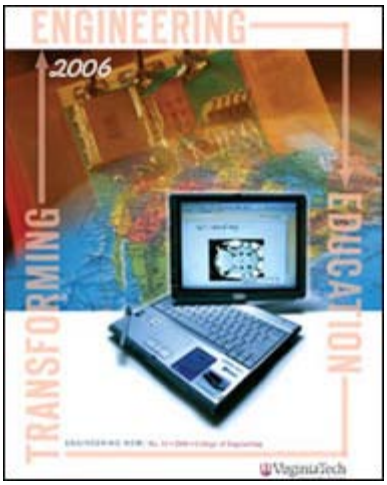

ENGINEERING NOW
No. 31 • 2006

College of Engineering

VirginiaTech

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The Metamorphosis of the Freshman Engineering Program Into a Degree-Granting Academic Department

During the past nine years, Virginia Tech's Department of Engineering Education (EngE) has greatly revised and enhanced its program, securing both university and National Academy of Engineering (NAE) accolades.

As background, Virginia Tech's freshman program was created in 1968 as the Division of Engineering Fundamentals. Its sole mission was teaching and advising freshmen. Diversity among the faculty was practically non-existent, and remained so until Dr. Hayden Griffin took over in 1997.

Since then, a major metamorphosis has occurred. Freshman courses have undergone four major revisions. The department has created sophomore level programming and computer-aided design courses to support other engineering departments. The faculty has become active in scientific and educational research, publishing in an array of journals. The faculty is receiving university-wide teaching awards. And the diversity of the faculty has changed from an all-white male background to having eight female faculty (or 50 percent of the faculty), one of whom is African American. The department has also employed two female faculty advisers.

Less time is spent lecturing in classes, and more time is devoted to hands-on work in laboratory settings. There is also more hands-on software instruction on such topics as Excel, Matlab, and Inventor, using Virginia Tech's new convertible tablet PC requirement for engineering students.

A host of benefactors has supported the learning process for EngE. Lockheed Martin, General Motors, Cummins, Lexmark, Briggs and Stratton, Black and Decker, Kodak, and individual alumni have contributed parts and cash gifts to help with the new design labs. Even the Virginia Tech Student Engineers' Council, representative of the engineering student body at Virginia Tech, has contributed handsomely to the design projects, awarding approximately $ 50,000 of its generated income since 1997 back to programs to support faculty initiatives in engineering education. This show of student support is truly indicative of how well-respected the program is among its constituents.

In 2003, Dr. Griffin led the department in another major change. As the faculty became more engaged in research, EngE added a graduate program. The news was first published on NAE's Center for the Advancement of Scholarship on Engineering Education's (CASEE) website in April 2004. The new graduate engineering education program was listed as a resource on the CASEE scholarly resources link for doctoral programs in engineering education.

Since then, the department has established an interdisciplinary certificate in engineering education, developed practicum and innovative graduate engineering education courses, and created masters of science and doctoral programs that respond to the urgent need for well-prepared leaders of change in engineering education and administration. In a little more than a year, EngE faculty secured over $4 million in NSF grants for innovative interdisciplinary curriculum and gender issues challenging engineering educators.

EngE faculty at Virginia Tech have a long history of success with engineering design projects at the undergraduate level that emphasize hands-on, minds-on learning, communication skills, teamwork, innovation, inventiveness, and interdisciplinary focus. These best practices are now core to the new graduate program in EngE, providing graduate students the opportunity to learn about, experiment

with, and research these topics as they become better prepared educators and leaders of change in engineering education for K- 12, post secondary, and policy/ administration locally and nationally.

In the spring of 2006, the EngE department secured a prestigious Exemplary Department Award from the university for its innovative and effective approaches to introductory courses at both the undergraduate and graduate levels. The university attaches a $ 10,000 cash award with this selection.

As the EngE graduate program at Virginia Tech continues to gain national recognition and interest from other institutions, the faculty energy and enthusiasm soars. There are growing interdisciplinary and cross-institutional collaborations, publications, and presentations at professional conferences, such as the American Society of Engineering Education Annual Conference and the Institute of Electrical and Electronic Engineers' Frontiers in Education Conference, and invited positions at the National Science Foundation sponsored workshops on engineering education.

I hope you will enjoy learning more about our prominent engineering education program that, first and foremost, greatly benefits the incoming freshman engineering students, tomorrow's leaders of science and technology.

Richard C. Benson
Dean of Engineering

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In 2006, the University Named the Department Of Engineering Education Exemplary--Here's Why

Engineering Education—Taking the Road Less Traveled

—Virginia Tech's Department of Engineering Education (EngE), led by Hayden Griffin, faced a fork in the road. It could choose the routine, straight path or it could head into new, uncharted territory. By selecting the latter, the EngE department is at the forefront of educating a new breed of engineers.

When a Virginia Tech student enters a freshman engineering classroom in 2006, there is a 50 percent chance that the professor will be a female. The instructor's degree may or may not be in a field of engineering. The average age of the faculty member is about 40. This profile is considerably different from what the majority of engineers who are over 30 today experienced when they were pursuing a degree.

In addition to the exceptional gender diversity, the 16 faculty members of the Department of Engineering Education (EngE) also have extraordinary disciplinary backgrounds. They have earned degrees in many different fields of engineering, as well as mathematics, English, chemistry, and linguistics. Thus all efforts of the department are inherently diverse and interdisciplinary, serving as a model to its students.

During the past few years, the program has expanded into rigorous and quantitative educational research and maintains a continuing commitment to the creation and utilization of modern teaching and learning principles as applied to engineering education. The mission of the department includes its modern, student-focused introduction to engineering for the 1,250 first-year students (all of whom enter Virginia Tech as non-degree general engineering students, before they transfer to a degree-granting program after successful completion of required courses).

In addition, the department has increased its emphasis on conducting research and offering courses and programs to alleviate the current national shortage of engineering and technology teachers. This emphasis has culminated in the offering of graduate programs in this area.

