

Update on ACCEND: Two Years of Experience on the Accelerated Engineering Degrees (ACCEND) Program in Civil and Environmental Engineering at the University of Cincinnati

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Abstract

The Department of Civil & Environmental Engineering at the University of Cincinnati initiated a combined five-year BS and MS degree program in Environmental Engineering (the Accelerated Engineering Degree (ACCEND) Program) beginning with the entering freshman class in 2003. This program combines cooperative education (co-op) and research experiences integrated within the traditional classroom education experience, and is in-line with recent recommendations concerning undergraduate education by the American Society of Civil Engineering and the National Academy of Engineering. Both of these groups have advocated a Master's degree as the first professional degree for practicing engineers. The College of Engineering at the University of Cincinnati has a long and distinguished history as a leader in engineering education. The College introduced cooperative engineering education in 1906, and has maintained a mandatory cooperative education system ever since. Our undergraduate programs span five academic years and includes an average of six co-op quarters for a typical baccalaureate degree. Our graduates are highly sought by employers. This paper presents the general structure of this degree program, its curriculum, marketing strategy, and the results of two years of implementation. The successful use of distance learning will be discussed as this is one of the cornerstone elements of the program which allows students to take courses while away from campus on their co-op sessions.

Introduction

It is becoming increasingly evident that current technological and societal needs demand a greater level of preparation for the engineering profession than the historical baccalaureate degree. Both the American Society of Civil Engineers¹ and the National Academy of Engineering have advocated a Master's degree as the first professional degree for practicing engineers. Currently, most graduate engineering degrees are earned by international students who are returning home in ever increasing numbers.

The importance of providing an education that is grounded in the practice of the

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profession has long been recognized. The Engineering Criteria 2000 established by ABET provide a clear and pragmatic indication of the benefits of integrating education and practice. Many of the program outcomes and assessments articulated by ABET in Criterion 3 can best be met through this integration.

The College of Engineering at the University of Cincinnati has a long and distinguished history as a leader in engineering education having introduced cooperative engineering education in 1906, and has maintained a mandatory cooperative education system ever since. Our undergraduate programs span five academic years and include an average of six co-op quarters. With our cooperative education component, we are in a unique position to offer a five-year combined BS and MS program to satisfy all of the components of the first professional degree.

Environmental engineering education has rapidly expanded in recent years. Once considered to be a subset of civil engineering, environmental engineering has now developed into a separate engineering discipline of its own, particularly at the graduate level. Most environmental engineering programs originally focused only on water sanitation, but they have now expanded to include all aspects of the human and terrestrial environment — water and wastewater management, air quality, solid and hazardous waste management, noise and light pollution, and radioactive waste management to name a few. Some universities are establishing separate environmental engineering degree programs or even creating a separate Department of Environmental Engineering², but many educators believe that environmental engineering education should still be coupled with more traditional programs such as civil or chemical engineering.

With this in mind, in 2002-2003 the Department of Civil and Environmental Engineering at the University of Cincinnati initiated a combined five-year BS and MS degree program in Environmental Engineering with cooperative and research experiences integrated with the education. This program, called the CEE ACCEND (for Accelerated Engineering Degree) Program, will allow our engineering students to obtain a BS degree in Civil and a MS degree in Environmental Engineering in a five-year time period. During the first academic year the degree program has been offered to incoming freshman as an option, whereas simultaneously a structured marketing strategy and distance learning opportunities for students are being developed. The program will be fully launched for the academic year 2003-2004.

General Structure of the Program

General details of the CEE ACCEND Program have been discussed in other publications³ but are summarized here for the sake of clarity. The CEE ACCEND program includes four quarters of regular cooperative jobs coordinated by the Division of Professional Practice for the students, and two quarters of paid research cooperative experiences in which the students will work on research projects on campus under the supervision of a faculty member. During each of the four outside cooperative jobs, the students takes at least one undergraduate course via distance learning. Thus, the students coming out of this program will be prepared to either go to

the practice of engineering, or pursue a Ph.D. degree in environmental engineering.

All students are recruited to enter the program at the beginning of their freshman year. However, those students who excel during their freshman year can be eligible to join before the beginning of their sophomore year.

The benefits to the University of Cincinnati of the combined BS and MS degree program include:

- Recruitment of high quality students;
- Development of a regional impact in engineering and higher education;
- Increase in the number of U.S. students in our graduate program;
- Recruiting students who represent increases over normal class sizes; and,
- Producing potential Ph.D. students.

