UNIVERSITY OF
Miami
FACULTY SENATE

MEMORANDUM

TO: President Edward T. Foote II

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: January 26, 1996

SUBJECT: Faculty Senate Legislation #95005(B) - Establishment of the B.S. in Environmental Engineering Degree Program

The Faculty Senate, at its meeting of January 22, 1996, voted to approve the establishment of the B.S. in Environmental Engineering Degree Program (#95005(B). Attached is the text of the proposal.

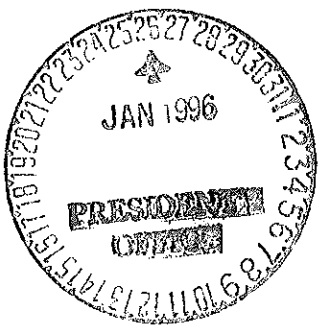
This legislation is now forwarded to you for your action.

2/5/96
Mr. Chairman,
I approve.
Thanks.

KY/b

Attachment

cc: Provost Luis Glaser
Dean Temares, College of Engineering
Professor David Chin, Chair, Department of
Civil and Architectural Engineering



325 Ashe-Admin. Bldg.
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For Distribution to All Senators

SELECTED PORTIONS OF

A Proposal for a New Degree Program: Bachelor of Science in Environmental Engineering

Department of Civil and Architectural Engineering

Contents

Executive Summary

The Department of Civil and Architectural Engineering is proposing the establishment of a baccalaureate program in environmental engineering. This program fits in well with the depth of faculty resources and infrastructure that exist within the College of Engineering.

In 1992, the Department of Civil and Architectural Engineering established an environmental option within the baccalaureate program in Civil Engineering. This option has been very successful in attracting about 10 - 15 students per year since 1992. As a result of the demonstrated popularity of environmental engineering at the University of Miami, and the relatively small cost of changing from an environmental engineering option to a free-standing environmental engineering degree, the Department of Civil and Architectural Engineering is proposing the establishment of a baccalaureate program in environmental engineering. Many of the students currently enrolled in the environmental engineering option of the Civil Engineering program have expressed a preference for a baccalaureate degree in environmental engineering and we infer that, by establishing this program, potential students who are presently choosing not to attend the University of Miami because they are interested primarily in an environmental engineering degree will now have the opportunity to study at the University of Miami.

Accreditation is a central issue in any engineering program, since most States require graduation from an accredited program as a prerequisite for registration (licensure) as a professional engineer. Reviews of the accreditation criteria that apply to the proposed environmental engineering degree program, and the curricula of all accredited environmental engineering programs in the United states are presented in this proposal.

The curriculum for the baccalaureate program in environmental engineering has been designed on the basis of the accreditation requirements for environmental engineering programs, the curricular content of existing accredited environmental programs in the United States, a review of related courses at the University of Miami, and our own vision of the educational content of a modern environmental engineering program.

Institution of a baccalaureate program in environmental engineering is expected to cost the University a modest $20,000 per year in increased operational costs. This cost is primarily associated with the need to add a new course in air pollution, a part-time technician in the environmental engineering laboratory, and the recurring cost of technical supplies generated by increased laboratory usage. We expect that these marginal costs will be more than offset by the increased revenue generated by increased student enrollment. In fact, the break-even point seems to be an incremental enrollment of only two students into the program. Given that there are presently only nine accredited baccalaureate environmental engineering programs in the United States, and the unfulfilled demand for environmental engineering professionals in society, we have no doubt that the incremental costs of this program will be more than offset by increased revenues from *new* student enrollment.

1 Introduction

1.1 Global Perspective

The American Academy of Environmental Engineers (AAEE) is the lead society for the accreditation of environmental engineering programs in the United States, and they define environmental engineering as "...the application of engineering principles to the management of the environment for the protection of human health; for the protection of nature's beneficial ecosystems and for environment related enhancement of the quality of human life."

The modern field of environmental engineering evolved from the field of sanitary engineering, which was concerned primarily with the design and analysis of water and wastewater systems. The name-change ocurred during the late 1960's [7]. Today, environmental engineering is one of the most popular specialties in the civil engineering profession, and it is not uncommon to poll undergraduate civil engineering students and find over 50% with a primary interest in environmental engineering. These students often want a degree that is a combination of water-related engineering and environmental science [8].

The rapidly increasing knowledge base required to specialize in environmental engineering is driving the evolution of environmental engineering as a separate discipline. This evolution is currently being accomodated by graduate programs, which tend to offer relatively elementary courses in the environmental field, and have resulted in a master's degree being the basic degree requirement to practice environmental engineering. Most master's degree programs in environmental engineering are within the civil engineering discipline, although there are some within the mechanical and chemical engineering disciplines [6]. Civil engineers primarily focus on the design of water distribution and sewer systems, mechanical engineers tend to focus on air pollution, and chemical engineers tend to focus on the reduction of wastes generated by industrial facilities.

With the emergence of new baccalaureate programs in environmental engineering, some practitioners see this as an opportunity to elevate environmental engineering graduate courses to levels that are more state-of-the-art than are presently feasible, given the level of preparation of entering graduate students from traditional disciplines [5]. The sub-disciplines (i.e. professional fields) within environmental engineering are recognized to be: air quality, water quality, solid waste management, and industrial hygiene [7]. Within these sub-disciplines are such multi-media specialty areas as hazardous waste management and wastewater engineering.

Combined with the strong demand in the marketplace for environmental engineers, it has been suggested [1] that the strongest argument in favor of increased environmental engineering undergraduate education is that the great majority (approximately 95%) of the B.S. level engineers in the United States are being educated in fields that do not provide a good foundation for further development, through education or practice, in the environmental engineering field. This concern is particularly relevant since the National Council of Examiners for Engineering (NCEE) has recently introduced (1993) a separate Environmental Engineering examination for registration as a professional engineer, which in effect recognizes environmental engineering as a separate discipline. Clearly, the baccalaureate degree in environmental engineering will ultimately become the primary professional degree for becoming licensed as a practicing environmental engineer.

