

## International Context for First Year Engineering Students

Michael H. Gregg, Richard M. Goff  
Division of Engineering Fundamentals  
Virginia Polytechnic Institute and State University

In response to information gained at the October 2000 GEE'3 conference in Aachen, Germany and the critical need for U.S. engineering students to have international academic and industrial experience, our first engineering courses are being modified to allow a select group of first year students to take these courses at Virginia Tech's Center for European Studies and Architecture (CESA) in Riva San Vitale, Switzerland in conjunction with classes at its Blacksburg, Virginia, U.S.A. campus.

Engineering freshman at Virginia Tech typically take two introductory engineering courses during their first two semesters; these courses are EF1015 and EF1016. These two courses are prerequisites for all higher-level engineering courses. Many students enroll in the College of Engineering at Virginia Tech with a substantial dossier of Advanced Placement, International Baccalaureate or transfer credits. These credits complicate the process of filling a student's schedule without enrolling the students in higher-level engineering classes. Providing the introductory EF1015 and EF1016 courses during the summer preceding their entry to Virginia Tech allows these students to:

- Satisfy their engineering prerequisites
- Consider semester abroad programs
- Thrive as engineers in the international arena
- Enroll in higher level engineering courses
- Gain valuable international experience
- Make personal contacts with other engineering students
- Develop an awareness of international cultural diversity

These courses, EF1015 and EF1016 (Introduction to Engineering) will be modified to be taught in a four week intensive format to include international components and site visits. Funding for this modification has been requested from Virginia Tech's Center for Excellence in Undergraduate Education. The course will be offered summer 2002 in Switzerland and will be structured on a class size of 15.

Students taking the initial offerings will be surveyed and interviewed later in their academic careers to assess the impact of this course on their undergraduate experience and on subsequent international experiences. This paper discusses the formulation of the concept, development of the curriculum and syllabus, logistical and financial considerations and development of international visits to industry and universities.

## Introduction

Virginia Tech, a land grant institution, is well into its second century. Its objectives are education, research, and community service. Virginia Tech has grown over the past 130 years from an institution with a student body of 43 to its current enrollment of over 25,000, comprising about 5000 new freshman each year. Of these entering freshman, roughly 1500 will enter the Engineering program.

Virginia Tech's engineering program puts an emphasis on immediately involving its entering engineering students in engineering topics. These introductory topics are structured to give these students a taste of engineering curricula and to expose them to problem solving techniques. Early involvement in engineering problem solving helps stimulate, refresh and/or retain the interest that these students have already shown in the engineering profession. Virginia Tech's success in maintaining a respected and rigorous engineering program is combined with an exceptionally high retention rate of its freshman in engineering. The latest figures indicate that nearly 70 percent of freshman engineering students graduate from Virginia Tech with an engineering degree; an additional 20 percent graduate from Virginia Tech with other than an engineering degree, and the remainder transfer to another institution or take on other challenges.<sup>1</sup> Although admission standards to the engineering program are reasonably high (average 1250 combined SAT and top 10% of class), we feel our high retention rate is partially attributable to the exposure the students gain in their first engineering classes. At Virginia Tech these classes are EF1015 and EF1016.

## First Year Courses

Engineering Fundamentals EF1015 is the students' first exposure to engineering at Virginia Tech. The faculty take this opportunity to present the students with a myriad of engineering topics. A two credit class, EF1005 sections are purposely kept small (maximum of 32) to engender a personal relationship among classmates and with their EF instructor/advisor. For nearly two decades Virginia Tech has required entering freshman in engineering to purchase their own computer. This EF1015 class is, therefore, an introduction for many of these students to ownership, maintenance, and use of a computer. The EF1015 syllabus includes an introduction to the profession, examination of ethics and ethical theories, traditional pencil-and-paper problem solving techniques, algorithm development and graphing. These skills are then translated to computer solutions, currently via MATLAB™.

EF 1016 addresses traditional engineering graphics and computer graphics, with one desired outcome an enhanced ability to visualize in three dimensions. This year, Virginia Tech is using Autodesk's Mechanical Desktop Release 6.0. We intend to introduce NC milling into the EF1016 course this semester. EF1016, like its sibling EF1015, meets for two 50 minute classes each week and is a 2 credit course. As many of our students have no engineering graphics experience or computer experience upon entering the program, we do not intend to produce industry-ready drafters or computer-aided-drafters. We do, however, want these students to use their cognitive skills to explore engineering design. It is this design challenge that often sparks an interest in different aspects of engineering for the student.