Some of the educational innovations introduced in the freshman curriculum in the past nine years include:

- Long-term collaboration with industrial design (ID), mentoring mixed teams of engineering and ID students as they design and fabricate toys, mobiles, and assistive technology devices.
- The Earth Sustainability Project, where ENGE 1024 students are given a small number of materials (clay, a bandana, bamboo skewers, plastic bottles, etc.) and are told to design and build a project to address education, agriculture, nutrition, and energy issues in Third World countries.
- Hands-on experiments illustrating Archimedes' Principle, mechanics of fluid flow, computation of surface areas, and other engineering activities, all done in the classroom.
- Introduction of engineering communication, including both speaking and writing, as a significant learning objective of the first-year engineering courses. * Introduction of teamwork as a significant portion of all of the first-year courses.
- The use of electronic portfolios to encourage students to become reflective learners and also to provide information that can be used to assess student progress toward both course and program educational objectives.
- The use of clickers in larger classes to gauge student understanding of concepts to determine student attitude and response to various learning situations, and to get the students more actively involved in the learning process. In addition, a number of online surveys have been conducted to systematically assess the learning outcomes of our courses. The faculty is also collecting data on students' prior experiences and learning styles in continued efforts to improve students learning experiences.
- Introduction of global engineering issues including exposure to study-abroad options. In response to a recent (April 2006) clicker-based feedback response, about 43 percent of students in ENGE 1024 expressed interest in exploring study-abroad options in their study plans.
- The MacGyver Box program, in which teams of students use the materials in a toolbox full of "stuff" (popsicle sticks, batteries, motors, wheels, duct tape, etc.) to design and build a project using only the materials and tools in the box.
- Introducing research-based engineering applications to engineering students in their first semester engineering course. Last spring a faculty member from the Department of Biological Systems Engineering (BSE) made a presentation on "a sustainable trip to Mars."

- As part of a major curriculum reformulation funded by the National Science Foundation, several EngE faculty members are currently working with faculty members from other engineering departments, particularly BSE, and the School of Education to develop spiral linkages between freshman and upper-level engineering courses. This is EngE's first effort to bring research findings from educational psychology to improve teaching pedagogy in engineering.
- EngE faculty members have created a two-course sequence for preparing students for undergraduate research and then teaching them how to report on that research following a summer research experience.
- EngE faculty are involved with instructors in other colleges to develop more effective presentation slides for use in large classes. The initial results are very promising.
- As a result of these innovations, students in the first-year engineering classes are now completely engaged in the learning process. They are learning actively and collaboratively in situations where in past years they might have been bored and inactive. The success rate (grade of C- or better) in ENGE 1024, the first engineering course, is currently over 90 percent. This is up from approximately 60 percent success (D- or better) 0 years ago. Efforts to work with colleagues in other disciplines are fruitful as well.
- More recently, with the development of graduate programs in the department, graduate students from across the College of Engineering and the School of Education are taking EngE's introductory graduate courses in engineering education. Several successful courses are now listed, including Preparing for the Engineering Professoriate, Foundations of Engineering Education, Design in Engineering Education and Practice, and Advanced Engineering Research Methods.
- Students from almost every department in the College of Engineering, as well as from the School of Education, have enrolled in these courses. A total of eight EngE graduate courses are now approved, with more being designed for implementation. The next set of graduate courses will be in the area of engineering communication, including a course on how teachers can and should respond to student communication assignments in the field of engineering. This course will answer the question often asked by engineering faculty, "How can you grade communication assignments without going crazy?"
- The innovations described here are truly a group effort by the EngE faculty. All of the faculty members have been working collaboratively to make the courses continually better and more relevant to the needs and interests of students. It is an exciting place to be both a teacher and a student.

Hayden Griffin

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Engineering Education Faculty


Lisa McNair


Hayden Griffin


Maura Borrego


Tom Walker


Tamara Knott

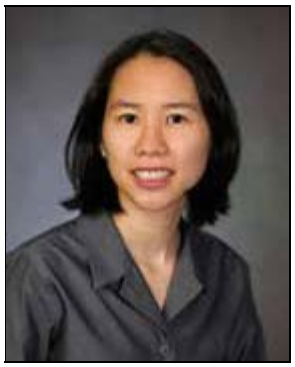

Bev Watford


Mike Gregg


Jeri Reinholtz


Vinod Lohani


Deborah Pollio


Jenny Lo


Jeffrey Connor


Jean Kampe


Janis Terpenny


Richard Goff

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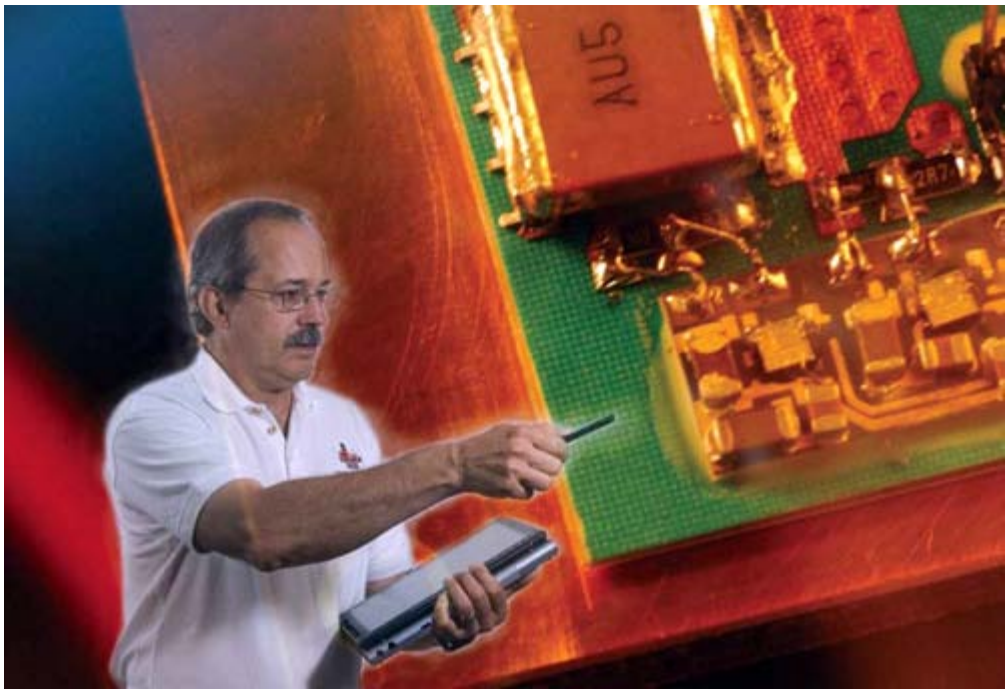
Marie Paretti

The Times, They Are a Changing



When computers were first required in Virginia Tech's engineering curriculum in the early 1980s, faculty needed to concentrate on the device at the same time that they lectured. Today, Tom Walker, professor of engineering education, uses a tablet PC to implement active learning techniques. Virginia Tech is the first large public engineering school to require entering freshmen to purchase tablet PCs.

Engineering Education Continues to Move into Uncharted Waters

"It's fun to be first. The guy who is second, third, or fourth doesn't generate the same excitement as when you know you are pioneering," Paul E. Torgersen told the Chronicle of Higher Education in 1984 about the College of Engineering's decision to require its entering freshmen to own personal computers. It was the first public university to do so.