There seems to be little doubt that graduates with baccalaureate degrees in environmental engineering will have ample job opportunities [1, 5]. In fact, there are indications that unprecedented demand for environmental engineers in the 1990s and beyond is causing many universities to increase the curricular presence of environmental engineering at the baccalaureate level [1].

dicate that an independent free-standing environmental engineering program is viable, and, besides attracting the current pool of students who are also interested in civil engineering, this program will additionally attract those students that are interested only in environmental engineering. Informal polls of students currently in the environmental engineering option show that there is almost unanimous support for the development of a baccalaureate program in environmental engineering. The proposed environmental engineering program will also be attractive for transfer students from engineering programs at junior colleges, with the environmental engineering degree requiring approximately two years of additional study.

The issue of accreditation for any new engineering program is critical, since engineers cannot be licensed unless they are graduates from an accredited engineering program. This consideration must somehow be accomodated within the reality that engineering programs are not permitted to request accreditation unless they have produced graduates. We realize that it would not be responsible to admit students to a program that is not accredited, since this would limit their professional opportunities, therefore we are proposing that in the interim period between the environmental engineering baccalaureate program being adopted by the University and being put up for accreditation, we will encourage students to do a dual-degree program in which they will be granted baccalaureate degrees in both civil engineering and environmental engineering in nine semesters, compared with the eight semesters that it takes to do these degree programs separately. Students in this dual-degree track will have a fully accredited civil engineering degree and can become licensed professionals. After approximately three graduating classes, the environmental engineering baccalaureate program will be put up for accreditation, and then subsequent classes will be encouraged to pursue this degree as a separate track.

2 Program Requirements for Accreditation

Engineering programs in the United States are accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET), and many states require graduation from an accredited engineering program as a prerequisite for becoming a licensed professional engineer.

Environmental Engineering programs are accredited at either the Basic Level (undergraduate) or Advanced Level (graduate), however, the Engineering Dean's Council opposes dual accreditation of both undergraduate and graduate programs [5]. Currently, most graduate environmental engineering programs are not accredited, and accreditation has been mostly sought at the undergraduate level. The criteria for ABET accreditation fall into two categories: general criteria and program-specific criteria; and all accredited programs must meet both sets of criteria. These criteria for ABET accreditation of all engineering programs in the United States are published annually by ABET. The latest requirements may be found in [2, 3].

2.1 General Criteria

The general criteria for accreditation of undergraduate programs fall within the following categories: (1) Faculty; (2) Curricular Objective; (3) Curricular Content; (4) Student Body; (5) Administration; (6) Institutional Facilities; and (7) Institutional Commitment. The salient features of these requirements are described in the following sections.

advanced chemistry or physics may be used to satisfy the basic science requirement, as appropriate for various engineering disciplines.

Courses in engineering topics include subjects in the engineering sciences and engineering design. Engineering sciences have their roots in mathematics and basic sciences, but carry knowledge further towards creative application. Such subjects include: mechanics, thermodynamics, electrical and electronic circuits, materials science, transport phenomena, and computer science (other than computer programming skills). Engineering design is the process of devising a system, component, or process to meet desired needs. The engineering design component of a curriculum must include the following features: development of student creativity, use of open-ended problems, development and use of modern design theory and methodology, formulation of design problem statements and specifications, consideration of alternative solutions, feasibility considerations, production processes, concurrent engineering design, and detailed system descriptions. It is also essential to include a variety of realistic constraints, such as economic factors, safety, reliability, aesthetics, ethics, and social impact.

Courses in the humanities are concerned with man and his culture, while courses in the social sciences are concerned with individual relationships in and to society. Examples of traditional subjects in these areas are: philosophy, religions, history, literature, fine arts, sociology, psychology, political science, anthropology, economics, and languages other than English or a student's native language. The humanities and social science courses contained within an engineering program must provide both breadth and depth, and not limited to the selection of unrelated introductory courses.

Besides meeting the course requirements in mathematics, basic sciences, engineering topics, social sciences, and humanities, each educational program must include a meaningful, major engineering design experience that builds upon the fundamental concepts covered in these courses. Furthermore, each program must have an appropriate amount of laboratory experience such that the students develop a competence to conduct hands-on experimental work such as that expected of engineers in the discipline represented by the program. All engineering programs must have an appropriate amount of computer-based experience, evidenced by a knowledge of the application and use of digital-computation techniques for specific engineering problems.

2.1.4 Student Body

Student body criteria relate to the admission, retention, and scholastic work of students, and the records of graduates both in further acádemic study and in professional practice.

2.1.5 Administration

Administration criteria relate to the attitude and policy of the administration of the College of Engineering toward teaching, research, and scholarly production, and the quality of leadership at all levels of administration of the College.

2.1.6 Institutional Facilities

Institutional facilities criteria state that an engineering program must be supported by adequate physical facilities, including office and classroom space, laboratories, and shop facilities suitable for the scope of the program's activities. Other criteria relate to library and computer facilities.

4 University of Miami BSEnE Curriculum

4.1 Course Requirements

The University of Miami BSEnE program was developed by considering: (a) the curricular content of existing ABET accredited environmental engineering programs; (b) the courses currently available and being offered at the University of Miami; and (c) our vision of the responsibilities and challenges facing an environmental engineer in the 21^{st} century.

The curricula of accredited environmental engineering programs in the United States have been reviewed in the previous section, and the common course contents identified. On reviewing the environmental courses currently available at the University of Miami, we find that most of the key environmental engineering courses are currently being offered within the Department of Civil and Architectural Engineering, primarily as part of the environmental engineering option in civil engineering. Other courses that are basic to any environmental engineering program are found principally in the Department of Mechanical Engineering (air pollution and related courses), Department of Industrial Engineering (industrial hygiene and related courses), and the Departments of Chemistry and Biology. The consensus of the group that developed the environmental engineering curriculum is that, except for a single course in air pollution that needs to be developed, there are sufficient courses already existing and being offered at the University of Miami to constitute an accreditable and relevant environmental engineering program.