An elective freshman laboratory experience has been in place for several years. This lab introduces students to the different engineering disciplines using a hands-on approach. This laboratory class employs a combination of reverse engineering (take apart common devices) and laboratories from different disciplines. The aim is to introduce our students to engineering disciplines, to introduce assembly and design topics, to promote and encourage the understanding of engineering drawings and associated visualization issues, and to also generate enthusiasm for our profession. At the same time we teach students some basic skills (such as using wrenches and calipers) and give them an understanding about how devices are designed and why, as well as the roles of the different engineering disciplines in the production of the device.

### International Components

An international component, either implicit or explicit, is part and parcel of any undergraduate engineering education. Virginia Tech's core curriculum requirement includes a 3 credit hour requirement in the area of Critical Issues in a Global Context. Core curriculum classes, however, are taken over a student's undergraduate tenure; incorporating international components in the first and second semesters of the freshman year poses a much larger administrative and financial challenge. Undergraduate engineering students at Virginia Tech currently require a minimum of from 128 to 134 credit hours for graduation; there is no room in the curriculum for additional classes. The material in the two introductory classes has in the recent past been characterized as 'ten pounds of peanuts in a five pound bag'; incorporating additional material having an international component would exacerbate the problem. Recent restructuring of the EF class sequence has added a green engineering component, and the authors have recently received funding to add some international components to the problems and design projects. These modifications, by design, are minor in nature although they impact each of our freshman engineering students. A more in-depth and, therefore, restricted program was needed.

The authors' recognition of the need for international content for our freshman engineering students was reinforced through participation in the October 2000 GEE'3 (Global Engineering Education) Conference in Aachen, Germany. This trip included meetings with many colleagues representing both domestic and foreign engineering programs. Meetings with faculty and administrators at both RWTH (Rheinisch-Westfälische Technische Hochschule) in Aachen, and EPFL (Ecole Polytechnic Federale du Lausanne) in Lausanne, Switzerland further reinforced the need of our engineering students to have a broader global outlook, and the need to imbue that outlook in the freshman year. Feedback from students currently enrolled in international programs of study were also positive.

Subsequent to this trip small groups of Virginia Tech faculty met to discuss strategies and priorities in Virginia Tech's efforts to internationalize the university experience. The University Office of International Programs organized these discussion groups of 5 to 8 faculty members as part of its planning efforts. Some of the questions raised were:

- \* If you could spend \$50,000 per year to stimulate internationalization at Virginia Tech, how would you spend the money? This approximate amount is currently devoted to course development and faculty international travel.

- \* How do we best encourage/develop the next generation of faculty to take on international teaching, research or outreach activities?
- \* How can we do a better job of educating students about the need to master a foreign language, take courses with international content, study or intern abroad?
- \* About the Semester Focus programs (China last year; the Alpine Region this year): Have they been effective in bringing glimpses of the larger world to students unable to travel abroad? What would you change?
- \* What is the single most important element in international programs at Virginia Tech?

None of the faculty in my discussion group addressed the potential of students traveling abroad; most discussion turned on the possibilities of sabbatical or foreign faculty research. Virginia Tech's University Office of International Programs (UOIP) lists the following reasons for study abroad:

1. Study Abroad lets you explore the world for a summer, semester, or even a year while you're still a Virginia Tech Student.
2. Study Abroad will set you apart from other job seekers in a very competitive job market. You will Highlight your experience abroad in job interviews and on your resume.
3. Study Abroad can help you develop new skills, more independence and self-confidence. You'll return from Study Abroad with new skills that just can't be learned on campus.
4. Study Abroad helps you see the world from a completely new perspective. The simplest things take on a new meaning when you are overseas.
5. Study Abroad introduces you to a new culture - a new way of life (Whether you go to Ecuador or Zimbabwe, you'll learn to recognize and appreciate how culture determines values and behaviors.)
6. Study Abroad will give you an opportunity to make lifelong friendships with people you wouldn't have met. You might even find yourself 'adopted' by a local family.
7. A semester, summer, or year abroad gives you the opportunity to participate in an international internship - an impressive asset in today's global market place.
8. Study Abroad can give you an unparalleled opportunity to develop genuine fluency in a foreign language and meet your foreign language requirements.

9. Study Abroad helps you learn what it really means to be an 'American.' You'll learn what makes life in the United States different from anywhere else.
10. You'll be part of the elite 1% of Undergraduates who have studied abroad.

## CESA

“Virginia Tech's Center for European Studies and Architecture (CESA) is a study abroad center in Riva San Vitale, Switzerland, on Lake Lugano near the Italian border. It is housed in Villa Maderni, a 200 year old villa with beautifully restored frescoed ceilings. The upgraded facilities include computer labs, architecture studio, classroom, small library, administrative offices, dark room, dormitory rooms and dining room. All students eat in the villa family style. A second facility providing additional student housing is La Pabiana, a beautiful home on a nearby hillside.

