IMPACT

ENGINEERING THAT MAKES A DIFFERENCE

Focusing On Partnerships

ACCORDING TO THE DEAN

As we look to the future, our goal is to be at the forefront of engineering education and research in a number of select areas. One way we can do this is by making partnerships as integral to the Engineering School as excellence in our core disciplines. As this issue of *IMPACT* shows, the interplay between these two strategies has already produced impressive results.

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Engineering is in a constant state of flux. Technology is evolving at breakneck speed, and the types of problems that confront us are growing in complexity. They require multiple perspectives and a broad range of skill sets to solve. The future of engineering lies, to a great extent, in interdisciplinary work.

This is certainly true at U.Va. You can find our faculty joining together across disciplines and even across school lines to find new, more powerful ways to frame research problems and address them. In the process, they're setting the stage for dramatic advances in a host of fields and providing students with unusual opportunities.

An example is the work that Associate Professor Gabriel Robins and his students are conducting in the newly created field of computational biology. This field, which didn't exist a decade ago, is the key to recent breakthroughs in cloning and in sequencing the human genome. Robins has been collaborating extensively with Professor William Pearson, a specialist in biochemistry and molecular genetics. Among other projects, they have developed a computer algorithm that can help scientists reconstruct evolutionary trees, which trace relationships among species. Their method outperforms other available techniques and has been adopted by research groups around the world.

Exposure to biological computation has shaped the careers of a number of their students. Graduates of the research group work for Merck Laboratories and Epic Systems. One student, Doug Blair, who worked with Robins on parallelizing codes for computational biology, cofounded Parabon Computation, a startup company, based on his work.

Associate Professor Rob Kelly found a collaborator just a few buildings away. One of the materials scientist's interests is the corrosion that occurs to a stainless steel surface beneath a fastener. The corrosion is related to the size of the micron-scale gap that exists between the two objects. If you think that this is an insignificant problem, think again. Corrosion costs the U.S. some $230 billion annually.

In order to confirm computer simulations he was developing with student Jason Lee, Kelly needed a test model with rigorously defined, micron-scale geometry. Associate Professor Michael Reed, an electrical engineer who specializes in microfabrication, had just the expertise he needed. Not only did Reed's design help Kelly and Lee uncover new relationships that shape corrosion, it set the stage for analyzing the process itself. Sherri Wang, a student of Kelly and Reed, has embedded sensors in Reed's model. The team can now trace the mechanisms as well as the magnitude of crevice corrosion under clearly controlled circumstances.

Rob Kelly, Sherri Wang, Michael Reed

Building working partnerships requires enthusiasm and commitment—but the results are worthwhile. "Not only did I advance research in my own area," Kelly notes, "but I learned a great deal about what Michael does as well."

Scott Acton and Dr. Klaus Ley

GRANTS AWARDED

Tracking Individual White Blood Cells—Automatically

Did you ever wonder why you raise a lump when you hit your head or bang your elbow? It's because the surrounding tissues release molecules that recruit white blood cells to the scene, where they destroy damaged tissue and fight infections. There are, however, cases where the body activates the inflammation response inappropriately. When it does, white blood cells can attack healthy tissue. In the joints, for example, inappropriate inflammation can cause arthritis, while in the arteries it can cause heart disease.

By shedding light on the mechanisms that enable white blood cells to cause inflammation, Dr. Klaus Ley, a professor in the Department of Biomedical Engineering, hopes to set the stage for focused drugs to counteract these diseases and others like them. Among other techniques, Ley uses digital video images to measure the velocity of individual white blood cells moving through blood vessels in living animals. Tracking these cells, however, is time-consuming and difficult work.

Now, thanks to a collaboration with Scott Acton, an associate professor of electrical and computer engineering, this process is about to speed up considerably. Acton's specialty is image and video analysis. Together Acton and Ley recently received a $1 million grant from the National Institutes of Health to develop a system capable of tracking white blood cells automatically.

The task facing Acton and Ley is formidable. Images from living tissue are often imperfect, with cells overlapping and moving in and out of focus. Acton uses advanced image processing techniques to recognize the moving cells and to analyze their motion. His most recent tracking system uses elastic contours that find cell boundaries.

"We've both learned a lot about each other's field in the course of this research," Acton says. "That's one of the benefits of this kind of partnership."

