of new websites.

“The intuition has always been that the way that malicious actors use online resources somehow differs fundamentally from the way legitimate actors use them,” said Nick Feamster, acting director of Princeton’s Center for Information Technology Policy, who collaborated on the research with colleagues at Google and the Universities of California at Santa Barbara and Berkeley. “We were looking for those signals,” Feamster said. “What is it about a domain name that makes it automatically identifiable as a bad domain name?”

Being able to detect malicious sites at the moment of registration before they’re being used can have multiple security benefits, Feamster said. Those sites can be blocked sooner, making it difficult to use them to cause as much harm — or, indeed, any harm at all if the operators are not permitted to purchase them.

“The key advantage is to respond promptly for defense and limit the window during which miscreants might profitably use a domain,” the researchers wrote. –by Josephine Wolff

NEW FACILITY REVEALS ATOMIC DETAILS, SPURS DISCOVERIES WITH GLOBAL VALUE

The Princeton Institute for the Science and Technology of Materials (PRISM) held a daylong event Oct. 26 to inaugurate a major upgrade and a new location for its equipment for imaging and fabricating nano- and atomic-scale structures. Investments by the University have made the labs among the best in the world and perhaps unique in their “one-stop shop” combination of analysis and fabrication, institute director Craig Arnold, professor of mechanical and aerospace engineering, told the audience of scientists and engineers from academia and industry.

The tools, now located in the newly built Andlinger Center for Energy and the Environment, will enable advances in fields such as energy storage, energy-efficient electronics, environmental and medical sensing, and biological research. “Materials science and engineering is truly an enabling discipline for many applications that are so important for solving societal problems,” said Emily Carter, dean of engineering.

The facility is open to researchers within and beyond Princeton. More information is available at http://iac.princeton.edu.
Design is one of our very oldest disciplines, the method for applying knowledge and skills to make or do something deliberately different. Today design takes many forms, from the creation of new exotic materials and structures, to the laws and policies that define our societies.

As Princeton’s mission is to prepare our students to serve humanity, we have a responsibility to teach them how to innovate through design. Here in the engineering school, generations of students have found a beloved rite of passage in car lab, robot lab, structures labs, and other capstone design courses. A newer course, “Engineering Projects in Community Service,” enables students across campus to work on real-world community-centered projects. We now also offer a rapidly maturing and already impactful program in the emerging area of “design thinking.”

Design thinking is an analytical process for effectively addressing human needs as constrained by the real world. It is a meta-process that applies broadly to: graphic design; architecture; material and product design; designing new companies; and public policy. At Princeton, we teach design thinking so our students can tackle the thorniest challenges, known as “wicked problems.” A wicked problem is a problem too complex to describe with a finite number of words. Our program focuses on these critical attributes of design thinking:

Designing for an Infinitely Complex World

by Derek Lidow ’73
• Dealing with complex human needs and emotions requires empathizing with potential users and all affected constituencies;
• Embracing difficult or intractable constraints through a process of reframing;
• Creating interdisciplinary design teams; and
• Determining the effectiveness of design through the testing of prototypes with real potential users.

Design thinking’s cross-disciplinary team approach and its focus on emotional factors complement engineering design and its emphasis on analytical models. Incorporating ethnographic methods, abductive reasoning, and prototyping methods with directed emotional tests inform and complement the design and testing of materials, products, structures, and complex communications.

The Keller Center for Innovation in Engineering Education teaches four design thinking classes and runs a year-round co-curricular program, Tiger Challenge (page 6). Our “Creativity, Innovation, and Design” class (page 8) introduces students from around campus to design thinking and has quickly become one of the most popular and highly rated classes on campus. To satisfy the demands of students who aspire to careers in strategic consulting, policy, entrepreneurship, or other forms of innovation, we now offer more advanced and challenging design thinking classes, such as “Designing Ventures to Change the World” and “Design of the Imminent Future.” As you will read, our classes have already led to student designs that the University has found innovative and practical enough to implement as permanent fixtures of campus routine.