At that time, IBM had just unveiled the state-of-the-art personal computer, the IBM PCjr, or "Peanut" as it was dubbed by the computing industry. Newsweek devoted a full page to the Peanut in its Nov. 4, 1983 edition, saying the device was "not a humble little home computer; it's a powerful machine that may shape the computer market for years to come." The prophetic article went on to add, "(the) PCjr may also rattle the education market, now dominated by Apple and Commodore. Last week IBM and Virginia Polytechnic Institute signed a deal under which every freshman engineering student will be required to have a PCjr next fall."

Since that auspicious start, the College of Engineering has continued to score more firsts. For the 993-94 academic year, the college became the first institution of higher learning to request that its entering engineering freshmen purchase a PC with multimedia capabilities. In 2002, as the engineering buildings became equipped for wireless needs, the college moved its requirement to laptops, again keeping it in the forefront of engineering education.

For 2006, the college is asking all new students to purchase a tablet PC. This type of PC has all of the functionality of a laptop and the additional capability to act as a notebook for pen-based input.

"With our decision to move to convertible tablet PCs, our College of Engineering continues to lead in the implementation and use of technology in education," says Richard Benson, dean of the College of Engineering. "It's still fun being first!"

As these ever-changing student capabilities challenge the faculty to continually upgrade their capabilities, the engineering education (EngE) faculty, in particular, have stepped up to the challenge.

As Jean Kampe, EngE associate professor, explains, "EngE intends to implement the tablet convertibles in both first- and second-semester courses for the fall 2006 general engineering freshmen. Our goal is to help our students see the full capabilities of these machines, and we hope that the convertibles will facilitate the collaborative efforts required of these students through their academic years and beyond."

Kampe's vision today is also a reflection on her colleagues' past educational roles when the EngE faculty was instrumental in the incorporation of the PCjr, the PC with multimedia capabilities, and the laptop.

The move to the tablet PC opens the way for instructional opportunities not found with traditional notebook computers. Students can write or sketch equations onto the tablet portion and save these handwritten notes, taken during class, to the computer as a document. In using the tablet PC in the classroom, the faculty has additional flexibility to implement active learning techniques. Currently several faculty are using the tablet PC for easily annotating their presentations during class, electronic grading, electronic submission of lab reports, acquiring student feedback electronically, and peer grading.

Additional applications for use with the tablet PC in or outside of class include a digital sketchpad for diagrams, writing mathematical equations, advanced note taking, organizing and sharing with OneNote, collaboration tools like ConferenceXP and ReMarkable Texts, Physics Illustrator and ChemPad for exploring different concepts, converting handwritten class notes to digital text, complete diagrams and projects in class, and pen-based 3D design software.

This latest partnership is with Fujitsu for the hardware and Microsoft for the software. Fujitsu's tablet PC was selected based on its reliability and flexibility, as well as the company's ability to support learning experiences in or outside of the classroom. "We are calling our collaboration a Premier Partnership," says Glenda Scales, associate dean of computing and distance learning for the College of Engineering, "and our objective is to improve the process of learning."

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The Effective Engineering Communicator is No Longer an Oxymoron, Starting in the Freshman Year

In the Olden Days--Communication skills were not part of an engineer's education, and the frustration often showed. Today's Virginia Tech engineering students have the advantage of using the Engineering Communication Center. Marie Paretti, one of the co-directors, is a well-published author, including a paper on an integrated engineering communications curriculum for the 21st century.

In an unusual move by an engineering college, and in an attempt to provide the engineers of the 21st century with top-notch professional skills to complement their technical expertise, Virginia Tech has opened the Engineering Communication Center (VTECC).

In the global marketplace, U.S. engineers need superior communication and collaboration skills, according to co-directors Marie Paretti and Lisa McNair, faculty members in Virginia Tech's Department of Engineering Education (EngE) who hold Ph.D.s in English and in linguistics, respectively. To better prepare students for the kinds of work environments they'll face upon graduation, the uncharacteristic pair of engineering faculty members "hope to build and deliver focused teaching practices that meet the needs of students and faculty."

VTECC personnel provide teaching support to the College of Engineering, including team-teaching arrangements and individual course lectures on topics in communication and collaboration relevant to engineering students.

They are also available to consult with departments to develop, integrate, and assess communication and collaboration skills targeted to the needs of the contemporary workplace. They cultivate multidisciplinary networks that create communities of first-year students, upper-class students, graduate students, and practicing engineers to foster professional development. The VTECC helps engineering students improve their writing mechanics, rhetorical knowledge, and rhetorical ability.

In conjunction with its teaching mission, the center conducts research on communication and collaboration in the engineering workplace. To help develop best practices for industry, their research addresses such issues as teamwork across disciplines, cross-cultural collaboration, and communication in engineering design.

Those practices also become the basis for what happens in the classroom as center faculty members bring industry-based research back to the university. Additional research projects on campus focus on how students learn these skills and what teaching strategies best promote student development.

"In each case, we seek to understand what happens in the workplace, what practices facilitate engineering work and what practices hamper it, and what strategies we need to bring back to the classroom to better prepare our students," Paretti explains.

The center is available to other engineering departments to help improve collaboration and communication skills targeted to the needs of the contemporary workplace.

Paretti and McNair offer teaching support, including team teaching, consulting with faculty, and individual lectures on topics in communication and collaboration relevant to engineering students. They also provide workshops and lectures on a wide range of topics, such as writing proposals, presenting research orally, and evaluating communication assignments within engineering courses.

Paretti, who holds a bachelor's degree in chemical engineering from Virginia Tech and a doctorate in English from the University of Wisconsin, has worked as an engineer, a technical writer, and an educator. Since 2003 she has directed engineering communications programs in Virginia Tech's Departments of Engineering Science and Mechanics and Materials Science and Engineering.

Paretti's achievements include authoring "An Integrated Engineering Communications Curriculum for the 21st Century" (Proceedings of the 2005 Frontiers in Education Conference, Indianapolis, Ind., 20-22 October 2005).

McNair holds a bachelor's degree in English from the University of Georgia and a doctorate in linguistics from the University of Chicago. McNair joined Virginia Tech's EngE Department in fall 2005 after serving as an associate director of technical communications at Georgia Tech. McNair served as the curriculum coordinator for the National Science Foundation-funded pilot project on the development of curriculum to improve undergraduate communication skills across the curriculum. The results of this project are summarized in an assessment report that showed specific improved learning outcomes in courses that included workforce communication practices. Her current teaching approach combines data from the workforce with proven rhetorical approaches from the field of technical communication.