> *viva.ee.virginia.edu/*

ALUMNI PROFILE

Doing What Comes Naturally

Scott Ferber (SEAS '91) is a perfect example of a person who can truly say that his undergraduate experience set the stage for his career. Together with his younger brother John, the systems engineering graduate formed Advertising.com, a leader in Web, e-mail, and wireless marketing. Their competitive advantage—optimization technology that applies mathematical theory and advanced techniques in direct market testing, response modeling, and performance prediction to online advertising.

After graduating from the Engineering School and completing a master's in systems engineering at Stanford, Scott Ferber joined CapitalOne, one of the largest direct mail marketers in the nation. Around the same time, his younger brother John was creating the first Internet-based multiple player video game, HoverRace. In 1996, their combined interests led them to build an early ad server to post real ads on the billboards lining the virtual racetrack. "The next step was almost too obvious," Scott recalls. "We realized that the Internet was the ultimate direct marketing opportunity."

Scott Ferber of Advertising.com

Two years later, they launched Advertising.com, a privately held company that numbers the likes of AOL Time Warner and WorldCom among its investors. Their AdLearn® technology is capable of automatically analyzing real-time campaign data and adjusting it to meet advertisers' specific objectives. It does this by analyzing billions of combinations of different variables including campaign creatives, media, location, consumer behavior and preferences, time of day, and day of week. As a result, banner ads controlled by AdLearn become more effective, rather than lose their punch, as time goes on.

"The great thing about what I'm doing is that I'm actually using the things I learned as an undergraduate," Ferber says. "It's what I love. From professors like Bill Scherer, Jack Gibson, and Don Brown, I learned how to structure a problem and to do the math I needed to solve it. It was an incredibly formative experience."

> *www.advertising.com*

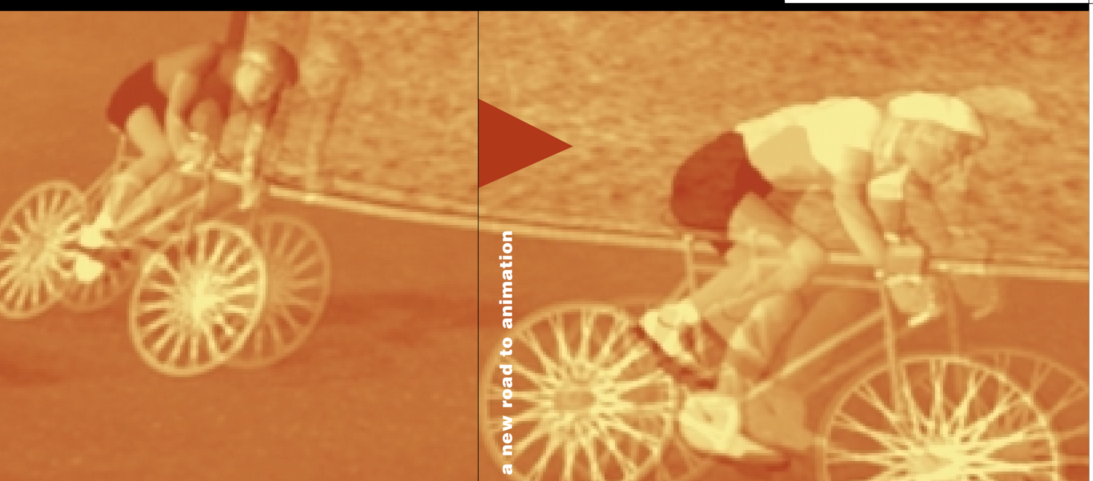
ENGINEERING THAT MAKES A DIFFERENCE

IN THE LAB

Making It Look Natural

Most of the animated human figures found in video games and movies are based on a technique called motion capture. By placing sensors or markers on a human body, it's possible to trace a specific action in great detail, enabling animators to duplicate it exactly over and over again.

That's the strength of motion capture—but that's also its weakness. Even when we confine ourselves to one of the millions of motions we're capable of performing, we inject subtle variations to compensate for changes in the environment, our energy level, and even our mood. And when it comes to producing realistic groups of animated human figures that interact with their environment and with each other, the problems



inherent in using rote motion capture are multiplied. Assistant Professor David Brogan takes a different, more inherently flexible approach. First, he develops algorithms to simulate the underlying physics of a particular motion such as pedaling a bicycle. People make these activities look easy, Brogan notes. "In my work," he says, "I'm drawn to human activities that are smooth and graceful. Examine them in detail, though, and you realize just how complex they are."

