The Accelerated Engineering Degrees (ACCEND) Program in Civil and Environmental Engineering at the University of Cincinnati

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Abstract

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 include an average of six co-op quarters for a typical baccalaureate degree and our graduates are highly sought by employers. However, both the American Society of Civil Engineering and the National Academy of Engineering have advocated a Master's degree as the first professional degree for practicing engineers. 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 (the Accelerated Engineering Degree (ACCEND) Program) with cooperative and research experiences integrated with the education. The BS component of the degree will be in Civil Engineering, and the MS component in Environmental Engineering. This paper presents the general structure of this degree program, its curriculum, and marketing strategy. 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.

I. Introduction

While the baccalaureate degree may have sufficed for most practicing engineers, it is becoming increasingly evident that current technological and societal needs demand a greater level of preparation for the profession. In fact, engineering is the only profession where an undergraduate degree is a sufficient first professional degree. Both the American Society of Civil Engineers (ASCE Task Committee, 2001; Walesch et al., 2003) 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 profession has long been recognized. Many colleges of engineering, however, continue to struggle with the dilemma that faculty are excellent engineering scholars with little or no

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expertise in the practice of engineering. 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. 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 include an average of six co-op quarters. The management, corporate relations, student preparation, placement and assessment for the cooperative program is managed by a separate academic unit, the Division of Professional Practice, with its own tenure-track faculty complement. Thus, 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. However, our next step in a comprehensive cooperative educational program is the inclusion of both industrial and research experiences in the graduate programs.

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 mushroomed 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 Engineering (Bishop, 2000), 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 ACCEND Program 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.

II. General Structure of the Program

The ACCEND program will include 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 will take at least one undergraduate course through 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.

We anticipate offering this program to individuals who are capable of the workload and likely to succeed in a program that requires a higher level of self-motivation and maturity than a traditional undergraduate education. To maximize success and retention in the program, the College is assisting us in developing an instrument to evaluate student readiness for the combined BS and MS degree program. Students' prior performance is a good indicator of their future academic success. Grade point average and performance in standardized tests (SAT and/or ACT) is one measure that will provide an indication of a student's readiness for this program. Students who have completed advanced placement courses in calculus, physics, and other humanities and social science courses will be selected to participate. Students who lack some of these desired advanced placement courses but show promise, will be invited to come to the campus the summer before they will be starting their college education to complete these deficiencies. 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 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.

III. 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. 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.

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

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Table 1 Sample of Environmental Engineering Elective Courses

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).

V. 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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