Entrance Requirements

The students selected for the BS/MS program in Civil and Environmental Engineering must have a High School GPA of 3.00/4.00 or better, and must be eligible for the University of Cincinnati's Cincinnatus Scholarship Program (for information please see the following web site: http://giveto.uc.edu/giving/funding_projects_cincinnatus.asp). The Cincinnatus Scholarship Program transforms the typical scholarship application process into an interactive event where students visit UC for a one-day competition where they are assessed on the basis of academic abilities, creative skills, and leadership potential.

Competition award levels for the Cincinnatus Scholarship Program are:

- Six \$60,000 Cincinnatus awards (\$15,000 per year);
- 100 Founders awards of \$20,000 (\$5,000 per year);
- 200 University awards of \$10,000 (\$2,500 per year); and,
- Century awards of \$6,000 (\$1,500 per year).

In addition, every student who participates in the Cincinnatus Scholarship Program will be awarded at least \$1,500 in University of Cincinnati scholarship funds.

In order to continue in the program, the student must maintain a GPA of 3.25 or better at the beginning of the Winter Quarter of the freshman year. Most students will be recruited to enter the program at the beginning of their freshman year. However, those students who excel during their freshman year can be eligible to join before the beginning of their sophomore year. The students must maintain a GPA of 3.00 or better at the end of fourth year in order to advance to the graduate program.

Program Curriculum

A detailed ACCEND student schedule by quarter during the five year accelerated BS/MS program is shown in Figure 1, starting with the 2002-2003 academic year. Notice that participants are required to have advanced placement in order to complete the advanced degree in five years. If they don't acquire the advanced placement in high school, they can complete it in the summer before their freshman year.

Also, additional undergraduate course credits must be acquired outside the scheduled academic quarters from the undergraduate program to provide room in the five-year schedule for graduate course credits. In order to accomplish this, the incoming freshman must meet the following requirements in order to make room for an additional 46 credit hours:

- Requires advanced standing for Calculus I and II = 10 credit hours (helps course scheduling by satisfying math prerequisites at start of school);
- Requires advanced standing for two H/S courses = 6 credit hours;
- Attends school during the summer quarter of the second year = 16 credit hours;
- Takes distance learning courses during off campus co-op terms: 1 course per each of first four terms- 4 x 3 credit hours = 12 credit hours; and,
- Takes undergraduate courses during on-campus co-op terms- 2 credit hours = 2 credit hrs.

All ACCEND students take a number of required environmental engineering courses, in addition to taking the normal undergraduate civil engineering courses. These required courses include:

- Environmental Material Balances
- Environmental Hydrology
- Introduction to Environmental Engineering
- Air Quality Management
- Physical Principles of Environmental Engineering
- Environmental Engineering Seminar
- Environmental Math Principles
- Environmental Chemistry Principles

ACCEND students also have the opportunity to take numerous specialty courses in areas of environmental engineering of interest to them. In addition to the required environmental engineering classes, there are approximately 50 specialty courses available to students as electives. Table 1 shows a sampling of these.

Figure 1. Detailed Curriculum Schedule for Accelerated BS/MS in Civil Engineering (BS) and Environmental Eng. (MS)