An important issue that was addressed in developing our environmental engineering program was the issue that a newly created environmental engineering program will not be accredited until there are graduates from the program, and that practicing engineers cannot be licensed unless they are graduates from an accredited engineering program. This will create a problem for the initial environmental engineering graduates who complete the program prior to accreditation. We have addressed this issue by proposing, and recommending, a dual degree program in Environmental Engineering and Civil Engineering in which students complete the requirements for both degrees in nine semesters, compared with the eight semesters required for each degree. Clearly, students will have the option of choosing to pursue these degrees individually, accreditation requirements notwithstanding.

4.2 Admission Requirements

Admission to the environmental engineering program is the same as for all other programs at the University of Miami. According to the University of Miami Bulletin, the Committee on Admission bases its decision as to the admission of applicants upon evidence that they have the qualifications deemed necessary for academic success at the University of Miami. Principal factors in the admission decisions are: (1) secondary school record; (2) scholastic assessment test (SAT), scholastic assment test I (SAT I), and american college testing program (ACT); (3) counselor's evaluation form; and (4) an essay. Although specific criteria are not given for such measures as high school grade-point-averages and SAT scores, the College of Engineering has, on average, admitted students with the highest average SAT scores at the University. Based on our experience with these students in our existing engineering programs, we would expect that the pool of students attracted to our environmental engineering engineering program will be similarly qualified and perform adequately. A similar statement can be made regarding the quality and performance of transfer students, where it is the policy of the University that only courses passed with a grade of C or better at an accredited

Bachelor of Science in Environmental Engineering

Freshman Year

Fall Semester			Spring Semester		
CEN 101	Intro. to Civil/Env. Engrg.	1	CHM 112	Principles of Chemistry II	4
CHM 111	Principles of Chemistry I	4	ARC 191	Architectural Graphics	3
ENG 105	English Composition I	3	ENG 107	Writing About Science	3
MTH 110	Calculus I	5	MTH 112	Calculus II	4
SS/H/A Elective		3	PHY 205	Physics I	3
		16			17

Sophomore Year

Fall Semester			Spring Semester		
CEN 210	Mechanics of Solids I	3	CEN 211	Mechanics of Solids II	3
CEN 350	Transportation Engineering I	3	CEN 212	Structural Lab	1
MTH 211	Calculus III	3	EEN 205	Electrical Engineering I	3
PHY 206	Physics II	3	MTH 311	Ordinary Differential Equations	3
PHY 208	Physics Lab I	1	PHY 207	Physics III	3
SS/H/A Elective		3	PHY 209	Physics Lab II	1
		16	IEN 311	Probability and Statistics	3
					17

Junior Year

Fall Semester			Spring Semester		
CEN 330	Fluid Mechanics	3	CEN 301	Computer Applications	3
CEN 340	Intro. to Environmental Engrg.	3	CEN 430	Water Resources Engineering	3
CEN 345	Water and Waste Analysis	3	CEN 440	Des. Water Qual. Control Sys.	3
MEN 303	Thermodynamics I	3	Basic Science Elective		3
IEN 351	Industrial Safety Engrg.	3	SS/H/A Elective		3
		15			15

Senior Year

Fall Semester			Spring Semester		
CEN 481	Design Project I	1	MEN 520	Air Pollution	3
CEN 540	Environmental Chemistry	3	ENE Elective		3
CEN 541	Pub. Hlth. & Env. Microbiology	3	ENE Elective		3
CEN 543	Solid and Haz. Waste Engrg.	3	CEN 482	Design Project II	2
SS/H/A Elective		3	CEN 402	Professionalism and Ethics	3
SS/H/A Elective		3	SS/H/A Elective		3
		16			17

Figure 10: Environmental Engineering Curriculum

To support these courses are a laboratory course in Water and Wastewater Analysis (CEN 345), and a variety of applied science courses such as Environmental Chemistry (CEN 540), Public Health and Environmental Microbiology (CEN 541). Students in the BSEnE program will have the flexibility to choose two elective courses in environmental engineerng and one Basic Science elective from the lists shown in Figure 11. These electives will permit the student to take advanced courses in either water and wastewater engineering (CEN 530, CEN 531, CEN 532), industrial hygiene (IEN 558, IEN 559), air quality control (MEN 521), or remote sensing and solar energy utilization (MEN 510, MEN 530). The list of basic science electives will provide the student an opportunity of more in-depth study in biology, chemistry, and the earth sciences, depending on the interests of the student. The proposed BSEnE curriculum will require 129 credits for graduation, which is fairly typical of other accredited programs in the College of Engineering. The semester-credit requirements for the proposed BSEnE program are compared with the requirements of other BSEnE programs in Table 6. Based on these data, it is clear that the credit requirements for the proposed BSEnE

Table 6: Semester-Credit Requirements of BSEnE Programs

School	Semester-Credits
Cal Poly	140
Northwestern	144
Univ. of Florida	130
Michigan Tech	131
Univ. of Central Florida	132
Montana Tech	145
New Mexico Tech	138
Syracuse	131
RPI	134

degree program are commensurate with the requirements of most accredited BSEnE programs in the United States.

In the initial stages of implementing the environmental engineering program, students will be encouraged to pursue a dual degree program in civil engineering and environmental engineering. When the environmental engineering program is accredited, then pursuit of an individual environmental engineering degree will also be encouraged. This approach is dictated by the requirement that graduation from an accredited degree program is a prerequisite for registration as a professional engineer. The following additional courses must be taken by students in the Environmental Engineering program to satisfy the requirements of the Civil Engineering program: Structural Analysis (CEN 310), Concrete Structures (CEN 320), Steel Structures (CEN 321), Geotechnical Engineering I & II (CEN 370,CEN 470), Geotechnical Engineering Lab (CEN 371), and Transportation Engineering II (CEN 450). These courses amount to 19 credits, and therefore the curricula of both the Civil Engineering and Environmental Engineering programs can be covered in nine semesters, compared with the eight semesters required to complete these programs individually.