More information can be found at http://www.eng.vt.edu/vtecc/.

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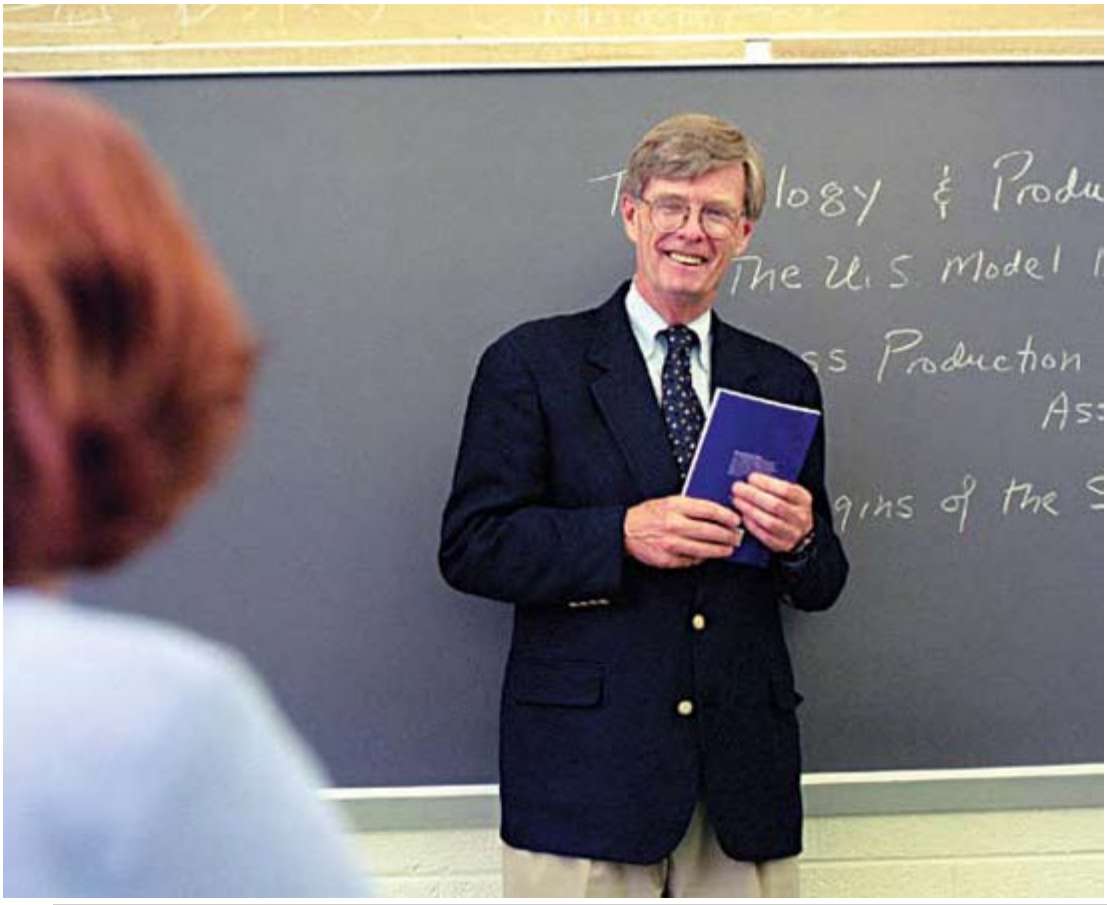
50 Years in the classroom



Editor's Note: In this issue of Engineering Now, as we highlight the national leadership of Virginia Tech's Department of Engineering Education and its numerous distinctive contributions to technological education, we decided to focus on one nationally known engineering educator, Dr. Paul E. Torgersen. In the spring of 2006, he celebrated 50 continuous years of teaching engineering. On this four-page spread, Michael Chappell, a mechanical engineering student, and the 2005-06 chair of the Virginia Tech Student Engineers' Council (SEC), interviewed Dr. Torgersen about his tenure in the classroom, which began in 1956. A brief bio of Dr. Torgersen appears below.

Mr. Chappell: Teaching for 50 years gives you a unique perspective on engineering education. What advice would you give the beginning engineering professor? A first-year engineering student?

Dr. Torgersen: The new assistant professor has to understand that our expectations include research and the securing of funding to conduct that research, as well as scholarship and work with graduate students. All of that's important. But also, and not necessarily of secondary importance,
the individual must develop his or her skills in the classroom.

I feel strongly that while we lay out carefully the research obligations, we need to also lay out the obligations of the individual to be coherent and intelligent and facilitate the learning process in the classroom with undergraduate students. All together it is a demanding career but a very satisfying one. If you don't enjoy both teaching and research, then I think one should find some other career path.

As far as the student is concerned, I often have had the chance to speak to freshmen. I spoke at orientation this past fall. And I tell them two things. First, in the freshman year one should focus on one's studies, get the best possible grades. Don't become involved in too many other activities, but get good grade--grades you're comfortable with and with which your parents are satisfied. After the first year, then begin to enjoy the total college experience. Become involved in other activities, in intramural sports, in the many, many extracurricular clubs there are on campus. A college education is a lot more than a classroom education and students should take advantage of these other opportunities before they leave.



Mr. Chappell: What changes in engineering education do you see in the future?

Dr. Torgersen: It's not easy to look into a crystal ball and predict the future and yet we have to do that. I would suggest that engineering and engineering education are becoming international and students must recognize that. Among other things, I think proficiency in at least one foreign language would be helpful. We don't see much of that happening now. I hope we will see more of it in the future. Understanding other cultures will be important.

After having said that, I think engineering in the future will have constraints that engineering in the past has not had. We talk about these in my class: energy... the cost of energy is going to increase; environmental concerns will be an over-arching constraint; and the international competition will be there much more so than in the past. I was chatting with a young man from India who was commenting on their education in their institutes of technology. It's very difficult to get into those institutes. He said for some students, MIT or Cal Tech is a backup institution, if they're not admitted into an Indian institute. Those are the graduates with whom our graduates will be competing. There are perhaps a half a dozen Indian institutes. They are good. And education in China is coming on strong.