Brogan also creates control algorithms that describe the things that must be done to perform an activity successfully. The result: a simulation that can reproduce how a person pedals, steers, and maintains balance on a bicycle. For instance, the biomechanical motion of the person on the bicycle changes realistically as they change speed.

The mathematical basis of simulations also makes realistic interactivity possible. In essence, Brogan places his bicyclist on the road with other bicyclists and develops a variety of software tools, including machine learning and cluster analysis, to create the artificial intelligence needed to make interactivity realistic.

Ultimately, though, Brogan would like to create animated characters with a sense of their own style. "This would mean figuring out what makes Michael Jordan jump like Michael Jordan," he says. "We're not there yet!"

> *www.cs.virginia.edu/~dbrogan/*

ENGINEERING FOR KIDS

The School of Engineering is doing its bit to encourage more students to consider a career in engineering. With the help of a $150,000 grant from the Payne Family Foundation, mechanical and aerospace engineering professors Joseph Humphrey, Larry Richards, and Gaby Laufer are leading an effort to design engineering teaching kits for middle school students.

IN THE CLASSROOM

Ethics and Engineering

The whole point of engineering is to change things—but quite often it does so in ways that the creators of new technologies cannot foresee. The Internet, for example, has made it possible for people to collaborate and share information over great distances. At the same time, people have used this access in unanticipated ways, sometimes violating laws or making others uncomfortable.

Internet access is the principal vector for highly destructive computer viruses, while the widespread and persistent availability of personal information on the Internet poses questions about our right to privacy. And the ability to rip MP3 files and exchange them with others is the basis of ongoing discussions about intellectual property, in college dorms as well as in courtrooms.

Deborah Johnson's specialty is making people aware of the ethical issues produced by technological change and giving them a framework to think about them. The newly appointed Anne Shirley Carter Olsson Professor of Applied Ethics, Johnson specializes in information technology, and her book, *Computer Ethics*, has been widely adopted. As she points out, "Engineers, by virtue of their education, are uniquely equipped to take a leading role in addressing these problems. To do this effectively, they need a foundation in ethical thought."

Johnson's courses, as are all the offerings of the Division of Technology, Culture, and Communication, are part of the school's effort to prepare our students to be leaders in society as well as in their professions.

Professor of Applied Ethics Deborah Johnson

VEF NEWS

Virginia Engineering, the magazine of the Virginia Engineering Foundation, has a new look. The latest issue features long-time professor and inspiration Doris Kuhlmann-Wilsdorf, named Inventor of the Year at age 79.

> www.seas.virginia.edu/vef/publications/winter02/

INDUSTRY CONNECTION

VMEC Summer Scholars

In recent years, Virginia has emerged as the preeminent East Coast center for semiconductor fabrication and research, with Dominion Semiconductor and Infineon Technologies building multimillion-dollar facilities here. One of the consequences of these developments has been the creation of the Virginia Microelectronics Consortium. Founded in 1996, this unique partnership was established specifically to facilitate industry-academic partnerships to meet the educational, training, and research needs of the commonwealth's microelectronics industry. VMEC members include six of the leading colleges and universities in the Old Dominion as well as the Virginia Community College System.

One of the ways VMEC achieves this mission is through its Undergraduate Scholars Exchange Program. Created for students between their junior and senior years, the ten-week summer program gives students the opportunity to work hand in hand with some of the foremost researchers in the field. The only catch: they can't work at their own institution.

"We want to broaden our students' experience by exposing them to different researchers and areas of research," says James Aylor, chair of U.Va.'s Electrical and Computer Engineering Department and the 2001 chair of the VMEC Operations Committee. But wherever they go, they can be assured they'll be working on the cutting edge.

VMEC summer student Tim Van Drew

Students in the Undergraduate Scholars Exchange Program have worked on such state-of-the-art research projects as athermal annealing of ion-implanted compound semiconductors, silicon gate MOS training, and microwave chemical deposition of thin films.

"This is the best way we could think of to get a highly qualified group of students excited about semiconductor design and fabrication," Aylor says. Each participant receives a $5,000 stipend and three course credits in microelectronics at his or her home institution. In 2002, students will be hosted at each of the six member institutions as well as at Dominion and Infineon.

> *www.vmec.vt.edu/*

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