4.6 Resources Required

All of the courses in the environmental engineering curriculum, with the exception of a course in air pollution control. are presently being offered on a regular basis. Consequently. the faculty

CAPSULE: Faculty Senate Legislation #95005(B) - Establishment of the B.S. in Environmental Engineering Degree Program

RESPONSE BY THE PRESIDENT: DATE: 2/9/96

APPROVED: Yes

OFFICE OR INDIVIDUAL TO IMPLEMENT OR PUBLISH: _____

EFFECTIVE DATE OF LEGISLATION: _____

NOT APPROVED AND REFERRED TO: _____

REMARKS (IF NOT APPROVED): _____

_____

_____

_____

#95005

SYNOPSIS OF ACTIONS

taken by the

Executive Committee

University of Miami Board of Trustees

Tuesday, December 17, 1996

APPROVED Faculty Senate Legislation #95011(A), Amendment to Section A2.4 of the Faculty Charter, regarding librarian faculty voting rights.

APPROVED the establishment of the following degree programs: B.S. in Environmental Engineering; M.S. in Medical Informatics; and M.S. in Neuroscience.

AUTHORIZED the senior vice president for Business and Finance or the vice president and treasurer to take the actions necessary to transfer the assets under management by TCW/Cursitor Eaton to Templeton and Warburg, Pincus.

DELEGATED to the Investments Committee the power to redistribute assets among approved investment managers and within policy guidelines.

AUTHORIZED the president, the senior vice president for Business and Finance, and/or the assistant vice president for Facilities Administration to enter into contracts and make purchases on behalf of the University in an amount not to exceed $1,900,000 for the design phase of Option II of The Miami Project to Cure Paralysis.

APPROVED the increase in design scope of the Professional Arts Office Building to approximately 150,000 square feet, along with an increase in parking and a total project cost of $23,000,000, and **AUTHORIZED** the president, the senior vice president for Business and Finance, and/or the assistant vice president for Facilities Administration to enter into contracts and make purchases on behalf of the University in an amount not to exceed $850,000 for the design phase of the project, contingent upon a timetable demonstrating that the building can be completed so that Dominion Tower leases need not be renewed.

APPROVED, with one amendment, the University's Speaker Policy for Student Activity Fee Funded Student Organizations as recommended by the Student Affairs Committee.

APPROVED the exchange of approximately $9 million of 1996 University Bonds for tax-exempt Dade County Educational Facilities Authority (DCEFA) bonds.

UNIVERSITY OF
Miami

January 19, 1996

Dr. Kamal Yacoub, Chairman
Faculty Senate and Government
325 Ashe Building
Coral Gables Campus 33124-4634

Dear Kamal:

The Environmental Science Steering Committee reviewed the latest proposal for a BS Degree in Environmental Engineering submitted by the Department of Civil Engineering. We enthusiastically support the proposal.

Sincerely,

Michael S. Gaines
Chair

MSG/dw

Department of Biology
P.O. Box 249118
Coral Gables, Florida 33124-0421
Telephone: 305-284-3973
Fax: 305-284-3039

LCH:fac.msg.Letters.Kamal Yacoub.96

CDFHI

UNIVERSITY OF Miami

MEMORANDUM

DATE: 28 November, 1995

TO: Dr. Otis B. Brown, Dean
Rosenstiel School of Marine and Atmospheric Science

Dr. Harry A. DeFerrari, Chair
Division of Applied Marine Physics

FROM: Dr. David A. Chin, Chairman
Department of Civil & Architectural Engineering

SUBJECT: Proposed Baccalaureate Program in Environmental Engineering

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Attached is a copy of the proposal for a new baccalaureate program in environmental engineering (BSEnE) that is currently being considered by the Faculty Senate.

I have become aware that some faculty at RSMAS have questions regarding this program and Dr. Michael Brown (AMP/RSMAS) and myself, have agreed to set up a meeting to answer all questions and resolve any outstanding issues. Dr. Brown will coordinate with RSMAS faculty, and the meeting is scheduled to take place within the next two weeks. Please forward all of your concerns to Dr. Brown at your earliest convenience. Thanks.

DAC/oc
Attachment
c: Dr. Brown, Professor, AMP/RSMAS
Dr. Temares, Dean, College of Engineering
Dr. Yacoub, Chair, Faculty Senate

DAC/oc
Attachment

Department of Civil & Architectural Engineering
College of Engineering
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Fax 305-284-3492

UNIVERSITY OF
Miami

MEMORANDUM

CDFHI

DATE: 28 November, 1995

TO: Michael S. Gaines, Chair
Environmental Science Steering Committee

FROM: Dr. David A. Chin, Chairman
Department of Civil & Architectural Engineering

SUBJECT: Proposed Baccalaureate Program in Environmental Engineering

---

Attached is a copy of the subject proposal to be considered by the Environmental Science Steering Committee. Please provide me with any Committee feedback in advance of the next Faculty Senate Meeting on 22 January, 1996. Thanks.

DAC/oc
Attachment
c: Dr. Kamal Yacoub, Faculty Senate ✓

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UNIVERSITY OF Miami

MEMORANDUM

DATE: 9 November, 1995

TO: Dr. Kamal Yacoub
Chair, Faculty Senate

FROM: Dr. David A. Chin, Chairman
Department of Civil & Architectural Engineering

SUBJECT: Proposed New Degree Program in Environmental Engineering

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On behalf of the faculty in the Department of Civil and Architectural Engineering I would like to thank the Ad-hoc Committee for their efforts in reviewing our BSEnE proposal. Such dedicated service to the University frequently goes unrecognized.

In response to the Committee's query regarding the lack of a computer programming/science course in the proposed curriculum, I direct your attention the attached copy of the BSEnE curriculum. In the Spring semester of the Junior year, CEN 301 (Computer Programming Applications) is a computer programming/science course. As indicated in the attached syllabus for CEN 301, Fortran Programming and Numerical Methods constitute approximately 75% of this course.

If either the Ad-hoc Committee or yourself have any further questions regarding the content of the BSEnE curriculum, please do not hesitate to contact me. I look forward to this item being taken up by the Faculty Senate on 27 November. Thanks again for your efforts.