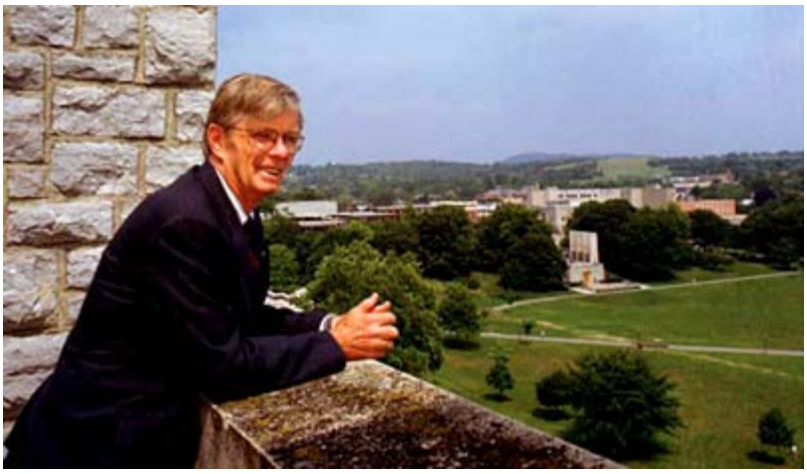
Mr. Chappell: If a commitment to research is necessary for a College of Engineering, is there a downside?

Dr. Torgersen: Yes, without question. First, I think President Steger has to be commended for proposing that Virginia Tech become a top 30 research university. The College of Engineering made that commitment two or three decades ago. Engineering has been taught with a faculty that has a concurrent commitment to research and to teaching for some time.

Is there a downside? Yes. The downside is seeing if the undergraduate student is lost in all this and we end up teaching undergraduates with graduate assistants or in huge classes in order to free up faculty to do research. I think we have to ask the question: Is the undergraduate student being shortchanged in this process? It is certainly possible to carry the focus on research to an extreme.

Mr. Chappell: You have seen the College of Engineering increase in stature over the years, and you have occupied a number of administrative positions. Which position is most demanding?

Dr. Torgersen: If you look at the hierarchy of the university from faculty to the department head to the dean, and possibly to the provost and the president, I'm convinced that the most demanding position in this hierarchy is that of the department



head. The department head has to occupy a position between the faculty, who can be very, very demanding and sometimes unreasonable, and the larger university and its goals and objectives. The department head is on the firing line every day.

Mr. Chappell: Did you have a particular leadership style or overarching philosophy of administration?

Dr. Torgersen: Well I have two responses to that question. First, my philosophy has always been that I work for the faculty...faculty members do not work for me. I will have been successful if the faculty is successful. And my role is to see that they succeed. And that means that if a professor comes to me and says, "I need support for such and such" my immediate reaction is, "Yes, how can I help?" Now, it may be that the proposal is not feasible, but I think there is an attitudinal approach that's very important in administration, and that is, you as an administrator succeed if the people working for you are successful.

Second, I think it's imperative that you keep a finger on the pulse of what's happening. When I was in administrative positions as department head, dean, even president, I made a point of getting out from behind my desk once a week and walking the corridors, encountering faculty in their office and asking how things were going. You'd be surprised how responsive your administration can be if you unexpectedly pop in an open door and talk to a professor of English or chemistry and ask, "Is there anything I can do to make your job a little easier?" You'll get a lot of advice, maybe more advice than you want. But you'll also foster an atmosphere of openness and communication,
which I think is very helpful.

Mr. Chappell: Why did you continue to teach engineering while serving first as dean and then as president?

Dr. Torgersen: This began more as an experiment. It occurred to me that being a dean would be more than a full time job, but I was reluctant to give up my teaching. So the first semester I put on my schedule, in ink, my class meeting times, and then added my dean's duties around them. Somehow it worked. I found that I was enjoying the hours in the classroom at least as much as I was enjoying serving as dean. And then the same pattern followed as president. To be fair, you have to understand that at least a few faculty were convinced that the only hour of the day when I knew what I was doing was when I was in the classroom!

Mr. Chappell: Is Theory of Organization the class you always taught?

Dr. Torgersen: Yes, I started teaching that at Oklahoma State through the encouragement of a wonderful gentleman by the name of H.G. Thuesen and when I came to Tech, I taught that course plus some others. But that was the one course I could offer as dean and as president without significant class preparation time. It's helpful to be able teach a course where you know the material well enough not to have to spend two or three hours in preparation before every lecture.

Mr. Chappell: I think it's a great course. This class fits you and the students really well.

Dr. Torgersen: Well, as you know, we start with a very abstract and theoretical model of the organization and then attempt to add flesh to that construct with case studies and personal experiences. Even with a large class, we draw out observations from the students. And we read Machiavelli and might examine the pre-Civil War manufacture of muskets at Springfield Armory and the current financial condition of General Motors. Each semester the readings and illustrations change. I think I may get more out of it than the students. At the end of the semester I have a real sense of fulfillment. Another 125 students have been exposed to a classic text, Thuesen's teachings, and to my teachings and a bit of my experiences in administration.

Mr. Chappell: You are now well past the usual age of retirement. Why do you continue to teach?

Dr. Torgersen: When I stepped down as president in January 2000, the then dean of engineering, Bill Stephenson, offered me the opportunity to continue to teach and in return he would provide me with an office and some travel monies. I have significant commitments in Washington with the National Academy of Engineering, so it's helpful to have a secretary and an office and a telephone. But I think most importantly, it's very, very satisfying. I enjoy my teaching and as long as I'm healthy, I'd like to continue.

Mr. Chappell: Are there some achievements for which you would like to be remembered?

Dr. Torgersen: A friend calculated that during my tenure as dean and as president, I signed slightly in excess of 62,000 diplomas. And I'd like to think I had some modest influence on the educational process that was involved in awarding those diplomas. So rather than some singular achievement, I think I'd like to be remembered for having a positive impact on 62,000 students whose diplomas I signed, plus maybe the eight or ten thousand students I had in class.

Mr. Chappell: How did you react when you learned a Virginia Tech academic building would be named in your honor?

Dr. Torgersen: My first reaction was absolute astonishment because this is an honor beyond anything one would hope one would receive in one's career. I think the dedication was a memorable day in our lives, and what I mean by "our lives" is the lives of my whole family. We had some very nice, very impressive people there as a part of the dedication and I think perhaps as a sidelight, when it was all over, I noticed my grandchildren treated me with a little more respect.

Mr. Chappell: Is there any individual with whom you have come in contact over the years that you particularly admire?

Dr.Dr. Torgersen: Well, I've had two mentors. First, in my years at Oklahoma State, Professor H.G. Thuesen. He really introduced me to what a campus community and what a university are all about in a way that you could not replicate simply by interacting with faculty of your age and your peer group. And he also introduced me to the course he was teaching and he insisted I begin to teach, and which I continue to teach over the years. Second, I'd have to admire Jack Hancock, who founded Roanoke Electric Steel, lived in Roanoke, and had me serve on the board of his company. But more than that, he was a doorway to many, many legislators and even governors here in Virginia, and to some very influential people who have had an impact on me, my career, the College of Engineering and the university. Jack Hancock, in many ways, was a father to me.

