Students who grew up in the age of the Heathkit came to the Engineering School with a deep appreciation for and native understanding of electrical and computer engineering. The electrical and computer engineering faculty could count on the majority of their students having spent countless hours building, testing and troubleshooting electrical devices. The Heathkits of old are long gone and the field of electrical and computer engineering itself has become dramatically more complex. The challenge today is not simply to replicate the Heathkit experience, but rather to reimagine it for today’s students. The Charles L. Brown Department of Electrical and Computer Engineering has found in National Instruments (NI) an active partner that is not only helping us meet our curricular goals, but also extending that relationship beyond the classroom, providing internships and career opportunities for our students.

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In a fundamental way, the goal of the Charles L. Brown Department of Electrical and Computer Engineering is to find ways to make better, more productive connections. This idea most obviously drives our research, but it also has motivated us as we reconsider our curriculum. We are trying to more effectively bridge gaps between theory and practice, lecture and lab, devices and systems. We are also attempting to integrate topics that have been treated in isolation in the past.

It would be difficult to overemphasize the transformation this entails. Our transition to a more hands-on, integrated curriculum requires us to change not only what we teach, but how and where we teach it. Our new, three-course Fundamentals sequence (the FUN classes) illustrates the difference. We have combined Linear Circuits, Electronics, and Signals and Systems — previously offered sequentially — into an interconnected series of breadth-first and progressively more-advanced classes so that we can underscore the interrelationships among these topics. To drive these connections home, we’ve organized these courses as studios, with teams of student collaborators tackling a series of hands-on projects over the course of the semester that are integrated spatially and temporally with the lectures. This new style of pedagogy is, in turn, causing us to reconfigure classroom space in a building designed for engineering in the late 1940s!

The process of putting this transformation in place has also been one of making connections. For example, we’ve made connections with National Instruments (thanks in part to Eric Starkloff (EE ’97), the company’s executive vice president of global sales and marketing), a company that has introduced a range of compact, highly capable, affordable devices that are ideal for studio use. This connection has blossomed into a partnership that includes internships and career opportunities for our students (such as Kyle Teegarden (EE ’14), past president of IEEE @ U.Va.), as well as funding for equipment and space. And we have been pleased to reconnect with alumni like Dudley White (EE ’76, ’77) and his wife, Barbara (AE ’81), whose support for experiential learning includes substantial funding for Thornton Hall renovations.

The theme of connections is also guiding us as we renew and expand our faculty. We chose the three new professors highlighted in this newsletter — Andreas Beling, Steven Bowers and Daniel Weller — not only for the tremendous promise of their research and teaching, but also because their expertise intersects with strengths in the department and around the University. They will be instrumental in building the centers of excellence that distinguish our department and prepare our students for successful careers.

The net effect of the connections we’ve made this year and will continue to make into the future will be a stronger, more agile, more relevant department, seen as a world-class leader in both education and research.

John Lach
Professor and Department Chair
Developing Leaders of Innovation

When the department took up curriculum reform in 2013, the faculty set its sights on better integrating knowledge across the curriculum and making active, hands-on learning the centerpiece of our courses. These goals, in turn, led naturally to a change in teaching style, a shift from the traditional lecture-lab arrangement to studio-style classes that emphasize hands-on learning and collaborative projects.

The department’s undergraduate programs committee, led by Professor Lloyd Harriott, learned a great deal from early adopters like Professors Scott Barker, Joanne Bechta Dugan and Harry Powell, who had already developed studio approaches for some of their courses, integrating lectures and laboratory activities so as to better connect theory and practice. The dilemma that Barker confronted in reconfiguring his RF and Wireless Circuits course is typical of the challenges they faced.

“I wanted to refocus the course on information that would carry over to the workplace,” Barker says. “This meant using integrated circuits rather than concentrating on transistor-level design.” With the advent of companies that inexpensively produce custom printed circuit boards, Barker saw an opportunity to give students a more immediate understanding of such system-level phenomena as noise and distortion. He would have them design printed circuit boards, send them out to be made and then test them to see if their designs worked.

Initially, however, his ambitions were frustrated. There was no simple, integrated software program available that students could use to both design their circuits and lay them out for fabrication. Testing presented yet another obstacle. The instruments he would need were both bulky and expensive, which meant that each student would have limited exposure to conducting measurements.

Barker’s search for a solution took him to NI, which had just purchased AWR, the software company that developed Microwave Office, the only program Barker could find that would adequately meet his needs for RF and microwave circuit design. Even better, NI was in the process of integrating the software with its PXI suite of low-cost measurement instruments.