DAC/oc
Attachments
c: Dean M. Lewis Temares, College of Engineering
Prof. Michael Gaines, Department of Biology
Prof. James Nearing, Department of Physics
Prof. Jerome Catz, Department of Mechanical Engineering

Department of Civil & Architectural Engineering
College of Engineering
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Bachelor of Science in Environmental Engineering

Freshman Year

Fall Semester			Spring Semester		
CEN 101	Intro. to Civil/Env. Engrg.	1	CHM 112	Principles of Chemistry II	4
CHM 111	Principles of Chemistry I	4	ARC 191	Architectural Graphics	3
ENG 105	English Composition I	3	ENG 107	Writing About Science	3
MTH 110	Calculus I	5	MTH 112	Calculus II	4
SS/H/A Elective		3	PHY 205	Physics I	3
		16			17

Sophomore Year

Fall Semester			Spring Semester		
CEN 210	Mechanics of Solids I	3	CEN 211	Mechanics of Solids II	3
CEN 350	Transportation Engineering I	3	CEN 212	Structural Lab	1
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PHY 206	Physics II	3	MTH 311	Ordinary Differential Equations	3
PHY 208	Physics Lab I	1	PHY 207	Physics III	3
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Junior Year

Fall Semester			Spring Semester		
CEN 330	Fluid Mechanics	3	CEN 301	Computer Applications	3
CEN 340	Intro. to Environmental Engrg.	3	CEN 430	Water Resources Engineering	3
CEN 345	Water and Waste Analysis	3	CEN 440	Des. Water Qual. Control Sys.	3
MEN 303	Thermodynamics I	3	Basic Science Elective		3
IEN 351	Industrial Safety Engrg.	3	SS/H/A Elective		3
		15			15

Senior Year

Fall Semester			Spring Semester		
CEN 481	Design Project I	1	MEN 520	Air Pollution	3
CEN 540	Environmental Chemistry	3	ENE Elective		3
CEN 541	Pub. Health and Enviro. Micro.	3	ENE Elective		3
CEN 543	Solid and Haz. Waste Engrg.	3	CEN 482	Design Project II	2
SS/H/A Elective		3	CEN 402	Professionalism and Ethics	3
SS/H/A Elective		3	SS/H/A Elective		3
		16			17

Figure 10: Environmental Engineering Curriculum

COURSE DESCRIPTION

AEN/CEN 301 - Computer Applications in Civil / Architectural Engineering
Fall 1995

1994/1995 Catalog Data:	3 credits. Exploration and modeling of Civil/Architectural systems. Topics will include numerical analysis, constrained and unconstrained optimization, systems analysis, and software evaluation. Students will solve problems using existing packages and software developed by them. Prerequisite: MTH 211, CEN 210.
Textbooks:	Koffman, E.B. and Friedman, F.L. (1993). *FORTRAN With Engineering Applications*, 5th Edition, Addison-Wesley Publishing Company, New York. *The Student Edition of MATLAB*, Prentice Hall, Englewood Cliffs, NJ.
Coordinator:	Dr. Ahmad H. Namini, Associate Professor of Civil and Architectural Engineering, Room 320, McArthur Engineering Building
Goals:	During the course, the student will become familiar with the analytical modeling and solution of engineering problems with the aid of student-developed Fortran programs and MATLAB.
Prerequisites by Topics:	MTH 211 (Calculus III) CEN 210 (Mechanics of Solids I)

Topics:

1. Introduction (1-2 classes)
2. Fortran Programming (13-15 classes)
3. Matrix Algebra (3-4 classes)
4. Numerical Methods (13-15 classes)
5. Computer Graphics (3-4 classes)

Lab Projects: None

Computer Usage: Extensive use of Fortran compiler and MATLAB.

Grading Policy:

Examination #1	25%
Examination #2	25%
Computer Assignments	50%

UNIVERSITY OF
Miami
FACULTY SENATE

MEMORANDUM

To: Dr. David Chin
Chair, Department of Civil and Architectural Engineering

From: Kamal Yacoub
Chair, Faculty Senate

Date: November 7, 1995

Subject: Proposed New Degree Program in Environmental Engineering

Attached is the report from the Faculty Senate Ad-hoc Committee reviewing the proposal submitted by your department for a new degree program in Environmental Engineering. As you see, the report is favorable and complimentary. However, it does raise one question concerning the lack of a computer programming course in the proposed curriculum.

I look forward to receiving your response to the Committee's query. After receiving your response, I will schedule your proposal on the Faculty Senate agenda. Please note that the agenda for the November 27 meeting and all attachments need to be mailed no later than November 20, 1995.

KY/ca

attachment

cc: Dean Lewis Temares
Prof. Michael Gaines
Prof. James Nearing
Prof. Jerome Catz

c:\doc\yacoub\11-7-95.chn

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UNIVERSITY OF Miami

MEMORANDUM

CDFHI

TO: Kamal Yacoub
Chair, Faculty Senate

FROM: Michael S. Gaines MSG
Chair, Department of Biology

DATE: November 2, 1995

SUBJECT: PROPOSED NEW DEGREE PROGRAM IN ENVIRONMENTAL ENGINEERING

Our committee met on November 2, 1995, to discuss the new program proposed by the School of Engineering. The committee was impressed with the thoroughness of the proposal. The proposed curriculum is similar in content to that of other Environmental Engineering Programs around the country. Our only query is why there is no computer science in the curriculum.

MSG/dw
cc: James Nearing, Dept. of Physics
Jerome Catz, Dept. of Mechanical Engineering

Department of Biology
P.O. Box 249118
Coral Gables, Florida 33124-0421
Telephone: 305-284-3973
Fax: 305-284-3039

UNIVERSITY OF Miami

MEMORANDUM

TO: Kamal Yacoub
Chair, Faculty Senate

FROM: Michael S. Gaines MSG
Chair, Department of Biology

DATE: November 2, 1995

SUBJECT: PROPOSED NEW DEGREE PROGRAM IN ENVIRONMENTAL ENGINEERING

Our committee met on November 2, 1995, to discuss the new program proposed by the School of Engineering. The committee was impressed with the thoroughness of the proposal. The proposed curriculum is similar in content to that of other Environmental Engineering Programs around the country. Our only query is why there is no computer science in the curriculum.

