WE are very proud of our students at the Engineering School — and with good reason. Our undergraduate students are the most outstanding group we have ever seen. In fact, judged by their combined SAT scores and their record of community service, they are the best group of students to have enrolled at the University of Virginia.

Our responsibility — and it’s one that we feel deeply — is to provide an education that’s equal to their talents. As part of our strategic plan, we committed to providing students with sustained, high-impact educational experiences that complement and extend the learning that goes on in our classrooms. With support from alumni and friends as well as from the University, we are meeting this goal.

In this issue of UNBOUND, we explore the growing range of these experiences. As you’ll read, our undergraduates have the opportunity to test lifesaving products in developing countries, organize and present their own one-credit courses, design and build vehicles for national competitions and conduct meaningful research alongside our graduate students. Our exciting new teaching internship program for graduate students is helping prepare them for careers in higher education.

The rationale for these initiatives is straightforward. When students take responsibility for applying knowledge in real-world situations, they grow and mature both as engineers and as individuals. It’s a powerful experience that adds a completely new dimension to engineering education — and it’s clearly one that is very attractive. Our applications for admission increased 15 percent over the past year alone.
Cover Story

4 Experiential Learning

Thanks to our experiential learning programs, our students leave the Engineering School with the skills needed to work effectively on teams.

Features

Connecting Data and Dance Music

Jasdev Singh (CS ’14) is applying machine learning techniques to the world of electronic dance music.

Testing Water

Lark Washington (CEE ’15) worked with a potters cooperative in South Africa to test MadiDrops, a water-purification device developed by Professor James Smith.

Entrepreneurship

Gabriella D’Agosto (BME ’14) is applying her entrepreneurial skills to her post as vice president of the Society of Hispanic Professional Engineers.

Video: Graduate Student Wins Three-Minute Thesis Competition

Lindsey Brinton’s ability to translate her research into a compelling, readily understandable statement won her the People’s Choice Award in Universitas 21’s Three-Minute Thesis Competition. The graduate student in biomedical engineering is helping develop ways to detect pancreatic cancer earlier. vimeo.com/channels/u213mt2013/76679646

Visit Us Online: www.seas.virginia.edu
EXPERIENTIAL LEARNING

When students take responsibility for an engineering project, they are motivated not simply to apply the knowledge needed to get the job done but also to master it.
LEARNING BY DOING

Engineering is the science of compromise. Rarely do engineers have the freedom to develop and deploy the most technically elegant solution. Rather, their task is to achieve the best possible outcome given constraints on their work. Time and money, safety and security are just a few of the limitations engineers have to accommodate.

To be successful, engineers must be able to chart a course from the ideal world of theory to the real world of practice. The Engineering School's experiential learning program gives them the opportunity to learn how to bridge this gap. “This is an invaluable skill for students to learn, regardless of their career choice,” says Professor George Cahen, the School’s director of experiential programs.

The Engineering School supports an extensive range of student-run experiential activities, reflecting students’ diverse interests. To cite just a few, each year a student team designs and synthesizes an organism from standardized genetic parts and enters it in the International Genetically Engineered Machine competition. Another team designs and builds an open-wheel, off-road vehicle to race at SAE Mini Baja events. Other students work with ecoMOD, a collaboration with School of Architecture students to create sustainable, modular homes for affordable housing organizations. Today, more than 600 students participate in 20-plus experiential activities.

In the process of contributing to these projects, students learn teamwork — another valuable skill. And they also come to understand their own strengths and preferences. “Some students gravitate to design, while others find a home in administrative areas like fundraising and budgeting,” Cahen observes.

The past five years have seen rapid growth of the School’s experiential learning programs, thanks to funding from the engineering course fee approved by the Board of Visitors and support from friends of the School, most notably Linwood A. “Chip” Lacy Jr. and his wife, Connie. The Lacys have long provided annual support for student-run experiential learning activities. They also funded the creation of a design lab in Rice Hall and were the driving force behind the construction of Lacy Hall and the Ann Warrick Lacy Experiential Center, which occupies its top two floors.