“National Instruments had developed these tools for the cellphone market, but they were perfect for academic use,” Barker says. “They were very enthusiastic about our using them in the classroom, providing helpful suggestions as well as generous discounts.”

Kyle Teegarden (EE ’14), one of Barker’s students, was a beneficiary of the change. “The NI equipment made it seamless to go from theory all the way to testing,” he says. “It really is motivating when a device you’ve designed actually performs the way it is supposed to.”

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One of the problems that the undergraduate committee identified in the traditional curriculum was that it was only after students took the first three courses for the major — Linear Circuits, Electronics, and Signals and Systems — that they could develop a systems-level appreciation for electrical and computer engineering. “Students had a tendency to view the material in each course in isolation,” says Associate Professor Harry Powell, who also serves as the director of instructional labs. “We reinvented the fundamental courses as a sequence that spans all three disciplines, giving students the systems view much earlier.” This reinvention yielded ECE Fundamentals I, II and III — tagged “the FUN classes.”

To reinforce this integration, the faculty reimagined the courses as studios — and here again they turned to NI to help realize this vision. Just in time for the introduction of FUN I, the company introduced VirtualBench, which combines five traditional benchtop instruments in a single, compact device. U.Va. was among the first to adopt it for academic use. The combination will be equally useful in the second course in the sequence. “VirtualBench, combined with NI’s LabVIEW software, is allowing us to develop hands-on signals and systems experiments for FUN II,” Powell says. “It makes it possible for us to convey the real-world impact of what students had previously seen as an abstract, mathematical topic.”

VirtualBench is a game-changer in other ways as well. “We couldn’t have created studios without it,” Powell says. “Each group of three or four students now has at its disposal a whole laboratory suite of professional-quality equipment in a form factor that can be stored in a cabinet between classes.”
BUILDING A BETTER PARTNERSHIP

NI has been more than a source of enabling instrumentation, however. As the relationship between the department and the company strengthened, the partnership between the two organizations deepened. This is because the company views the educational market, financially and philosophically, as one of the keys to its success. “We have a fundamental belief that our tools can improve the teaching of science and engineering concepts,” says Eric Starkloff (EE ’97), the company’s executive vice president of global sales and marketing. “We have a global team interfacing with 7,000 engineering schools in 55 countries — and once we identify schools that are doing interesting things with the undergraduate curriculum, we work hand in hand with them to help them realize and publicize their innovative ideas.”

At U.Va., NI’s help has taken many forms, including the discounting of laboratory equipment costs and the investment in new facilities. NI, along with Dudley White (EE ’76, ’77) and his wife, Barbara (AE ’81) (see article at right), helped fund the creation of an ECE student project and collaboration space in Thornton Hall.

Starkloff also began visiting the department several times a year and exploring opportunities for closer collaboration. Following one of these meetings, NI organized a course designed to certify participants on its LabVIEW software tools.

But the relationship is not one-sided. NI has started stepping up its recruiting of ECE students, finding them an excellent fit for its Engineering Leadership Program. “We are looking for students who are really strong technically in engineering and who also have the potential to be business leaders in different parts of our company,” Starkloff says. “With its emphasis on communication, U.Va. is an excellent place for us to recruit.” In fact, Teegarden is one of the recent graduates that NI has placed in the program.

Also, U.Va. faculty members have proved to be an excellent sounding board to help the company improve its products. “We had one of the best product feedback sessions we’ve ever conducted with any group, just last December,” Starkloff says. “Our development engineers really appreciated the feedback they received from the U.Va. faculty.”

NI has been so impressed with the U.Va. curriculum changes so far that it plans to disseminate the course materials developed for the FUN sequence and embedded systems courses to other universities. As Starkloff points out, the publicity is mutually beneficial. “It’s an opportunity for us to showcase our tools while positioning the department as a leader in curriculum innovation,” he says. “We truly believe that what we’re doing together can help produce better engineers — and we want our partners around the world to know about it.”

A NEW SPACE FOR A NEW CURRICULUM

Changing the curriculum means more than changing course descriptions. For faculty, it means exploring new approaches to teaching. For the department, it means developing new spaces to accommodate collaborative, hands-on learning. In summer 2014, the department worked with the Provost’s Office to renovate a classroom for the new studio-style courses. In fall 2015, the department will unveil a greatly expanded student project suite, thanks in large part to the generosity of alumni Dudley White (EE ’76, ’77) and his wife, Barbara (AE ’81).