Mr. Chappell: Throughout your career, how have your wife and family supported you?

Dr. Torgersen: Well, both have been very understanding of the demands of the job. In a sense, it has been a partnership among my wife, my three children, and myself...that is, my career has been a partnership...and my children understood they may have had a tennis match or a basketball game and at the last minute I could not be with them because we had an important alumnus coming into town and I had to spend time with him. My wife is more outgoing than I and she's been a real help in the social obligations of serving as dean and as president. I can't begin to overstate how supportive they have all been. With my wife, it really has been a partnership more than just a marriage.

Mr. Chappell: Are you optimistic about the future of engineering at Virginia Tech?

Dr. Torgersen: The answer there is both yes and no. Yes in the sense that I think we have brought together some very fine faculty, some very good students, and I think those ingredients--a faculty and a student body that have high aspirations--would lead one to be optimistic. I'm not optimistic about the physical plant. I think we exist in buildings and offices and in particular, laboratories, that are hopelessly outdated. I think the undergraduate student is being seriously disadvantaged by these facilities. Other colleges of engineering have much more modern facilities than Virginia Tech. Randolph Hall, in particular, is an abomination that should be torn down and replaced with a modern building. If we can put $52 million into a stadium expansion, I think we can put that much money into a rebuilding of Randolph Hall.

Mr. Chappell: What are your plans for next year, after 50 years in the classroom?

Dr. Torgersen: I make this decision on a year-by-year basis, depending on my health, on the encouragement of my wife, and perhaps most importantly, the encouragement of our dean, Dick Benson. When I even begin to talk about winding down, he cites as an example Joe Paterno at Penn State. Dean Benson came from Penn State. He says as long as Paterno, in his late seventies, can continue to coach football, surely you can continue to teach engineering. So I guess I'm kind of focused on Joe Paterno and see what his future looks like.

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Fifty years in the classroom means:

You may have taught three generations: the current student, the student's parent, and the student's grandparent.
Gerry Clarke, retired president and CEO of Energy Services Group, currently living in Williamsburg, and a 1968 industrial engineering alumnus, testifies Paul Torgersen did so with his family.

Or you get an email like this one:

Courtney Cecil, a Virginia Tech engineering student in 2005 writes:
I have held constant interest in taking your Theory of Organization class for the past several years... I have heard several retirement rumors. I am hoping for the opportunity to hear you lecture before then. Are you, by chance, force-adding people to your class? I unfortunately was unsuccessful in my course request... I wish I had a better excuse in that I actually need the class next semester but unfortunately I don't, I have just heard such positive things about how interesting your lecture is that I'm more concerned with having you as my teacher than actually get-ting in the class. Yes sir, my dad said he had you as a teacher and was quite impressed.

Paul Torgersen's response:

Your dad had me.... You're enrolled. Bring by a force-add slip when you have the chance. What grade did your dad earn? Or perhaps I'm not supposed to ask that question.

And when the 50 years was over:

Paul Torgersen had signed more than 62,000 diplomas.

Paul Torgersen--Brief Bio

Paul Torgersen discovered he had a career in the classroom inadvertently. He claims his parents were convinced that while he was in college he majored in tennis, a fraternity, and industrial engineering, in that order. He graduated without any specific career objectives because he had a two-year service commitment through ROTC. While in the Air Force he enrolled in some evening graduate courses

that were offered at Wright-Patterson Air Force Base by Ohio State.

Near the end of that two-year period, he had a course taught by the department head. Apparently the two clicked because the professor asked if Torgersen would come to Columbus, Ohio, to be his graduate teaching assistant and complete the master's degree requirements in one year.

Late that spring, the department lost some faculty at the last moment, and Torgersen was persuaded to accept a position as a full time instructor. This obligated him to pursue a Ph.D. As he recalls: "I really backed into both opportunities. The first semester, fall 1956, was rather harrowing. I had in class some students who were older and I'm also convinced that some students knew more about the subject than I did. But somehow we worked our way through that term and I found at the end of the semester, I was really enjoying this classroom experience. I taught as a full-time instructor for three years, finished my Ph.D., and was then afforded the opportunity to teach at Oklahoma State University. With my wife and two very young daughters, we headed to Oklahoma in a new Volkswagen bug that cost $ 1,695. And I began teaching as an assistant professor at Oklahoma State. "After six years at Oklahoma State, both my wife and I knew that we wanted to return back East. It occurred to me that I might want to seek out the position of department head. Both came available at Virginia Tech...a faculty appointment on the East Coast and the opportunity to be head of the department. So we arrived in January 1967 and I was a full professor and as a department head. I was nervous about this new career move because I had no administrative experience."

The remainder of Torgersen's brief bio is a huge part of Virginia Tech's history. From 1970 until 1990, he served as the dean of the College of Engineering, raising it from the bottom 10 percent of the colleges of engineering in the U.S. in terms of research expenditures to the top 10 percent by 1985, the year it celebrated its 100th anniversary of awarding its first degree.

He then served as president of Virginia Tech's Corporate Research Center and was also interim vice president for development and university relations. He was named president of Tech in fall 1993 and served until January 2000.

Torgersen is a Fellow of the Institute of Industrial Engineers and the American Society of Engineering Education. In 2001 he received the institute's highest recognition--the Frank and Lillian Gilbreth Award. In 1991 he received ASEE's Lamme Medal. He earned Virginia Tech's first Affirmative Action Award, its 1992 Sporn Award for Teaching Excellence, and was named Virginia's Engineering Educator of the Year in 1992. In 1986 he was elected to the National Academy of Engineering and more recently to the governing board of that same organization.

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Now, We Just Want to Have Fun

—When the engineering professor taught from the book alone, the learning experience could often be tedious. When the engineering education classroom opened up to hands-on, minds-on projects, the enthusiasm of Professor Richard Goff and others became contagious.

The Hands-On, Minds-On Philosophy Starts in EngE and Carries Over to Prominence in Design Competitions

Since 1997, Virginia Tech engineering freshmen have received hands-on experiences in the Engineering Education (EngE) classroom in many innovative ways.

A testimonial to these efforts is the engineering student body's financial support of these efforts. In fact, the Virginia Tech Student Engineers' Council (SEC) has provided more than 90 percent of the funding required for materials and supplies. The SEC, with profits it receives from organizing an annual career fair, has provided between $20,000 and $50,000 annually for the past nine years to faculty who must compete with their 300 Virginia Tech engineering colleagues to receive a grant.