Lacy Hall has made a dramatic difference. Before the construction of Lacy Hall, student teams worked wherever space was available. Now, with ample room to work in a convenient location, students can pursue more-ambitious designs and realize them more readily. Lacy Hall has been outfitted with state-of-the-art machinery, giving students a taste of what they might encounter in industry.

Lacy Hall is just the latest step in the Engineering School’s efforts to bolster experiential learning, which University President Teresa Sullivan calls “one of the most profound and effective ways for students to acquire new knowledge.” As Engineering School Dean James Aylor points out, experiential learning is particularly apt for engineers. “You can’t become an engineer by reading a textbook alone,” he says. “You need the opportunity to apply what you’ve read to the real world. Only then does it become meaningful.”
In the year they devote to preparing for the International Genetically Engineered Machine (iGEM) competition, Team Virginia members maintain a hectic pace. They have just 12 months to familiarize themselves with the techniques of synthetic biology, identify new and potentially useful qualities they can add to a biological system, and design and produce this new system using standardized genetic building blocks or by creating their own.

Last year, all this hard work paid off. Team Virginia created a standardized DNA molecule that permits the tunable production of bacterial minicells, which could be targeted to deliver medical therapeutics. The team’s work earned it a gold medal at the North American iGEM Jamboree, a trophy for Best Human Practices and an invitation to the Global iGEM Championship at MIT.

Team members are motivated by the opportunity to move the field of synthetic biology forward. iGEM has its origins in a monthlong course developed at MIT in 2003. Students organized the first competition in 2004, and by 2013, 215 teams from every continent were vying to produce projects with the best combination of creativity, effectiveness and potential impact.

“Through genetic engineering and DNA manipulation, we try to solve a problem that affects people’s lives,” says Gregory Brown (BME ’16), one of last year’s team members. “It could be related to food, energy, health or manufacturing processes.” Although they draw on their faculty advisers — Associate Professor Jason Papin in biomedical engineering, Assistant Professor Inchan Kwon in chemical engineering, Assistant Professor Alison Criss in microbiology and Associate Professor Keith Kozminski in biology — for guidance, students take responsibility for every aspect of the project. Former team member Alexander Zorychta (BME ’13) underscores this point, “When we find a problem that we think deserves solving, it’s up to us to acquire the knowledge and develop the skills needed to solve it.”

VIDEO: Members of the iGEM team talk about the value of participating in the program and their most recent projects. wuvaonline.com/uva-students-win-genetics-competition/
It was a real nail-biter. The winds were creating havoc at the 2013 SAE Aero Design® East Competition in Fort Worth, Texas, and the 16 members of the UVa. Hoos Flying team saw their third-round flight as an opportunity to move up in the standings — if their remote-controlled plane survived.

Landing would be tricky. As the airplane circled the small airfield, Thomas Lockwood (MAE ’14), one of the members of the team, struggled to line the aircraft up with the runway. Complicating his efforts was the 31-pound payload the plane was carrying. As it touched down, the right wing grazed the concrete. The plane spun violently to its right, and the tail jackknifed over the fuselage. Despite the damage, the plane’s forward momentum kept it on the runway — and the flight counted. UVa. secured second place in the competition.

This was a major accomplishment. The SAE Aero Design East Competition, sponsored annually by SAE International, attracted 39 teams from universities around the world to compete in its “regular” classification. A third of the groups came from outside the United States, and before coming to Texas most had placed at the top of national competitions — in countries like Brazil, Canada, India, Italy, Mexico, Poland and Venezuela. Hoos Flying was the only U.S. team to reach the top five. In addition to creating a plane, each team wrote a report describing its design decisions and made a presentation. “It’s a great experience,” says Lockwood, the team’s president. “Competition is so much fun.”