MSG/dw
cc: James Nearing, Dept. of Physics
Jerome Catz, Dept. of Mechanical Engineering

Department of Biology
P.O. Box 249118
Coral Gables, Florida 33124-0421
Telephone: 305-284-3973
Fax: 305-284-3039

UNIVERSITY OF
Miami
FACULTY SENATE

MEMORANDUM

TO: Professor Michael Gaines, Department of Biology
Professor James Nearing, Department of Physics
Professor Jerome Catz, Department of Mechanical Engineering

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: October 12, 1995

SUBJECT: Proposed New Degree Program in Environmental Engineering

This is to ask each of you to serve as an ad hoc committee to review the above proposed program and to make recommendations to the Faculty Senate. I request that Professor Gaines chair this committee. It would be helpful if you could forward your report by the middle of November, if possible.

Thank you in advance for your service.

oct. 16, 95

b.c. : Dr. Lewis Temares ; Dean ; C.O.E.
b.c : Dr. David A. Chin ; Chair ; CAE

KY/b

325 Ashe-Admin. Bldg.
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305-284-3721
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UNIVERSITY OF Miami

MEMORANDUM

CDFHI

FACULTY SENATE

OCT - 5 1995

Date: October 5, 1995

To: Kamal Yacoub, Chairman
Faculty Senate

From: David A. Chin, Chairman
Department of Civil and Architectural Engineering

Subject: BSEnE Proposal

As per your request, six copies of the subject proposal are attached. If you need any additional materials, please let me know. Thanks.

c: Dean Temares

Department of Civil & Architectural Engineering
College of Engineering
P.O. Box 248294
Coral Gables, Florida 33124-0630
305-284-3391
Fax 305-284-3492

UNIVERSITY OF Miami

Date: September 29, 1995

To: Kamal Yacoub, Chairman
Faculty Senate

From: M. Lewis Temares, Dean
College of Engineering

Subject: New Baccalaureate Degree Program

Attached is a proposal for a new baccalaureate degree program in the College of Engineering, Bachelor of Science in Environmental Engineering. This proposal was approved unanimously by the Faculty of the College of Engineering on 27 September, 1995.

I fully endorse this proposal, including the proposed annual budget of $17,000. Please initiate the process of Faculty Senate consideration of this new degree program. In addition, because of the importance of this new degree program to the Strategic Plan of the College of Engineering, and the necessity of promoting this program in our Spring recruiting activities, I request *early approval* of this program. It is highly desirable that this program be approved in time to be published in the AY96 University Bulletin.

The new Environmental Engineering program is to be administered by the Department of Civil and Architectural Engineering, and Dr. David A. Chin is the department Chair. Please contact Dr. Chin with any questions on the proposed degree program, and for follow-up action in response to the Senate requests for any additional materials. Thank you in advance for your efforts on our behalf.

cc: Dr David A. Chin, Chairman, Department of Civil and Architectural Engineering
Dr. Samuel S. Lee, Associate Dean
Dr. Thomas D. Waite, Associate Dean for Research and Graduate Studies

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A Proposal for a New Degree Program: Bachelor of Science in Environmental Engineering

Department of Civil and Architectural Engineering

Contents

Executive Summary

The Department of Civil and Architectural Engineering is proposing the establishment of a baccalaureate program in environmental engineering. This program fits in well with the depth of faculty resources and infrastructure that exists within the College of Engineering.

In 1992, the Department of Civil and Architectural Engineering established an environmental option within the baccalaureate program in Civil Engineering. This option has been very successful in attracting about 10 - 15 students per year since 1992. As a result of the demonstrated popularity of environmental engineering at the University of Miami, and the relatively small cost of changing from an environmental engineering option to a free-standing environmental engineering degree, the Department of Civil and Architectural Engineering is proposing the establishment of a baccalaureate program in environmental engineering. Many of the students currently enrolled in the environmental engineering option of the Civil Engineering program have expressed a preference for a baccalaureate degree in environmental engineering and we infer that, by establishing this program, potential students who are presently choosing not to attend the University of Miami because they are interested primarily in an environmental engineering degree will now have the opportunity to study at the University of Miami.

Accreditation is a central issue in any engineering program, since most States require graduation from an accredited program as a prerequisite for registration (licensure) as a professional engineer. Reviews of the accreditation criteria that apply to the proposed environmental engineering degree program, and the curricula of all accredited environmental engineering programs in the United states are presented in this proposal.

The curriculum for the baccalaureate program in environmental engineering has been designed on the basis of the accreditation requirements for environmental engineering programs, the curricular content of existing accredited environmental programs in the United States, a review of related courses at the University of Miami, and our own vision of the educational content of a modern environmental engineering program.

Institution of a baccalaureate program in environmental engineering is expected cost the University a modest $20,000 per year in increased operational costs. This cost is primarily associated with the need to add a new course in air pollution, a part-time technician in the environmental engineering laboratory, and the recurring cost of technical supplies generated by increased laboratory usage. We expect that these marginal costs will be more than offset by the increased revenue generated by increased student enrollment. In fact, the break-even point seems to be an incremental enrollment of only two students into the program. Given that there are presently only nine accredited baccalaureate environmental engineering programs in the United States, and the unfulfilled demand for environmental engineering professionals in society, we have no doubt that the incremental costs of this program will be more than offset by increased revenues from *new* student enrollment.

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1 Introduction

1.1 Global Perspective

The American Academy of Environmental Engineers (AAEE) is the lead society for the accreditation of environmental engineering programs in the United States, and they define environmental engineering as "...the application of engineering principles to the management of the environment for the protection of human health; for the protection of nature's beneficial ecosystems and for environment related enhancement of the quality of human life."