Summer	Summer	Autumn	Winter	Spring
1st Year 2003-2004	Advanced Standing 251 Calc I 5 252 Calc II 4 256 Calc lab 1 H/S 3 H/S 3 Total 16	CHEM 101 Chem I 4 CHEM 111 Chem lab 1 PHYS 201 Phys I 4 PHYS 211 Phys lab 1 ENG 101 English 3 CEE 100 INTR.CEE 3 Total 16	CHEM 102 Chem II 4 CHEM 112 Chem lab 1 PHYS 202 Phys II 4 PHYS 212 Phys lab 1 ENG 102 English 3 ENFD 111 Comp. Lang. 3 36PD 120 Coop. CE 1 Total 17	CHEM 103 Chem III 4 CHEM 113 Chem lab 1 MATH 253 Calc III 4 MATH 257 Cal Lab 1 ENFD 101 Mech I 3 CEE 175 Comp. App 3 Public Speak 3 Total 19
2nd Year 2004-2005	ENFD 250 Graphics 3 MATH 254 Calc IV 4 MATH 258 Cal Lab 1 ENFD 102 Mech II 3 ECON 101 Econ I 3 ENFD 382 Thermo 3 Total 17	CHEM 204 Bio-Org. 4 MATH 273 Diff. Eqns. 5 CEE 272 CE Measurements 3 H/S 3 ENGL 492 Fluid Mech 3 Total 18	CO OP 1 ENFD 375 Str Mat'l 3	CEE 475 Const. Mat'l 3 CEE 474 Mat'ls Lab 2 CEE 345 Env. Mat. Bal 3 GEOL 374 Geology 4 CEE 381 Struc. I 3 MATH 276 Matrix 3 Total 18
3rd Year 2005-2006	CO OP 2 H/S 3	ECON 102 Econ II 3 CEE 480 Struc. II 4 CEE XXX Env. Hydrology 4 CEE 471 Intr. Envir. 3 ENFD 383 Fluid Mech. 3 Total 17	CEE 476 Soil Mech. 3 CEE 477 Soils Lab 2 CEE 493 Hyd. Systems 3 CEE 494 Hyd. Lab 2 MATH 366 Eng. Stats. 3 CEE 550 Finite El. 3 20PD 502 PD II 1 Total 17	CO OP 3 H/S 3
4th Year 2006-2007	CO OP 4 H/S 3	CEE 340 CEE Systems 3 CEE 504 IDS I 2 CEE 561 Senior Seminar 1 CEE 664 Air Management 3 CEE Elect. 3 CEE 653G Phys. Prin. 4G Total 16	UC-CO OP 5 CEE 505 IDS II 2	CEE 371 Elec. Circuits 3 CEE 351 Transp. 3 CEE Env. Elect. (U) 3 CEE Dual Elective 3 CEE 551 Reliability 3 CEE 506 IDS III 2 Total 17
5th Year 2007-2008	UC-CO OP 6 MS Thesis 9G	CEE Dual Elective 3 CEE 705G Grad Seminar 1G CEE 641G Env. Seminar 1G CEE 627G Math 4G CEE 647G Chemistry 4G CEE 648G Lab 1G Total 14 MS Thesis 2G	CEE 642 Grad Seminar 1G CEE Env. Grad. Spec. Required 3G CEE Env. Grad. Spec. Required 3G CEE Env. Grad. Spec. Required 3G CEE Env. Grad. Elect. Required 3G CEE Elective (U) 3 Total 13 MS Thesis 2G	CEE 643 Grad Seminar 1G CEE Env. Grad. Spec. Required 3G CEE Env. Grad. Spec. Required 3G CEE Env. Grad. Spec. Required 3G CEE Env. Grad. Elect. Required 3G Total 10 MS Thesis 2G

Table 1 Sample of Environmental Engineering Elective Courses

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Air Pollution	Water Quality	Environmental Hydrology
Aerosol Science and Engineering	Biol. and Microbiol. Prin. of Environ. Systems	Env./Hydrologic Systems Analysis
Design of Particulate Pollution Control Systems	Phys./Chem. Processes for Water Quality Control	Hydrologic Processes
Diffusion and Mass Transfer in Environ. Systems	Biol. Processes for Water Quality Control	Modelling Hydrologic & Hydraulic Systems
Design of Gaseous Pollution Control Systems	Environmental Biology and Microbiology Lab	Climate Change and Environmental Impact
Meteorology and Dispersion Modeling	Environmental Instrumentation	Environmental Soil Science
Atmospheric Chemistry and Monitoring	Municipal Solid Waste Management	Design of Natural Treatment Systems
Automotive Air Pollution Control	Advanced Topics in Environ. Water Chemistry	Limnology
Principles of Combustion	Hazardous Waste Management	Urban Hydrology and Water Resources
Industrial Sources of Air Pollution	Industrial Wastewater Treatment	Geochemistry of Natural Waters
Air Pollution Measurement Lab	Advanced Hazardous Waste Treatment	Groundwater Modeling

Finally, some additional provisions with respect to the curriculum are also in place. These are given below.

- Courses may NOT be counted for both the undergraduate and graduate degree;
- The student cannot reduce the co-op experience requirements;
- The required area of concentration courses for the undergraduate program will be taken during the 4th year;
- The required MS courses are offered Autumn Quarter through Autumn Quarter of the following year;
- Both degrees, BS and MS, will be given at the end of the fifth year. Students cannot petition to get a BS degree before completing the MS degree requirements;
- The student must allow for some interdepartmental substitution of required coursework in areas not closely related to participant's specialty area; and,
- The student is provided with a graduate research assistantship during the final year (fifth year) of the accelerated program, which includes a stipend of \$18,000/year for research, and full tuition fees of \$5,715 for in-state students and \$16,098 for out-of-state students (based on tuition costs for 2002-03).

Distance Learning Courses for ACCEND Programs

Students in the ACCEND programs will be taking courses while on co-op assignments. The cooperative education experience is an integral part of the overall academic program at the University of Cincinnati. Participating in the distance learning course is not to interfere with their cooperative education experience.