But competitiveness is not the only attribute of team members. SAE Aero Design East is the culmination of a yearlong effort that tests students’ resiliency, ingenuity and determination. For 2013, the team decided that to win it needed a plane capable of lifting more than a 30-pound payload. To realize this goal, the team divided itself into structure, propulsion and aerodynamics groups, but as club members discovered, things sometimes don’t go according to plan. “One of the things I like about the club is that you learn to deal with different kinds of problems that arise in the design process,” says team member C.K. Vanigalla (MAE ’14).

Working on the team also opens up opportunities for summer internships and job offers. It can also broaden the students’ horizons. Aaron Lam (MAE ’13) admits he didn’t know much about how planes fly when he decided to become an aerospace major. “Working with Hoos Flying helped me understand in concrete terms the significance of the theory I was learning in class,” he says. “It also inspired me to want to make things fly and to fly myself.” Lam is currently pursuing a pilot’s license.

**VIDEO:** It took months of work and a two-minute flight for Hoos Flying to secure second place in the 2013 SAE Aero Design East Competition. [www.youtube.com/watch?v=eo0WeDb2Egl](http://www.youtube.com/watch?v=eo0WeDb2Egl)
Three hundred million years of evolution have turned the dragonfly into a marvel of flight. These highly efficient insects can propel themselves in six directions and sustain bursts of speed of 30 miles per hour. Because insects move their wings so rapidly, even the most observant entomologists don’t fully understand the sequence of movements — and the associated deformation and rotation of wings — that produce flight. By combining a series of cutting-edge technologies, Associate Professor Haibo Dong and members of his Flow Simulation Research Group are shedding light on this mystery. Undergraduate Ventress Williams (MAE ’15) is part of this team.
Connecting Data and Dance Music

Electronic dance music is Jasdev Singh’s soundtrack. Singh listens to it throughout the day, when he’s studying, working out and going to class. But he is just as passionate about machine learning, a branch of artificial intelligence devoted to constructing systems that can discriminate among different kinds of data. When Singh (CS ’14) saw the chance to use his fourth-year independent research project to combine these two interests, he grabbed it.

Singh’s go-to source for new dance music is SoundCloud, a music-streaming service that enables musicians to post their latest recordings and fans to list favorites and create playlists. SoundCloud’s distinguishing feature is the waveform diagram it uses to represent audio tracks. During playback, listeners can follow the progression of the music along its waveform and post text comments at relevant timestamps. It’s like Google Maps for audiophiles.

Singh is employing machine learning to determine the sentiment of these SoundCloud comments — evaluating whether they are positive or negative — and using that analysis to make inferences about the accompanying audio. This study has practical applications. During internships at Microsoft and Twitter, Singh realized the potential of applying machine learning to consumer-generated data to create new product features. In the case of SoundCloud, knowing which parts of a track listeners like can help artists identify the most attractive segments to use when promoting their music.

In the world of dance music, DJs are trendsetters. Accordingly, Singh is using sentiment analysis techniques to measure listener reaction to tracks on their playlists. To determine the relative importance of DJs’ selections, he has analyzed 17 years of DJ Magazine’s Top-100 polls to trace their standings, their collaborations and relationships with other DJs, and the popularity of the genres they play.

He is combining these rankings with network diagrams of the playlists that DJs use at dance music festivals. Festival DJs often include tracks by other DJs in their sets — and the diagrams Singh creates reveal the patterns of influence among them. When DJs use the work of a lower-ranked colleague, it could be an early sign that that person’s work is about to break out. For music industry investors, that’s important information.

“As a computer scientist, I see all this data that’s readily available in the dance community,” he says. “I just want to step up and have fun with it.”

The group’s goal is not simply to help biologists understand how insects move from place to place. Dong and his students are using their knowledge of dragonfly flight as the inspiration for a micro air vehicle, a tiny, highly maneuverable, airborne robot. Among other issues, this means designing the most appropriate controls and actuators and finding the right combination of materials to approximate the weight, structure and flexibility of dragonfly wings.