The modern field of environmental engineering evolved from the field of sanitary engineering, which was concerned primarily with the design and analysis of water and wastewater systems. The name-change ocurred during the late 1960's [7]. Today, environmental engineering is one of the most popular specialties in the civil engineering profession, and it is not uncommon to poll undergraduate civil engineering students and find over 50% with a primary interest in environmental engineering. These students often want a degree that is a combination of water-related engineering and environmental science [8].

The rapidly increasing knowledge base required to specialize in environmental engineering is driving the evolution of environmental engineering as a separate discipline. This evolution is currently being accomodated by graduate programs, which tend to offer relatively elementary courses in the environmental field, and have resulted in a master's degree being the basic degree requirement to practice environmental engineering. Most master's degree programs in environmental engineering are within the civil engineering discipline, although there are some within the mechanical and chemical engineering disciplines [6]. Civil engineers primarily focus on the design of water distribution and sewer systems, mechanical engineers tend to focus on air pollution, and chemical engineers tend to focus on the reduction of wastes generated by industrial facilities.

With the emergence of new baccalaureate programs in environmental engineering, some practitioners see this as an opportunity to elevate environmental engineering graduate courses to levels that are more state-of-the-art than are presently feasible, given the level of preparation of entering graduate students from traditional disciplines [5]. The sub-disciplines (i.e. professional fields) within environmental engineering are recognized to be: air quality, water quality, solid waste management, and industrial hygiene [7]. Within these sub-disciplines are such multi-media specialty areas as hazardous waste management and wastewater engineering.

Combined with the strong demand in the marketplace for environmental engineers, it has been suggested [1] that the strongest argument in favor of increased environmental engineering undergraduate education is that the great majority (approximately 95%) of the B.S. level engineers in the United States are being educated in fields that do not provide a good foundation for further development, through education or practice, in the environmental engineering field. This concern is particularly relevant since the National Council of Examiners for Engineering (NCEE) has recently introduced (1993) a separate Environmental Engineering examination for registration as a professional engineer, which in effect recognizes environmental engineering as a separate discipline. Clearly, the baccalaureate degree in environmental engineering will ultimately become the primary professional degree for becoming licensed as a practicing environmental engineer.

There seems to be little doubt that graduates with baccalaureate degrees in environmental engineering will have ample job opportunities [1, 5]. In fact, there are indications that unprecedented demand for environmental engineers in the 1990s and beyond is causing many universities to increase the curricular presence of environmental engineering at the baccalaureate level [1].

1.2 Local Perspective

The University of Miami does not currently offer any degrees in environmental engineering, however there are two programs in the College of Engineering that offer options in environmental engineering. Environmental options are offered within the baccalaureate programs in Mechanical Engineering and Civil Engineering. Within the Mechanical Engineering program, the environmental option is not a popular high-profile track, say on par with the aerospace option in Mechanical Engineering and, unlike the aerospace option, students are not enrolled and mentored in the environmental option from the time they are freshmen. The situation is much different in the Civil Engineering program, where the environmental option is a popular high-profile option in which students are enrolled and mentored from the time they are freshmen. The environmental option in Civil Engineering as a separate track was adopted by the Department of Civil and Architectural Engineering in 1992, and immediately began enrolling students. A few students that were already in the general civil engineering program chose to switch immediately to the the environmental engineering track, however, the majority of growth in this option has been from new incoming freshmen. The enrollment in the environmental engineering option over the last five years, as well as the enrollment in the general civil engineering program is shown in Table 1. This table clearly

Table 1: Enrollment Trends

Year	Environmental Engrg.	General Civil Engrg.
1990	0	105
1991	0	104
1992	3	92
1993	10	81
1994	20	75
1995 est.	30	80

demonstrates the increasing popularity of the existing environmental engineering option in civil engineering. A superficial look at Table 1 would support the hypothesis that the pool of students enrolled in the environmental engineering option are being drawn from the civil engineering pool, and therefore do not reflect a new pool of students. However, given the new-student enrollment per year in the civil engineering program during the 1990-1994 period, shown in Table 2, and noting

Table 2: New Student Enrollment

Year	Civil Engrg. (non-environmental)
1990	26
1991	46
1992	57
1993	43
1994	49

that the environmental engineering enrollment has come almost entirely from new freshmen, then these data indicate that the environmental engineering option is not growing at the expense of the civil engineering program.

The growth of the environmental option demonstrated by the enrollment figures in Table 1 in-

dicate that an independent free-standing environmental engineering program is viable, and, besides attracting the current pool of students who are also interested in civil engineering, this program will additionally attract those students that are interested only in environmental engineering. Informal polls of students currently in the environmental engineering option show that there is almost unanimous support for the development of a baccalaureate program in environmental engineering. The proposed environmental engineering program will also be attractive for transfer students from engineering programs at junior colleges, with the environmental engineering degree requiring approximately two years of additional study.

The issue of accreditation for any new engineering program is critical, since engineers cannot be licensed unless they are graduates from an accredited engineering program. This consideration must somehow be accomodated within the reality that engineering programs are not permitted to request accreditation unless they have produced graduates. We realize that it would not be responsible to admit students to a program that is not accredited, since this would limit their professional opportunities, therefore we are proposing that in the interim period between the environmental engineering baccalaureate program being adopted by the University and being put up for accreditation, we will encourage students to do a dual-degree program in which they will be granted baccalaureate degrees in both civil engineering and environmental engineering in nine semesters, compared with the eight semesters that it takes to do these degree programs separately. Students in this dual-degree track will have a fully accredited civil engineering degree and can become licensed professionals. After approximately three graduating classes, the environmental engineering baccalaureate program will be put up for accreditation, and then subsequent classes will be encouraged to pursue this degree as a separate track.

2 Program Requirements for Accreditation

Engineering programs in the United States are accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET), and many states require graduation from an accredited engineering program as a prerequisite for becoming a licensed professional engineer.

Environmental Engineering programs are accredited at either the Basic Level (undergraduate) or Advanced Level (graduate), however, the Engineering Dean's Council opposes dual accreditation of both undergraduate and graduate programs [5]. Currently, most graduate environmental engineering programs are not accredited, and accreditation has been mostly sought at the undergraduate level. The criteria for ABET accreditation fall into two categories: general criteria and program-specific criteria; and all accredited programs must meet both sets of criteria. These criteria for ABET accreditation of all engineering programs in the United States are published annually by ABET. The latest requirements may be found in [2, 3].