The Tiger Challenge program enables teams of students from different disciplines and backgrounds to tackle “locally accessible and globally applicable” wicked problems. Student teams then work with local communities and agencies to prototype, test, and implement their innovative designs with the goal of achieving permanent, positive change. The Keller Center provides each student team with space at our Entrepreneurial Hub as well as with mentors and experienced advisers. We expect our Tiger Challenge teams to soon make meaningful improvements to the town of Princeton’s affordable-housing program as well as introduce new methods and products for dealing with people with spinal injuries.

We have created a cross-campus, cross-disciplinary design thinking program where students of all majors can become proficient in ethnographic practices and ideation processes, as well as how to effectively prototype and test ideas and products. With these skills, our graduates will have the confidence they need to tackle even the most wicked problems that face our world.

Above: First-year graduate students Annie Levine (left) and Veronica Boyce (right) familiarize themselves with a laser cutting machine in the Structural Models Lab, one of a growing number of makerspaces on campus. Spaces equipped with 3-D printers and other tools have become important resources for students pursuing design and entrepreneurship, as well as integrating arts, architecture, and other fields with science and engineering. (Photo above by David Kelly Crow. Photo of Derek Lidow, opposite, by Frank Wojciechowski)

Derek Lidow ’73 is an entrepreneurship specialist and lecturer in electrical engineering and the Keller Center for Innovation in Engineering Education.
TIGER CHALLENGE TEAM TACKLES AFFORDABLE HOUSING IN PRINCETON

by Michael Hotchkiss

Princeton students and OneRoof team members discuss their progress with Rafe Steinhauer (center), who oversees the Tiger Challenge program at Princeton's Entrepreneurial Hub. From left, Edric Huang, Juliansito Perez, Suzhen Jiang, and Douglas Bastidas. (Photos by Denise Applewhite)

Improving access to affordable housing is a critical challenge around the country and across the globe. It's also an urgent concern across Nassau Street from the University campus in the municipality of Princeton.

That made affordable housing a perfect fit for the inaugural Tiger Challenge, a program designed to help Princeton students tackle complex, real-world problems by providing support and nurturing their curiosity, creativity, compassion, and courage.

A team of four undergraduates called OneRoof spent part of last summer learning about affordable housing in Princeton through research and conversations with residents, municipal officials, affordable-housing experts, and Tiger Challenge mentors.

In short, Princeton's supply of 1,024 affordable-housing units — subsidized or price-controlled housing available through an application process based on applicants' income and other factors — is dwarfed by demand. The waiting list to secure affordable housing through one of the five entities that administer the units can stretch to many years. Without the ability to actually increase the stock of housing, the OneRoof team looked for creative ways to help people navigate the process and access other social services along the way.

“Through around 40 interviews and other empathy-oriented research methods, we’ve gained the trust of government officials, the town’s housing organizations, affordable-housing residents, and hopefuls,” said OneRoof team member Edric Huang, a junior anthropology major. “After analyzing all this raw data, we brainstormed where and how we could make an impact on this town and developed nine potential designs, which we intend to refine, narrow down, and test in the real world.”

Ideas include an improved online application, greater support for those on the waiting list, and a schools-based community network — all designed to improve the lives of those seeking affordable housing.

After uncovering gaps in information, the team is seeking to improve communications, not only between administrators and applicants but also between the participating agencies. One aim is to facilitate a more coordinated approach to helping applicants avoid problems with their current housing, such as issues with landlords or utilities, and to access other local social services.

“In the near future, we’re looking to determine the desirability, feasibility, and viability of these potential solutions and narrow them
down to one approach or a combination of approaches,” said team member Suzhen Jiang, a sophomore planning to major in computer science.

Rafe Steinhauer ’07, entrepreneurial program manager at the Keller Center who oversees the Tiger Challenge, said the OneRoof team’s focus on an issue that is “locally accessible but globally applicable” has helped shape the Tiger Challenge itself in the program’s first year.

“Affordable housing is a hugely important part of our community here in Princeton,” Steinhauer said. “It also is a hugely important part of almost every community in the United States. So while the students are focused on delivering things that will help our Princeton community, they are learning about this ecosystem of affordable housing that could be their life’s work if they choose.”

The OneRoof project fits into the University’s long-standing efforts to expand affordable-housing opportunities in Princeton, said Kristin Appelget, director of community and regional affairs at the University. It has provided more than $4 million to support a range of affordable-housing initiatives in Princeton over the past 10 years.