The Whites’ support for experiential learning in electrical and computer engineering reflects Dudley White’s own approach to learning. As an undergraduate, he would collect electronic parts that local manufacturers had discarded and use them to make circuits or components of various kinds. “I’ve always been drawn to real hands-on engineering,” he says. “The department’s effort to revise its curriculum to emphasize experiential learning was appealing to me.”

The Whites are creating an endowment for the experiential learning courses as well as for the new collaborative space. “I think this facility and the new curriculum will boost enrollment in the major,” White says. “It will also contribute to producing engineers who can balance their theoretical knowledge with practical experience.”
At the heart of the Internet revolution are photonic devices, bridging the world of light and electricity. Place a photodiode at the end of a fiber optic cable, and it will convert a photonic signal into the type of electronic signal that a computer can use. “Internet traffic is growing at an exponential pace,” says Assistant Professor Andreas Beling. “As a result, there is a pressing need for photodiodes that can respond at ever higher speeds with low noise and excellent sensitivity.”

Beling specializes in developing these high-power, ultrafast photodiodes, building on advances in device physics to produce photodiodes that will work in next-generation communications systems. This means creating detectors that operate in the phase-modulated environments created by such innovations as QPSK (quadrature phase shift keying) and other new modulation technologies. These breakthroughs are capable of transmitting many times more data at a given bandwidth than possible with previous methods. Beling’s photodiodes also benefit many analog fiber optic systems where power and linearity are crucial. Examples are mostly in defense; for instance, fiber optic antennae transmit and receive links and radar.

“My expertise is on the device side,” Beling says. “To build detectors that work in these systems, I draw on the insights of communications and systems specialists.” Beling has a number of collaborations underway with department experts in communications, a long-standing strength, as well as with researchers at government laboratories, private companies and such other academic institutions as Georgia Tech and the University of California at Santa Barbara.

One of his goals as he works on these projects is to conduct more of the system tests at U.Va. “In addition to making the devices in U.Va.’s clean room and characterizing them in my lab, I am putting them in systems to see how they behave,” he says. “If we can perform systems-level tests here, we can create more value for our partners.”

Assistant Professor Daniel Weller’s efforts to facilitate image acquisition and improve the quality of image reconstruction from devices like magnetic resonance imaging (MRI) machines begin — crucially — with an acknowledgment of constraints. In the case of MRI, this might entail accounting for slight movements by patients that degrade the images, as well as the physics of the device itself. Weller uses mathematical modeling tools to describe these constraints and applies signal processing theories and estimation techniques to produce algorithms that correct for these limitations and provide more-robust and more-efficient image reconstruction or acquisition.

Quite naturally, the proximity of the University’s School of Medicine and the Department of Biomedical Engineering were factors in Weller’s decision to come to U.Va. He has courtesy appointments in both schools and has already started collaborations with Professor Craig Meyer and Assistant Professor Michael Salerno, both of whom are developing new approaches to cardiac MRI.

Weller was drawn to magnetic resonance imaging for two main reasons. “MRI was developed by physicists and still has an engineering physics flavor, which I find very appealing,” he says. But Weller also appreciates the opportunity to use his knowledge of mathematics and signal processing to make a difference in the real world. “The fact that the work I do can potentially impact a patient’s life is very satisfying,” he says.

Although Weller has focused mainly on MRI, many of his techniques can be applied more broadly to other kinds of imaging. For instance, he is exploring collaborations with Assistant Professors Andreas Beling and Steven Bowers on terahertz technology, long a department strength. “My algorithms have the potential to address issues related to power and signal quality in terahertz imaging,” he says. “If we can solve these issues, we can expand the applications for this technology.”
We've recruited new faculty for the excellence of their own research and teaching and for their ability to bridge strengths within the department and U.Va. As Assistant Professor Steven Bowers points out, the value of moving emerging devices to integrated circuits is both compelling and well established. Engineers can create complex systems that occupy a fraction of the space and produce them plentifully and inexpensively, thanks to well-established foundry techniques. But porting new technologies to integrated circuits can pose challenges.

As devices shrink, variability can become an issue, especially for analog devices. Just a few misplaced atoms can significantly degrade analog performance. “The challenge is to find a way to ensure good analog performance despite variation,” Bowers says.