Williams is focusing on one of the subtle factors that contribute to a dragonfly’s amazing efficiency and control. Dragonfly wings bend as they move, in effect storing strain energy. This energy is released at critical moments when the wing snaps back into alignment.

To measure the strain energy, Williams is using the high-tech equipment in Dong’s lab — the trio of video cameras that produce three-dimensional images, reconstruction techniques that convert these images into computer models and computational fluid dynamics tools to compute vortex formation and wake structures.

But his analysis always starts with a trip to the University Dell to capture a dragonfly, where the most sophisticated technology he uses is a net.

WEB: To see Jasdev Singh’s favorites, go to soundcloud.com/jasdev-singh.
In rural communities of South Africa, people must often walk miles to find potable water, and even when they’re successful, keeping that water clean enough to drink can be a challenge. In response, James Smith, a professor in the Department of Civil and Environmental Engineering, has developed MadiDrops. Placed in water containers, these porous ceramic disks impregnated with copper or silver nanoparticles can kill the waterborne pathogens that cause diarrhea, vomiting and dehydration.

Intrigued, Lark Washington (CEE ’15) joined a team of undergraduates applying for funding from the University’s Jefferson Public Citizens program. Their goal was to travel to the Limpopo province in South Africa and assist students and faculty from the University of Venda in field-testing silver-impregnated MadiDrops. Washington also applied for an individual grant from the University’s Center for Global Health to test the copper-impregnated version. She received funding from both sources, enabling her to spend two months in South Africa.

MadiDrops are an example of sustainable technology. Except for the dilute nanoparticle solution painted on the finished disk, rural potters can mold them from local materials and fire them in traditional kilns. Accordingly, Washington and her colleagues enlisted members of the local potters cooperative to help them enroll members of the community to participate in the study.

The team ran a five-week trial, sampling water from the 30 participants on a weekly basis to measure the effectiveness of the MadiDrops.

“It was gratifying to see firsthand that technology could have a positive impact,” Washington says. “One woman told us that her infant was much healthier after she began using the MadiDrops. That was really rewarding to hear.”
It’s hard to imagine a better example of civil engineering intersecting with the forces of politics, commerce and culture than the Panama Canal. The original canal required the excavation of more than 250 million tons of material, the construction of two lakes and three sets of locks, and employed as many as 40,000 workers.

The canal project was outsized in other ways as well. Long before the term globalization gained currency, the Panama Canal was a global project. The French were the first to attempt to build the canal, but their efforts faltered in the face of corruption and disease. The Americans were successful, but the canal they built was the product of gunboat diplomacy, as well as engineering and medical expertise.

The complex history of the canal proved irresistible to Edward Berger, the associate dean for undergraduate programs, who has developed a Panama Canal case study that he has presented several times as a January-term course in Panama and on Semester at Sea. The Panama Canal expansion project, scheduled to double the capacity of the canal by 2015, provides an ideal window to both understand the past and to study one of the largest infrastructure projects underway today.

“You can’t teach this course in Charlottesville,” Berger says. “It’s only when you drive down into the new locks under construction that you can appreciate the audacity of this project.” Daniel Arango (MAE ’16), a student in the class, agrees. “We had amazing access to the expansion project,” he says. “The sheer size of the locks is amazing.” Students also gained an appreciation of the financial and labor controversies surrounding the project as well as the personal skills required for effective project management.

The course also examines the tangled history of the region from 1500 to the present and the mixed legacy of the American-governed Canal Zone. “Ideally, students come away with a more nuanced and sophisticated view of the U.S. role in the region,” Berger says. This year, the class was in Panama for Martyrs’ Day, which commemorates a deadly clash between Panamanian students and Canal Zone police, who were assisted by U.S. soldiers.