During this time, the SEC has awarded more than $300,000 in contributions to enhance engineering education at Virginia Tech. Approximately one-half of this money has supported the ideas developed specifically by the EngE faculty, the majority of which have been the hands-on design projects. Other support has come from General Motors, Lockheed Martin, Cummins, Briggs & Stratton, Black & Decker, and Lexmark.

A pilot program with 300 students led to the full-scale imple-mentation of an innovative hands-on early design program as an integral part of the EngE curriculum. The program was built around a standardized kit of tools and materials dubbed the "MacGyver Box." Teams of four students received a MacGyver Box, introduced to the design process, and then assigned projects to complete throughout the semester. For each project, the student teams were given design criteria (for things like ping pong ball launchers and vehicles), instructed to develop several design alternatives, and then asked to select and build their best design. The catch--only the tools and materials contained in the MacGyver Box can be used for construction and no replacement parts are allowed. This initiative offers an engaging method to introduce students to design, engineering economy, and the dynamics of teamwork.

In 2005, the MacGyver Box was replaced by the Mechatronics Experiment, led by associate professors Vinod Lohani of engineering education and Pushkin Kachroo of electrical and computer engineering. It is designed to give all engineering freshmen hands-on experience in mechanical construction, electrical and electronic circuits, and digital circuits from computer engineering. The ultimate goal of the course is for freshmen to use the engineering principles they learn to build a two-wheel mobile robot. The SEC $8,500 grant helps pay for the materials needed for this project.

Since 1998, when the college received a substantial gift from one of its alumni and created the Frith Freshman Engineering Design Laboratory, students have completed additional hands-on projects, except in many cases these projects are done in reverse order. Students are required to take apart such devices as lawn mower engines, computers, disposable cameras, and toasters to study their designs. Ultimately, they must put them back together incorporating ideas on how they could improve the designs.

Since its opening, thousands of students have used this lab, directed by Richard Goff of EngE. Activities are changed each semester. Industrial design students also use the lab, creating more of an interdisciplinary flavor. Another use of the lab has been for summer programs for high school and middle school participants. They have also taken apart computers, worked with the LEGO robotics competition, and repeated some of the experiments done by the college students. Older engineering students act as advisers to freshmen about the projects, providing input to faculty about their past experiences and mentoring the current students. This hands-on work increases the interaction between the students with each other and also between the students and faculty.

Four years ago, when the college required its freshmen to own laptop computers, the Frith Lab was equipped with wireless Ethernet, making it a state-of-the-art computer lab.

The department is also the organizational home of the Joseph F. Ware Jr. Advanced Engineering Laboratory, the focal point of hands-on student design projects in the College of Engineering. These projects range from human-propelled submarines to hybrid vehicles to unmanned vehicle systems. The Ware Lab, dedicated in 1998, was the first of its kind in U.S. engineering colleges, with an entire building dedicated to 24/7 student access to interdisciplinary design projects.

Benefiting from "hands-on, minds-on" training that begins in their freshman year, College of Engineering students become national leaders in technology design and development. Engineering freshmen discover the fundamental principles of making mechanisms work in the Frith Freshman Engineering Design Lab. Afterward, undergraduates from all 12 engineering departments are encouraged to work on design-and-build projects in the Joseph F. Ware Jr. Advanced Engineering Laboratory. Each year, College of Engineering undergraduates participate in national and international design competitions and have won a number of the most prestigious awards, including a total domination of the Intelligent Ground Vehicle Competition, as well as firsts in the International Aerial Robotics Competition, Human-Powered Submarine Race, Material Handling Student Design Competition, and FutureCar Challenge.

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Virginia Tech E-design Research Center Involves Engineering Freshmen in a Pilot Program

Around the World in a Nanosecond

—Engineering Education faculty member Janis Terpenny is bringing the latest in modernization to the design process. She is a founding co-director of the National Science Foundation Center for E-design, which allows visitors from remote locations to test and validate new design platforms via the Internet.

It's no secret that manufacturing industries continually seek to deliver products to the marketplace faster, at lower costs, and with higher quality. The challenge is how to accomplish these targets.

"The key is usually in the design technology, where 70 percent of a new product's life cycle costs are determined," says Janis Terpenny, associate professor of engineering education (EngE).

Virginia Tech is a strong player in the industrial design arena, and through Terpenny's efforts, has become more prominent, even including select engineering freshmen in the effort.

Terpenny is one of the founding co-directors of the National Science Foundation (NSF) Center for e-Design, an industry/ university cooperative research center. The NSF center's mission is to advance design methods, processes, and technologies for its customers to give them a competitive edge in the market place. The design focus is on complex products and systems for the aerospace, automotive, and medical devices industries. Companies in these areas derive their greatest profit from leading-edge high technology content products so product development needs to be especially innovative and efficient.

The center serves as a national resource for research, technology evaluation and deployment, engineering education, and information transfer. It plays a key role in serving the mutual interests of private industry, government agencies, and academia, including nurturing and developing well-prepared engineers for careers in the areas of intelligent product and system design, development, and realization.

"Information is the lifeblood of an enterprise and collaboration is the key to the seamless integration of design, development, testing, manufacturing, and servicing of products around the world," Terpenny says.

The e-design center maintains a variety of commercially available tools for benchmarking. Using the Internet, designers from remote locations can visit the center virtually and test and validate new design platforms. Designing via the Internet enables real-time product information sharing and collaboration among the various customers, suppliers, designers, manufacturers, and vendors. The participants can use decentralized product development tools, such as virtual analysis, prototyping, and simulation. Participating faculty have access to numerous Virginia Tech laboratories and facilities for innovative research and education initiatives.

Collectively the multi-university Center for e-Design has over $5 million of funding derived from five-year NSF grants at each member university and industry membership fees.

Industry members of the Center for e-Design include Aerosoft, ALCOA, ANSYS Inc., BAE Systems, Boeing, DRS Technologies, Engineous, Ewi, Ford Motor Company, Kodak, Phoenix Integration, Pratt & Whitney, Raytheon, Respironics, and Virtual e3D. The Institute for Critical Technology and Applied Science at Virginia Tech is also a participant.

The current list of member universities includes University of Pittsburgh, University of Massachusetts Amherst, University of Central Florida, and Virginia Tech.