Rather than refine the device design, Bowers’ solution is to create a feedback loop to optimize the performance of the existing device. He adds sensors and actuators on the analog side and pairs the analog device with a digital processor. The processor senses the performance, turns it into a digital signal, runs the signal through a series of algorithms and then uses the actuators to reroute the analog power and signal for optimal performance. Bowers’ system could be used repeatedly to increase performance during the life of the device. “You can run the self-healing routine to compensate for variation in the device’s fabrication and then run it again periodically as the device ages,” Bowers says.

Bowers envisions using similar approaches as he works with department colleagues to hasten the transition to integrated circuits of novel technologies in such areas as terahertz imaging and silicon photonics. “I like to take technologies that other people have developed and use integrated circuits to create systems that realize their full potential,” he says.

“I like to take technologies that other people have developed and use integrated circuits to create systems that realize their full potential.”

—Assistant Professor Steven Bowers
For Philip Asare, the fascination of engineering lies less with discovery than with the process of discovery. He views engineering not so much as an end but as an activity. “When most people think about engineering, they think about the product,” he says. “I think about how it gets made and how it affects people.”

Asare has selected a research topic that melds this philosophical approach with a practical goal. He is working with Professors John Lach and Jack Stankovic, co-directors of the U.Va. Center for Wireless Health, which develops wearable monitors that enable medical professionals to assess health more accurately. For these devices to be approved by the U.S. Food and Drug Administration, they must be safe, but as of yet there is no commonly accepted way to translate the medical injunction “do no harm” into specific design parameters. Asare is devising design tools and mathematical models for these devices to do exactly that.

In essence, Asare is trying to insert a precise, understandable concept of safety into the engineering process. “A lot of my time has been spent coming up with an adequate definition of safety so that the FDA, which regulates these devices, and the manufacturers who want to produce them, have a common understanding,” he says. Lach feels that Asare’s work has the potential to create uniform standards for these devices. “Having a shared concept of safety — and a design tool that embodies the way this vision of safety would work in a complex, dynamic system — is critical to advancing the field.”

Asare is set to graduate this spring and will begin a tenure-track faculty position at Bucknell University this fall.
When Samantha Mendis (EE, CS Minor ’15) arrived on Grounds as a first-year student, she was undecided about whether she would pursue biomedical engineering as preparation for medical school or focus on electrical and computer engineering. She chose the latter, and she’s glad she did. “Although the coursework is tough, the people here are team oriented,” she says. “If you need help figuring out how to do a problem or what classes to take, someone is always around, willing to help out.”

Mendis herself embodies that helpful attitude, serving as a teaching assistant for the introductory electrical engineering classes. “Having taken the courses recently myself, I understand the challenges students might face with the material,” she says. “It sometimes takes a while to wrap your head around some of the concepts we cover, but once you get it, it’s a good feeling.” As a TA, she has also assisted the faculty in integrating National Instruments’ VirtualBench measurement tool into the Fundamentals curriculum.

Mendis also enjoys the opportunities that pursuing electrical and computer engineering provide. For her Capstone project, she worked on a team building a closed-frame, 12-string, two-octave laser harp, based on the instrument that musician Jean Michel Jarre uses in his concerts. The harp is connected to a synthesizer and is played by breaking the laser at predetermined heights. “I’m not a musician, but my two partners on the project are,” she says. “As a result, I learned about something I knew little of and had fun in the process.”

Scott Tepsuporn (CpE, CS, EE ’15) felt like a kid in a candy store when he first looked at the many subjects covered in the ECE curriculum. “I said to myself, ‘Wow, this is awesome,’” he says. “There were so many things for me to be interested in.”

Tepsuporn has explored many of them during his undergraduate career. He is working with Professor Malathi Veeraraghavan to reduce the amount of variability in the throughput of high-speed data transfer. “Scientists at supercomputer centers need a reliable way to move their ever-growing data sets around the network,” Tepsuporn says. “As a result, there is a lot of competition for the available bandwidth.” Their solution is to create and refine a reliable path reservation system with a fixed bandwidth so researchers can know when the transfer will be completed.

Tepsuporn is also part of a team of undergraduates working with graduate student Philip Asare on BodySim, a project of the U.Va. Center for Wireless Health. BodySim is an open source framework, hosted on GitHub, that researchers working on body sensor networks can use to conduct virtual simulations based on individuals they capture using Microsoft Kinect. “Small changes in placement can make a big difference in the accuracy of a sensor reading,” he says. “Working with a simulation can help eliminate this variability.”