Finally, the course gives students the opportunity to explore Panama City and Panamanian culture. “It was a great experience trying new foods, riding local buses and getting a glimpse of what Panama was like when they were building the canal,” says Elyse McMillen (ChE ’16), another student in the class. “We also spent time in Panama City, which was far bigger and more modern than I imagined it would be. The contrast was powerful.”
University professors spend as much time teaching as conducting research — and their ability to inspire and inform students can have as much impact on society as the research they conduct. That’s why the Engineering School created the Graduate Teaching Internship Program, now in its second year. The program gives students considering an academic career the opportunity to develop and co-teach a course with experienced faculty mentors. Students selected for the one-semester fellowship receive a stipend to compensate them for time away from research. Engineering School alumnus Paul Voigt (ECE ’81) funded this year’s stipends.

“One priority of our strategic plan is to increase the impact of the graduate program,” says Pamela Norris, associate dean for research and graduate programs. “The teaching internship is one way we are meeting this goal.” Norris believes that the program will help the Engineering School attract highly motivated students who understand that...
demonstrable teaching skills are an advantage when applying for faculty positions.

Last fall, graduate student Ryan Johnson (MAE ’10, ’14) enlisted Patrick Hopkins (MAE ’04, ’08), an assistant professor of mechanical and aerospace engineering, as his mentor, and together they taught Applied Partial Differential Equations. Johnson had tutored students in the course for several years and had a number of ideas he wanted to try out. “Over the course of the semester, I felt that I became a more effective teacher,” Johnson says. “I developed a better sense of pacing and discovered the approaches that are personally most effective in getting concepts across to students.”

Hopkins adds that having graduate students in the classroom is beneficial to their own growth as educators and for what they bring to the undergraduates. “Doctoral students are at the forefront of their fields,” he points out. “Taking a course from someone who is keeping pace with the state of the art and who is committed to teaching is invaluable.”

And certainly the students in Johnson’s class appreciated the learning opportunity. The evaluations he received from students were universally glowing.

For Johnson, the program confirmed his decision to pursue an academic career. “When you’re a graduate student, people are always asking you whether you want to go into academia or not,” Johnson says. “It helps to know if you can actually reach students and teach them. That’s what this program enables you to find out.”

Graduates of the program who are now faculty members say it has given them a jump-start on their careers. Eva Andrijcic (SIE ’06), an assistant professor of engineering management at Rose-Hulman Institute of Technology, taught Systems Evaluation with Associate Professor Reid Bailey and Professor William Scherer, both in the Department of Systems and Information Engineering. “The Graduate Teaching Internship Program gave me a very clear understanding of the roles and responsibilities of a professor,” she says. “Having gone through the program made me a stronger candidate for Rose-Hulman, while making the transition to teaching on my own that much easier.”
One thing I really enjoy about entrepreneurship is coming together as a team, brainstorming solutions to all sorts of problems and then translating the best idea into a new design.” — Gabriella D’Agosto

The popular view of an entrepreneur is of a powerful, solitary figure — a Bill Gates, Steve Jobs or Mark Zuckerberg — who, through force of personality, bends an entire organization to a founding vision. Gabriella D’Agosto (BME ’14) has a more egalitarian perspective. “One thing I really enjoy about entrepreneurship,” she says, “is coming together as a team, brainstorming solutions to all sorts of problems and then translating the best idea into a new design.”

D’Agosto first became enthusiastic about entrepreneurship when she took Engineers as Entrepreneurs, a class taught by Professor Bernard Carlson, chair of the Department of Engineering and Society. She was part of a team of students from the class that took third place in the Engineering School’s Entrepreneurial Design Competition. They developed a collapsible bicycle helmet featuring D3O, a lightweight smart fabric that becomes rigid nearly instantaneously on impact. “Our thought was that if you could stuff your helmet into your backpack when you weren’t riding, more people would wear one when they were,” she says.

Encouraged by the experience, D’Agosto enrolled in the Engineering School’s Technology Entrepreneurship track. She has found that if you look, you’ll see that there are problems crying out for a solution. For her Capstone project, D’Agosto and her teammates are developing a medical device that can help laparoscopic surgeons more easily remove gallbladders.