In the classroom, Terpenny, who has affiliate positions with mechanical engineering and with industrial and systems engineering, is using the e-design center to involve engineering freshmen in a pilot program with students in the industrial design curriculum. Working with Richard Goff of EngE, the recipient of numerous teaching awards, they orchestrated a test case. They identified a test group, teaming engineering freshmen design teams with industrial design students in assistive technology design projects. Terpenny and Goff then compared the test group's work with design work done by other teams that did not have the advantage of interdisciplinary knowledge.

"The teams that collaborated with industrial design students performed better and learned concepts better, resulting in more successful design projects," Terpenny says. "This shows we need a new infrastructure at universities to allow for more collaborative spaces for students to brainstorm ideas and to build product prototypes in teams." For more information about the Center for e-Design, go to http://www.e-designcenter.info/.

The Solitary Man is Obsolete

—Working alone to solve engineering problems is like being inside a fishbowl. But when Vinod Lohani teams with his colleagues and students in the new engineering education interdisciplinary efforts, supported in part by several National Science Foundation grants, the results open up new possibilities.

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In Recent Years, Engineering Education Faculty Garnered $4 million in Interdisciplinary Research Contracts

A subtle change has occurred during the past decade in the freshman engineering teaching community at Virginia Tech. Instead of working alone in a conventional classroom for each enrolled course, the student now experiences Virginia Tech's "hands-on, minds-on" theory of learning engineering.

The entering freshman is likely to become a member of a student design team, possibly even working with students from outside the college, before the end of the first full year.

Virginia Tech's Department of Engineering Education (EngE) has become known for its collaborative work. Its educational program brings together faculty and students from engineering, education, science and technology studies, and allied disciplines to create a vibrant engineering education research community--one that can be modeled at other universities.

For example, EngE Professor Richard Goff, who holds the college-wide prestigious W.S. White Chaired Professorship for Teaching Innovation, has been instrumental in the development of hands-on active classroom learning experiences, frequently developing

and piloting activities that are later adopted for all first-year engineering students.

Some 10 years ago, Goff proposed a collaboration to Mitzi Vernon, a professor of the industrial design program in the College of Architecture and Urban Studies. Since then the two have engaged several hundred engineering and architecture students in the process of invention. For the past three years, they've been using the LEGO Robotics Invention System.

Each team of students receives tools at the beginning of the semester. Their instructions are to develop a vehicle that travels on a particular route that they design. The extra catch is that they must also add what the professors call a "postscript." This addition must attach to the vehicle in an "elegant" manner, travel with the robot for a distance of at least 10 feet, and react to something along its journey.

With these requirements in mind, the students develop their concepts, make prototypes, and on the last day of class, present their final demonstrations.

Other team-oriented, funded research projects in the EngE department include several successes. One was the Bridges for Engineering Education (BEEVT), a National Science Foundation (NSF) planning grant with participating faculty from EngE, civil and environmental engineering, mechanical engineering, mining and minerals engineering, technology education, teaching and learning, and the School of Education. BEEVT participants created a modern framework for engineering education, developed a new technology education master's/licensure program (TEMLP), and created an ongoing dialogue, or "bridge," between the university, public schools, and industry in the general area of engineering education.

"To teach technology education in Virginia, one must be licensed," Mark Sanders, a former vice president of the Council on Technology Teacher Education and a professor in the College of Liberal Arts and Human Sciences, explains. A graduate of the engineering, architecture, or design program at the bachelor's level can supplement his or her degree with 8 hours of technology education courses at the master's level and 5 hours of education courses (plus student teaching) to qualify to teach technology education at the K- 12 level.

Working with the engineering faculty, and specifically EngE members, Sanders helped to develop this fifth year TEMLP specifically for engineering graduates. "This graduate program builds upon the strong traditions of engineering and technology education at Virginia Tech," Sanders says.

Another team project used $1 million in NSF funding to EngE and biological systems engineering (BSE) faculty to enhance part of the undergraduate curriculum in the BSE department, explains Vinod Lohani, a principal investigator on the project.

The curriculum, bioprocess engineering, is a relatively new area in the emerging field of biotechnology. It encompasses a wide range of engineering practices involving the use of biological feedstocks for the production of food, fiber, and other value-added products, such as pharmaceuticals, biofuels, plastics, and industrial enzymes. Graduates of this option normally work in the food, pharmaceutical, or biotech industries or with numerous other companies that manufacture bio-based industrial products.

All of these efforts to ensure teamwork are providing much-needed rigorous research on engineering education. That research is disseminated directly into engineering classrooms by equipping future engineering faculty to act as change agents in their departments and disciplines.

Some of the benefits of this interdisciplinary engineering/ education arrangement include cross-listing of courses that are taken by a mix of EngE and education students and taught by a mix of EngE and education faculty; recruitment of "career switchers," technology education teachers seeking graduate work in EngE to become community college faculty, as well as engineers looking for a more "people-oriented" slant, such as teaching, industrial training, or technical representative.

There are also joint advising opportunities; engineering access to public schools (recruitment, engineering outreach); the mixing of engineering and education "cultures" (among both faculty and graduate students from both sides), yielding some subtle but significant benefits such as informal sharing of teaching pedagogies, advising practices, outreach efforts, and life experiences; and the enhancement of research proposals with genuine interdisciplinary research communities of engineers and educators with an established track record of working together.

The newly established graduate certificate in engineering education is the most recent interdisciplinary innovation. Over the past three years, nearly 100 graduate students from the College of Engineering and the School of Education have taken engineering education graduate courses, many learning for the first time the basics of human learning and how to become effective educators.

Graduate Certificate in Engineering Education Eligibility

Students with backgrounds in any engineering or science field are eligible for this 13-credit graduate certificate in engineering education. Students must take 12 credits of course work from engineering education, and any department in the School of Education, one course offered by the Graduate School (Preparing for the Future Professoriate), and a one-credit practicum in the engineering classroom. The practicum, supervised by a team of EngE faculty, work directly with graduate students who have teaching responsibilities in any department, providing a continuous mentoring, evaluation, and advising service to these students. Students in the practicum are also required to participate in curriculum development activities. The graduate certificate in engineering education will serve to clearly demonstrate to potential employers that these students have both course work and experience that enhances their ability to become successful teaching faculty.

Inventing the Future of Engineering Education

- Increase recruitment and retention
- Continue to implement and investigate cutting-edge technologies

- Expand and enhance existing interdisciplinary collaborations through funded research
- Increase funded research from literally zero in 2002 to some $4.5 million by 2005
- Expand international partnerships
- Increase peer-reviewed publications from 10 in 2004 to 40 in 2005
- Become an internationally recognized center of engineering education research
- Work with School of Education in K-12 arena
- Obtain program approvals--admit Ph.D. and master's students January 2007

Inventive — Inclusive — Interdisciplinary — International

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