The guiding principle in the development of distance learning courses is that the learning experience in these courses should be at least as good as in a traditional course. There is no *a priori* expectation that every course will be developed / delivered in the same way. There is an expectation that material in the course will be developed in a manner that enables the student to meet course learning objectives. It is also important that students' experiences are consistent from one course to another; they should not have to learn a new protocol for every course. Using a course management system such as Blackboard helps provide a consistent experience while providing mechanisms for interaction and student management.

The College of Engineering has had good success using streaming media to present course content. Moreover, we have found that students can perform at least as well if not better using this format compared with traditional teaching⁵. Use of streaming media mimics the traditional lecture and is less burdensome to develop than other web-based content. Courses are recorded while they are being presented to a traditional in-person audience. This material is digitized and encoded then placed on a server where it can be streamed on-demand.

For most courses, email will serve as the primary means of communication between students and the instructor. Since students are taking the courses while on co-op assignments, they are likely to have schedules that differ significantly. The courses are meant to accommodate these diverse schedules and will usually not require same time (synchronous) communication between all participants. Most instructors will also have "phone office hours" available for distance learning students.

The College recognizes that sufficient communication is absolutely necessary to help students have a good learning experience. Instructors and / or TAs should respond to questions or problems within 48 hours.

Students will log into the Blackboard course management system to get to the course content, assignments, announcements, etc. Typically, the instructor will require that a certain portion of the content be covered each week. This may mean reading a certain section of the textbook, watching certain videos, viewing certain web pages and completing particular assignments.

If video lectures are a part of the course, these may be provided on a companion CD which the instructor will provide.

When and where the content is covered is usually up to the student. Whether you watch the video lectures at home, at work during lunch breaks or after hours, etc. is up to you (and your employer if using work facilities.) There is typically no requirement that you be at your computer at a specific date and time. There will be requirements however, that students complete certain sections and assignments by specific dates.

Assignments will usually be submitted via email or by faxing material to the instructor. Feedback on assignments will typically be provided via email. Tests and quizzes will often be taken using Blackboard. These will be available on particular dates only and must be completed in a set time period. For example, the instructor may say, 'take Quiz 1 on Friday; you will have 1 hour to complete the quiz.' When you log into Blackboard on that Friday and go to the Quiz, as soon as you start, Blackboard will start a timer. After 1 hour you will not be able to answer any more questions.

When a student has questions about material or an assignment, they should contact the instructor using the protocol established by the instructor. Contact information is most often provided on a syllabus or in the "Staff Information" or "Course Information" section of Blackboard.

Students will need a computer and Internet access to take the course. Ideally, students will have a PC with a high speed Internet connection. If they are unsure of the type of internet connection or know they will not have a high speed connection, they may receive a CD from the instructor with some of the course materials on the CD. Even if this is the case, they will still need to use the Internet to access Blackboard.

Individuals participating in a distance learning course need to understand that they are responsible for completing course content according to the schedule established by the instructor. Since there are no regularly scheduled class meeting times, it will be up to the student to stay "on task" and complete the work required. Students are encouraged to regularly communicate with the instructor via email. Likewise, the instructors are strongly encouraged to communicate with students regularly as well.

Students are generally free to communicate with other students in the distance learning course. Again, email or instant messaging are typical means of communication. Often, students are permitted to collaborate on homework assignments. Of course, students are not to collaborate or share information regarding tests and quizzes.

Current Program Status

Recruitment of CEE ACCEND students has been mainly through the University's web site, and by means of notifying high school math, science and guidance counselors throughout Ohio about the program. The mailing lists for these teachers are available from state departments of education. The teachers are sent a letter introducing the program and a

brochure with the program specifics. This has proven to be fairly effective with about 50 - 60 inquiries per year asking about the program. Inquiries are from a tear-off mail-in information request card on the brochure sent to teachers, as well as from email requests from prospective students sent directly to the faculty program director.

Six students with ACT average scores of 28.7 were selected for the entering freshman class of 2003 (class of 2008). For the entering freshman class of 2004, nine students with ACT average scores of 29.6 were selected.

Conclusions

The last few decades have seen major advances in the techniques available for addressing environmental problems. These new procedures necessitate educating our new environmental engineers in ever more complex technologies. There is a need for environmental engineers with a minimum of an MS degree and with the practical experience to deal with these problems. The new ACCEND program at the University of Cincinnati, which provides a combined BS/MS program with practical co-operative education work experience, can serve as a model for other universities desiring to produce well trained environmental engineers capable of dealing with the myriad of new environmental insults we are facing daily.

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