After graduation, Tepsuporn will continue to investigate new fields as a member of Maritime and Aerial Perception Systems group, part of the Mobility and Robotics Systems section at NASA’s Jet Propulsion Laboratory. “I was looking for a job that would spread across a wide range of skill sets, and robotics is very multidisciplinary,” Tepsuporn says. “I think the breadth of the ECE curriculum helped convince NASA that I was the right candidate.”
When Fran O’Sullivan (EE ’80) graduated from the Engineering School, IBM was still a year away from introducing the PC, and IBM servers were the size of household washers. Although the technology O’Sullivan helps develop as IBM Systems’ general manager for strategy and operations is vastly more powerful and more compact, the lessons she took from her four years as an undergraduate here are still valid. O’Sullivan leads the hardware development and manufacturing for all IBM servers and storage products worldwide. “We often have projects that follow the sun,” she says. “The School’s focus on leadership, integrity and collaboration created a foundation for the skills I use every day to maximize the productivity of my global team.”

O’Sullivan is also grateful for the support and mentoring that faculty members like Professor Stephen Wilson provided at a time when there were few women in the Engineering School. “Professor Wilson was sensitive to the challenges we faced,” she says. “The School’s focus on leadership, integrity and collaboration created a foundation for the skills I use every day to maximize the productivity of my global team.”

O’Sullivan herself has become an advocate for women in STEM fields. As a member of the board of her local Girl Scout council, for instance, she helped organize robotic team competitions and technology days at her local Girl Scout camp. “Women’s participation in technology is critical,” she says. “I believe you develop better products when you can have diverse perspectives.”

Recognizing the importance of the unique blend of technological and leadership skills that the Engineering School promotes, O’Sullivan has also given her time to the School. She has served on the department’s industry advisory board and is currently a member of the School of Engineering Trustees. In addition to her desire to serve, O’Sullivan has professional reasons for staying in touch with SEAS. “If I want to keep my career vital, it’s absolutely essential for me to keep in touch with the next generation of engineers and business leaders,” she says.
The department has benefitted immensely from the dedication of staff who have devoted their careers to our faculty and students.

As the department’s senior fiscal technician, Gloria Walker was quite naturally the go-to person for questions about University policy and procedures and the inner workings of its Oracle system. Zealous about managing the department’s finances, she also really loved working with people. “It was so rewarding for me to assist students and faculty with purchases of equipment needed for their projects,” she says. “I really wanted everyone to feel welcome and that the department was there for them.”

Walker retired in 2014, and as Susan Malone, administrative assistant to the chair, says, the department misses her “contagious enthusiasm and warm personality.”

During her 32 years with the department, Walker contributed to a number of interdisciplinary and interuniversity initiatives, including the Solar House Project and the Virginia Microelectronics Consortium. “I had the opportunity to work on so many interesting programs over the years and to get to know so many interesting people,” she says. “I enjoyed every minute of it. Every day was a new learning experience and, at the same time, a new opportunity to make a difference.”

Although she hesitates to admit it, when Susan Malone joined the department in 1977, James H. Aylor, dean, was plain Jim Aylor, graduate student. “When I see people like Jim, Barry Johnson, Art Lichtenberger and others that I knew as students go on to be successful, it’s a great source of satisfaction,” she says.

As administrative assistant to the chair and the department’s staff coordinator, Malone has been a source of stability and continuity for the department, but one of the things she enjoys most about her job is the opportunity to change and grow. Over time she has refined and expanded her skills to meet the needs of the different ECE department chairs and the demands of ever-more-complex University procedures.

But Malone also loves finding ways to help students and staff — and in these instances her years of experience and the many relationships she has formed around the University are invaluable. “When people have a problem, I can often point them in the right direction and suggest people they can talk with to help them,” she says.

Robbie Burton liked her job so much that it took her 44 years to decide to retire from the University. As terahertz research administrator and office manager for the Microfabrication Laboratories, Burton was in charge of such areas as purchasing, payroll and project projections. “When I first started, the department was just half the size that it is now,” she says. “The growth has been amazing.”

Burton enjoyed the interactions with faculty, staff and students — “everyone was nice and cordial” — but she also liked the satisfaction of focusing on a project and taking it to completion. “It felt good to be able to resolve things,” she says. “I never thought when I first started that I would have spent so much time working with numbers, but I found out I had a knack for it.”

Although Burton’s now retired, she’s no less busy than she was before. She has shepherded her husband through a successful knee-replacement operation and helps care for her mother, who just celebrated her 100th birthday. “Between the two of them,” she says, “I keep occupied.”
Send your news, milestones and address changes to eceinfo@virginia.edu or P.O. Box 400743, Charlottesville, VA 22904-4743.

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