OneRoof is one of five teams participating in the first Tiger Challenge, Steinhauer said. All have used an innovation process known as “design thinking,” which puts the people most affected at the heart of innovation. Members of each team received a stipend for their work during the summer, along with on-campus housing, and will continue to receive financial support over the coming school year.

Other teams worked on topics including how to make long-distance research collaboration easier, and how to develop a safer alternative to the long spine board that emergency medical technicians, the military, and sports organizations use to transport injured patients.

OneRoof team members say the Tiger Challenge has combined a learning experience with the opportunity to give back to the community they call home for their four years at the University.

“For Princeton students like myself, it’s only too easy to get caught up in all the opportunities we have on campus and our various curricular and extracurricular pursuits,” Jiang said. “Involvement in this project is a way to give back — we should want Princeton to be the healthiest and happiest place it can be, the same way we’d want the best for our communities at home.”
Almost all of them failed.

“The Palmer Square exercise has become famous, or infamous,” said Derek Lidow, ’73, originator of “Creativity, Innovation, and Design,” the class that tested the students. The course, offered by the Keller Center, expects students to broaden their approach to design problems. As Lidow said, it teaches a series of skills that develop and flex creativity like a muscle group.

“The first time they go out, they all come back with one or two of the same insights. They are shocked. All of them,” said Lidow, an entrepreneurial specialist and lecturer in electrical engineering. “Even though we warn them. Even after four weeks of helping them get out of their mode of thinking like perfect business consultants.”

By the time the students redo the lab one week later, Lidow said, they all “break through.”

The Palmer Square lab is a mere warm-up. In the four years since its inception, “Creativity, Innovation, and Design” has pitted undergraduates against some of Princeton’s most intractable problems — “wicked problems,” as they are called, which are unsolvable but can be mitigated — by teaching them to create and design solutions from a new perspective. The instructors tutor the students in a five-step process called “design thinking,” and then assign them pre-selected wicked problems. The classes have dealt with, for example, student sleep imbalances, at-risk drinking, microaggressions, and identity crises.
The class has succeeded far beyond Lidow's expectations. It has climbed from one class annually to four sections per year, drawing students from the arts and humanities as well as engineering and the sciences, and necessitated hiring a second lecturer, design expert and researcher Sheila Pontis. Graduates have gone on to work in product design, including at the design firm IDEO. Lidow, the founder and former CEO of iSuppli Corporation, rejects the idea that creativity and innovation cannot be taught. Instead, he regards them as skills developed through practice and “good coaching.” The course, he said, is an amalgam of several design courses collapsed into one term that pushes students to evolve creatively.

From the beginning, Lidow envisioned University-wide participation. Administrators, deans, counselors, and professors are involved in framing the problems, then judge which end-of-semester presentations most effectively mitigate the initial problem and could be implemented.

The University is now testing several recent designs. In one, a re-imagined breakfast experience that includes cartoons, game boards, and a homier selection of food options aims to solve sleep imbalances by coaxing students to shift the start of their day.

Lidow asked another class to come up with plans to mitigate sexual-assault risks. Their solution, already implemented, included re-routing the TigerTransit bus to Prospect Avenue on party nights. The University installed brighter lighting on the bus and trained student volunteers to ride along and provide support. In its first six months, the system provided 1,923 rides. Of riders surveyed, 21 percent said they used the bus to get home safely, often due to alcohol consumption or to avoid someone seeking a sexual encounter. Some 16 percent took advantage of the peer counselors and many reported using the bus ride to rethink their plans for the balance of the evening.

A glance at the classroom in the Engineering Quad proves it serves no ordinary course. Desks are folded up or broken out as needed. Whiteboards on rollers surround or divide students. Storage bins contain rope, glue sticks, charcoal, or duct tape as if awaiting some precocious kindergartener.

Pontis said the specially designed class helps students tap the unconstrained creativity they indulged as children. Absent conscious effort, the brain is wired, she said, to minimize thinking differently and cognitive energy.

“I’ve learned that creativity and innovation do not happen in a vacuum,” said senior John Morone, a computer science major whose section last year worked on microaggressions. “Thinking hard about a problem will not help you solve the problem by itself. The class did not focus on one set path to creativity. Instead, it laid out many workflows — each with infinite variations — and brought to our attention approaches that could unleash creative avenues.”