D’Agosto has applied the same entrepreneurial spirit in her role as vice president of the Society of Hispanic Professional Engineers (SHPE). “There are many opportunities for SHPE to become involved with people in the community and students on Grounds,” she says. D’Agosto is helping the group bring 75 Hispanic students from Northern Virginia and Charlottesville to U.Va. for a two-day program on engineering. At the same time, she’s working to increase corporate involvement with the SHPE chapter, opening networking opportunities for members with companies like General Electric and Microsoft. Ultimately, she would like to encourage high schools around the state to form their own SHPE chapters, so that the college organization can build mentorship programs with them.

“This year we welcomed our largest Hispanic class to the Engineering School,” she says. “We are trying to build those numbers further by encouraging more Hispanic students to come to the School and by providing better opportunities for their success after graduation.”
STUDENT-TAUGHT CLASS

Nishant Shukla (CS, Math ’14) is a Haskell evangelist. This high-level programming language is centered on mathematical functions, unlike common programming languages like Java or C++. Because it’s rarely taught at universities, Haskell has acquired a mystique among computer scientists.

Shukla taught himself Haskell in high school and used it during internships at WillowTree Apps and Microsoft. When a friend, Engineering Student Council co-chair Anish Simhal, suggested Shukla consider teaching a class on Haskell, the idea clicked.

He got approvals from Edward Berger, the associate dean for undergraduate programs, and Kevin Skadron, chair of the computer science department, and enlisted Professor Jack Davidson as his adviser. Shukla offered Introduction to Haskell in spring 2013 as a one-credit/no-credit course. He also decided to offer the course informally online, attracting 1,200 people from around the world, in addition to 69 on-Grounds students.

Shukla admits to being nervous at first, but soon found his comfort zone as a teacher. “Every homework assignment had a feedback form asking for suggestions,” he says. “One result was that I increased the amount of class time devoted to group work.”

Shukla’s efforts have had their impact. His success has inspired other students to secure approval to teach courses in such fields as data visualization and auto mechanics. A month after the class ended, Packt Publishing invited Shukla to write a book on Haskell data analysis. It will appear this summer.

UNDERGRADUATE RESEARCH PUBLICATION

Once a year, Engineering School Dean James Aylor gets the chance to make the deans of other engineering schools green with envy. He sends them a copy of The Spectra, the student-published journal dedicated to research by Engineering School undergraduates. Now led by Tristan Jones (BME ’14), The Spectra showcases the range of the School’s programs and the quality of its undergraduates.

Certainly the variety of topics The Spectra covers is impressive. The past issue included articles on an experimental treatment for Crohn’s disease, the use of a road reservation system to optimize traffic during rush hour, the design of an autonomous underwater vehicle that incorporates features of a manta ray’s pectoral fin, and more. These papers grew out of independent student research projects, Capstone projects and the Engineering School’s Policy Internship Program in Washington, D.C.

The Spectra now issues a final call for articles at the beginning of the fall semester. The editorial board of 20 students reads all submissions, scores them and makes its selection. Board members then work with the authors to refine their articles for publication, lay out the publication and help coordinate printing.

“It’s been a revelation to me how many people are involved in getting something like this done,” Jones says. “And how many people throughout the School are willing to provide feedback and help us.”
Striking a Spark!

During their years at the Engineering School, students not only acquire a body of knowledge but also have the opportunity to apply that knowledge to their own projects. In the process, they begin to understand what it means to be discoverers, creators and innovators themselves.

Your support for student research, community service and all forms of experiential learning will strike a creative spark that will last a lifetime. Give now at www.giving.virginia.edu/engineering.

Join The Conversation

Facebook: www.facebook.com/uvaseas

Twitter: www.twitter.com/SEASUpdates

LinkedIn: www.linkedin.com/Wpzmjz

YouTube: www.youtube.com/seasweb

Visit Us Online: www.seas.virginia.edu