CESA schedules a variety of semester and summer programs to offer diverse learning experiences that go beyond the textbook and classroom to the people, museums, and cultures surrounding the site. Language instruction is offered by local professors, while other regular courses are generally taught in English by Tech faculty”<sup>2</sup>

Riva San Vitale is a small village, about the size of Floyd, Virginia, in the southern (Italian speaking) section of Switzerland, about 1½ hours from Milan, Italy. The Center for European Studies and Architecture (CESA) provides a learning environment which encourages close faculty-student as well as student-student interaction. CESA provides an opportunity for students to take college courses that count toward their degree while studying in Europe. Students may take field trips in connection with their program and may also travel independently. Presently three Virginia Tech colleges, the College of Business, the College of Architecture, and the College of Arts and Sciences, and the University Office of International Programs are directly involved with sending students to the Center. The College of Engineering has reserved a slot during the summer of 2002 for a select few incoming freshmen. Those students who study at CESA are housed in one of two buildings: Villa Maderni or La Pabiana. Villa Maderni, a two hundred year old restored villa, contains the Center's offices, classrooms, library and computer lab as well as residential facilities for about 30 students. La Pabiana, a home located on the hill above Villa Maderni, houses about 15 students.

In the fall semester, CESA offers two academic programs - one for third-year students in the Pamplin College of Business and one for students in the Department of Architecture. Two programs are also offered in the spring semester. One is a general program for undergraduates of any Virginia Tech college, taught by faculty of the College of Arts and Sciences. The other is for architecture students. In addition there are numerous summer program offerings, one of which (it is planned) will be a freshman engineering program.

## International Plan

Virginia Tech competes with many other engineering schools for the very brightest, mature and motivated engineering students. The College of Engineering has a well deserved reputation and its Division of Engineering Fundamentals has an exceptional record in attracting and keeping its engineering students. The best-of-the-best are more difficult to recruit. These are the students who provide their engineering classmates with a gauge of what can be achieved; these are also the students who are most recruited. Many engineering students choose Virginia Tech because of its reputation, its beautiful campus in Southwest Virginia, the successes of its athletic programs, and perhaps (although not documented) its engineering retention rate. Virginia Tech offers a 'common freshman year', students being accepted into the College of Engineering as 'general engineering' students pending the result of their first academic years success. Many of these best engineering students wish to enter Virginia Tech's College of Engineering within a department, not as general engineering students, and many opt for a university which offers that option. These same students often have a wealth of Advanced Placement and/or transfer credit. None (statistically) have credit for EF1015 and/or EF1016 – classes which are prerequisites for all upper level engineering classes.

To initiate the engineering international program and to simultaneously attract more of these highly qualified students a program of study has been proposed and funding has been requested. The Dean's office in the College of Engineering is promoting this program through guidance counselors and program administrators at the Math and Science Magnet Schools as well as the Governor's Schools in the state of Virginia. Scholarships are available to defray the cost of the program and would be proffered to students who chose to enroll at Virginia Tech for the upcoming Fall semester.<sup>3</sup> The problem of how to provide academic credit to these students when they are not currently enrolled at the University has proved troublesome. It will be resolved (apparently) in the following manner: when those students enroll at Virginia Tech following their CESA experience they will be assigned to special sections of EF1015 and EF1016. They will prepare and present a report on their CESA activities and receive grades and credit for these classes. These classes would be charged as part of their normal fall semester tuition, circumventing the problem of a summer tuition payment (that payment coming from students not currently enrolled.) Those few students who participate in the summer program but then elect not to attend Virginia Tech would therefore not receive credit for the experience – some insurance that the scholarship funds used to finance their summer international experience would remain with Virginia Tech students. The start-up nature of this program combined with the limited housing facilities in Riva San Vitale limit the enrollment in the program to 15 students. Two Engineering Fundamentals faculty would teach and facilitate in Northern Virginia and in Switzerland.

The EF1015 and EF1016 courses will be revised and restructured to fit within a four-week intensive program. Each of these classes traditionally includes at least 32 contact hours during a 16 week semester. The four week international program at 20 contact hours per week would provide more than the equivalent contact hours and would provide ample time for outside activities. Those portions of EF1015 and EF1016 which are highly computer dependent (MATLAB and Autocad) would be taught at Virginia Tech's Northern Virginia Center during a

two week period in late June, early July 2002. As most of our potential students would be from the metropolitan Washington D.C. area, this would preclude the problem of lodging. Faculty and students would then travel as a group to Riva San Vitale and the Center for European Studies and Architecture. The period of study at CESA would be July 14-24, 2002, and would include both traditional classroom instruction as well as visits to Milan, Italy and Ecole Polytechnic Federale du Lausanne (EPFL) in Lausanne, Switzerland. Concurrent visits to industry are in the planning stages. A short portion of an email from a CESA student best typifies the attitude of those students who participate at CESA:

“ The program over here at CESA is wonderful. I'm here with the International Studies program, and we're taking classes mainly dealing with Classics, Ancient Rome, etc..... But, to be honest, the best part about the semester is being able to travel independently in small groups on the weekends. You get to go to so many different places and see so many other things that you'd never see if you were in a classroom. We've been all over Europe and still have a whole 6 weeks left. Next week, we do take a group trip for 14 days up north to Koln, Trier, Hamburg, Frankfurt, and Amsterdam..... Most of the stuff we'll see has to do with Roman civilizations in Germany and also religeous (*sic*) reform in the churches. But, when that's over, April 6th, we have the weekend to travel (from Frankfurt, where the group trip ends), so I'm going to Stuttgart to see the Porsche and Mercedes-Benz museums and actual factories. I think being able to see stuff like that is the coolest part about the whole program...not that I don't like the classes :) .....”<sup>4</sup>

## Bibliographic Information

1. Gregg, M.H. “The Role of the Computer in Freshman Engineering Courses”, *ASEE Southeastern Divison Spring Conference Proceedings*, Gatlinburg, TN, 1996.
2. VT CESA web site (January, 2002): <http://www.international.vt.edu/cesa/index.html>
3. Congress recently passed a bill that provides money to allow students with financial need to study abroad. The bill, sponsored in the House by Rep. Benjamin Gilman (R-NY) and in the Senate by Sen. Richard Lugar (R-IN), authorizes \$1.5 million annually for grants of up to \$5,000 for needy students. Sens. Russ Feingold (D-WI), Susan Collins (R-ME), and Charles Schumer (D-NY) cosponsored the Senate bill. The Gilman/Lugar provisions passed the Congress attached to an unrelated bill supporting microenterprises in developing nations. The Department of State will administer the new study abroad program.
4. Anonymous Virginia Tech, CESA student email, AY2000.
5. Web site for VT CESA director (January, 2002): <http://www.international.vt.edu/GNNProg/vol5no2/04.html>
6. Web site for VT financial aid (December, 2001): <http://www.international.vt.edu/GNNProg/vol4no2/14.html>
7. Web site for VT International Programs (December, 2001): <http://www.international.vt.edu/PhiBetaDelta/publication/iefv17n2.html>

8. Cost of one summer month Global European Studies class: Approximate travel cost of \$3,000 for Virginia residents plus reduced Virginia Tech summer school tuition (30% Discount). To reserve a space in the program, a deposit of \$1,000 is due February 1, 2001. Estimated travel costs include: Euro Rail train pass and other transportation expenses when traveling with the professors, food and lodging when traveling and studying with the professors (independent travel costs are not covered), group tours or sponsored Inter-Europe travel for the class, including all entrance fees. After hours entertainment, individual excursions, and person purchase items are not included. Estimated cost may be adjusted because of fluctuating exchange rates.
9. Riva San Vitale VT CESA web site (December, 2001): <http://filebox.vt.edu/org/riva/>
10. VT students' Riva San Vitale picture site (January, 2002): <http://filebox.vt.edu/org/riva/photo01/archive/Riva/>
11. VT strategic international plan web site (December, 2001): <http://www.unirel.vt.edu/stratplan/PolicyInternational.html>
12. Swiss map with Riva San Vitale web site (December 2001): <http://www.comm.vt.edu/faculty/markham/images/SWITZ.jpg>
13. Fentiman, A.W., R.R. Britton, F.D. Meyers, "The First Two Years -- Are Engineering Students Learning the Skills They Need?", 1993 *Proceedings, American Society for Engineering Education*, Annual Conference, p 1029.
14. Genalo, L.J., B.D. Williams. "The Freshman Engineering Problems and Programming Course: Integrating New and Old Tools", 1994 *Proceedings, American Society for Engineering Education*, Annual Conference, p 1532.
15. Hart, D., B. Engerer, D. Goodman. "A Coordinated Freshman Engineering Program", 1994 *Proceedings, American Society for Engineering Education*, Annual Conference, p 2314.

## Biographical Information

MICHAEL GREGG is an Associate Professor in the Division of Engineering Fundamentals at Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg, Virginia. Mr. Gregg is the Director of Virginia Tech's Green Engineering Program and is a past chair of the Freshman Programs Division of ASEE.

RICHARD GOFF is an Associate Professor in the Division of Engineering Fundamentals at Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg, Virginia. Dr. Goff is a Diggs Teaching Scholar and is the Director of the Frith Freshman Engineering Laboratory.