Another former student in the class, junior Taylor Jones, said the course “helped me break out of a fixed mindset I didn’t even know I had.”

Combining classroom discussions with three-hour labs, the course paces students through a systematic approach: empathy or deep understanding of the problem, reframing, ideation or free association, prototyping, and testing. Students are graded in part on whether their end-of-term solutions are adopted by the University.

“Today, problems are getting more complex and boundaries between disciplines are blurred,” Pontis said.

“I graduated almost 20 years ago when a designer just dealt with well-defined problems. Now, a designer tackles broader and unframed challenges.

“That change in mindset is tremendously valuable to students,” she added. “This class helps students think differently and approach problem-solving in a creative way so that they are better equipped to solve complex problems facing society.”
Inspired by baseball, students put design into play

Caleb Gum and Jacob Kaplan were meeting about their advanced programming class last year when the topic veered to baseball. Kaplan, the manager of Princeton’s Club Baseball team, bemoaned the organizational headaches involved in keeping players on the diamond. Scheduling, attendance, and participation all had to be tracked.

“I said, ‘That’s our project,’” said Gum, a junior majoring in computer science.

Gum and Kaplan, along with classmate Katie Lim, put their heads together and got to work. The result was Clumbr, an app that schedules and tracks participation for practically any type of team. It’s a typical experience for students in the computer science department’s “Advanced Programming Techniques” class, in which students are expected to build an app that has a user interface, uses back-end storage, and has business logic.

“They get to experience things that they’re going to see in real life, like working with their peers and dealing with assignments that are underspecified,” said Brian Kernighan, a computer science professor who taught the course for many years. Gum’s team worked with lecturer Christopher Moretti, who led the course last spring.

Gum said one of the highlights of the class was developing a finished product — Clumbr is available on the Google Play store. He said the experience was “really positive.”

“Being faced with a challenging real-world scenario, we did just fine,” he said. — by Ezra Austin ’19
Traveling to Cuba, students combine mathematical and social aspects of design

A class of civil engineering students took a field trip this year, but it was not to a museum. Over fall break, the students and their instructors flew to Havana to examine firsthand Cuban shell structures.

“I am super excited,” Corrie Kavanaugh, a senior, said a few days before the trip. “One of the things that I think is really unique about Princeton is that it gives students the opportunity to go out in the field and learn from the real world.”

Shell structures are thin, wave-like constructions often resembling an airplane wing or a balloon. In this year’s offering of the class “A Social and Multi-Dimensional Exploration of Structures,” associate professors Maria Garlock and Branko Glišić introduced students to the creative ways the technique has been applied in Cuban architecture. The students work in groups to study specific structures. Kavanaugh said her team was examining a stadium in Havana’s Parque Jose Marti.

“It’s an incredibly complex geometry, and right now we can only guess at what the curvature is from photographs,” she said. “It will be really cool to actually get to see the structure in person after modeling it for so many weeks.”

The class also has the chance to speak with a designer of some of the structures and then undertake their own models of shell structures, culminating in an exhibit at Princeton’s Friend Center.

“I’m excited to see the country and experience the culture in Havana,” Kavanaugh said. “I feel like not many people have had the opportunity to study Cuba from a civil engineering perspective, so it will also be a unique experience from that perspective as well.”  –by Francesca Billington ’19

SoccerBot scores goal: Being ‘an actual electrical engineer’


From nerf gun turrets to ball-balancing robots, electrical engineering students in Car Lab apply the theoretical knowledge they’ve accumulated from their departmental courses to build their own inventive robotic machinery.

“I got into the electrical engineering department and actually decided to be an electrical engineer partly because of this course and how cool it looked,” said senior Zach Kendrick. The semester-long course, officially titled “Building Real Systems,” requires students to build two basic electronic system prototypes as they ultimately design their own computer-controlled vehicle in teams of two.

Seniors Dana Fesjian and Haley Chow built a “SoccerBot” last spring, a robot designed to locate soccer balls and successfully score goals.

“The class gave me the opportunity to be an actual electric engineer,” Fesjian said. “In the real world similar problems arise — something will stop working and you have to figure out why and fix it, or improvise and make something new.”

Although Fesjian said she spent between 80-100 hours working on the project, she said that building a machine almost entirely independently was incredibly rewarding and worth the hard work. –by Layla Malamut ’18
As lathes and grinders hummed and growled in the lab behind him, machine shop manager Glenn Northey proudly held out a thin, triangular metal box with a tiger’s face painted on one end.

“That weighs 2 pounds and 3 ounces,” said Northey, the main instructor this year for the Department of Mechanical and Aerospace Engineering’s “Engineering Design” class. “It lifted 500 pounds. Now that is impressive.”

“Engineering Design” requires students to design and build a functional project — in this case a box shaped like an airplane wing that will lift a set amount of weight. The students must design the structure, select the material, and analyze the plans until “they know where every hole and piece will be,” Northey said. The goal is to build the lightest structure that can perform the task.

“工程设计”要求学生设计和建造一个功能性的项目——在这种情况下是一个像飞机翅膀一样的盒子，用于提升一定重量。学生们必须设计结构，选择材料，并分析计划，直到“他们知道每个孔和部件的位置”，Northey说。目标是建造最轻的结构来完成任务。

“The first two years of MAE are for building theoretical background, and this is the class in which you get to apply that,” said Isabel Cleff, a junior. “I’ve done internships, and people on my team have done other internships, and so it’s cool to combine our practical knowledge.”

Kirk Robinson, a senior who took the course last year, said the project requires teamwork and planning as well as technical skill.

“Strategies are taught in the classroom,” he said, “but you really have to do it to understand.” —by Ezra Austin ’19

Watch a video about the class: http://bit.ly/orange-bowl
At its midpoint, the class “Operations and Information Engineering” switches from game theory to game mode.

Students spend the first part of the semester attending lectures, completing problem sets, and taking a mid-term exam. But after the fall break, they prepare for the “Orange Juice Bowl,” in which teams of students compete to run the most effective hypothetical orange juice company.

“I worked in the mergers and acquisitions group of an investment bank over the summer, so I had the chance to see businesses getting sold and bought,” said June Chang, a senior majoring in operations research and financial engineering. “However, it is definitely my first experience acting (although simulated) as the operations manager of a company, from controlling how many futures contracts to purchase for varying maturities to deciding how many storage facilities to acquire and to what capacity.”

Chang said he was fascinated by the ability to use mathematics in business as a way to minimize risk and maximize profit. In the orange juice game, teams are given the probability of problems, such as broken-down delivery trucks, and asked to work them into their operations. The team members will be expected to make decisions in response to a large number of variables and changing conditions that could affect their companies.

“I am definitely looking forward to sinking my teeth into this project and seeing what works and doesn’t, and improving our policy from there,” Chang said. “I am only worried that we have a lot to learn, but I am not worried about our performance — we have a brilliant group of people who without doubt will be a great team.” –by Francesca Billington ’19

Seniors majoring in chemical and biological engineering pepper graduate student Wes Reinhart with questions as he leads them through the mathematics of capturing and recovering excess heat in the most efficient way when designing a chemical plant. (Photo by David Kelly Crow)

“Orange Bowl” tests management mettle

Lorena Grundy, a senior in the chemical and biological engineering department, said that the most exciting part of their design course is the liberty to make key design decisions.

“The course fills students with a lot of confidence as seniors about to go out into the workforce,” Grundy said. “It’s amazing that by the time the course is over, I will be able to say that I designed and built this plant, and that it actually works.”

Titled “Design, Synthesis, and Optimization of Chemical Processes,” the course introduces students to the basic tools needed to design and optimize a simulated chemical plant. Students are first introduced to the chemical engineering software required to build the plant and then break into teams of three to four students to complete the final project.

“The class is like a dress rehearsal for the real world,” said Professor Yannis Kevrekidis, adding that building enterprise plants is a nominal skill every chemical and biological engineer should have.

Students also look forward to the lab as the convergence of all the concepts taught previously in other courses. Upon completion, Kevrekidis said, the teams’ chemical plants should produce a simulated product with realistic chemistry and production rates that also addresses safety concerns and control considerations.

“What I’m hoping to get out of this class is to exercise the skills and knowledge I’ve gained over the last three years and actually design a functioning power plant,” senior Frank Nguyen said. –by Layla Malamut ’18

Chemical plant design is ‘dress rehearsal’ for core skill