2.1 General Criteria

The general criteria for accreditation of undergraduate programs fall within the following categories: (1) Faculty; (2) Curricular Objective; (3) Curricular Content; (4) Student Body; (5) Administration; (6) Institutional Facilities; and (7) Institutional Commitment. The salient features of these requirements are described in the following sections.

2.1.1 Faculty

ABET requires that an undergraduate engineering program have no fewer than three full-time-equivalent faculty members. These faculty members must be able to demonstrate professional competence by a variety of means, such as a reputable publication record, and registration as a professional engineer.

2.1.2 Curricular Objective

The curricular objective criteria relate to the extent to which a program develops the ability to apply pertinent knowledge to the practice of engineering in an effective an professional manner. Specific objectives required by ABET are the development of:

1. The capability to delineate and solve in a practical way the problems of society that are suseptible to engineering treatment;
2. A sensitivity to the socially-related technical problems which confront the profession;
3. An understanding of the ethical characteristics of the engineering profession and practice;
4. An understanding of the engineer's responsibility to protect both occupational and public health and safety; and
5. The ability to maintain professional competence through life-long learning.

These objectives are normally met by embedding these objectives within the program curricula, or by providing specific courses fulfill these objectives.

2.1.3 Curricular Content

The curricular content required of all engineering programs is divided into the following three areas: (1) Mathematics and Basic Science; (2) Engineering Topics; and (3) Humanities and Social Sciences. The minimum requirements in these subject areas, in terms of semester credit hours, are given in Table 3. Besides fulfilling these numerical guidelines, programs must provide an integrated

Table 3: General ABET Course Requirements for Engineering Programs

Subject Type	Semester Credits Required
Mathematics and Basic Sciences	32
Engineering Topics (Science and Design)	48
Humanities and Social Sciences	16

experience aimed at preparing the graduate to function as an engineer.

Courses in mathematics must include differential and integral calculus, and differential equations. Additional work is encouraged in one or more of the subjects of probability and statistics, linear algebra, numerical analysis, and advanced calculus. Courses in the basic sciences must include general chemistry and calculus-based general physics, with at least a two-semester (or equivalent) sequence of study in either area. Additional work in life sciences, earth sciences, and

advances chemistry or physics may be used to satisfy the basic science requirement, as appropriate for various engineering disciplines.

Courses in engineering topics include subjects in the engineering sciences and engineering design. Engineering sciences have their roots in mathematics and basic sciences, but carry knowledge further towards creative application. Such subjects include: mechanics, thermodynamics, electrical and electronic circuits, materials science, transport phenomena, and computer science (other than computer programming skills). Engineering design is the process of devising a system, component, or process to meet desired needs. The engineering design component of a curriculum must include the following features: development of student creativity, use of open-ended problems, development and use of modern design theory and methodology, formulation of design problem statements and specifications, consideration of alternative solutions, feasibility considerations, production processes, concurrent engineering design, and detailed system descriptions. It is also essential to include a variety of realistic constraints, such as economic factors, safety, reliability, aesthetics, ethics, and social impact.

Courses in the humanities are concerned with man and his culture, while courses in the social sciences are concerned with individual relationships in and to society. Examples of traditional subjects in these areas are: philosophy, religions, history, literature, fine arts, sociology, psychology, political science, anthropology, economics, and languages other than English or a student's native language. The humanities and social science courses contained within an engineering program must provide both breadth and depth, and not limited to the selection of unrelated introductory courses.

Besides meeting the course requirements in mathematics, basic sciences, engineering topics, social sciences, and humanities, each educational program must include a meaningful, major engineering design experience that builds upon the fundamental concepts covered in these courses. Furthermore, each program must have an appropriate amount of laboratory experience such that the students develop a competence to conduct hands-on experimental work such as that expected of engineers in the discipline represented by the program. All engineering programs must have an appropriate amount of computer-based experience, evidenced by a knowledge of the application and use of digital-computation techniques for specific engineering problems.

2.1.4 Student Body

Student body criteria relate to the admission, retention, and scholastic work of students, and the records of graduates both in further academic study and in professional practice.

2.1.5 Administration

Administration criteria relate to the attitude and policy of the administration of the College of Engineering toward teaching, research, and scholarly production. and the quality of leadership at all levels of administration of the College.

2.1.6 Institutional Facilities

Institutional facilities criteria state that an engineering program must be supported by adequate physical facilities, including office and classroom space, laboratories, and shop facilities suitable for the scope of the program's activities. Other criteria relate to library and computer facilities.

2.1.7 Institutional Commitment

Institutional commitment criteria relate to the commitment of the institution, both financially and philosophically, to the engineering program. This commitment is evidenced by the relationship of the College of Engineering to the institution as a whole, by the fiscal policy toward and the financial resources available to the College of Engineering, and by the suitability of facilities including laboratories, libraries, and computer facilities.

2.2 Program Criteria

Program-specific criteria are requirements for specific programs that take precedence over general program requirements. For each specific engineering program, there is a lead professional society that is responsible for developing the program-specific requirements. The American Academy of Environmental Engineers (AAEE), sponsored by twelve professional societies including ASCE, is the lead society in ABET accreditation of Environmental Engineering programs. Program-specific accreditation criteria for Environmental Engineering programs are in the areas of: (a) faculty qualifications; and (b) curriculum. These requirements are described in the following sections.

2.2.1 Faculty Qualifications

Program-specific criteria for environmental engineering requires that the majority of the engineering members of the environmental engineering faculty should be registered (licensed) professional engineers or should be Engineers-in-Training.

2.2.2 Curriculum

ABET currently requires that, as a minimum, at least two areas of environmental engineering must be provided in the curriculum from amoung the following four areas [2]:

- air pollution control engineering
- water and wastewater engineering
- solid and hazardous wastes engineering
- environmental and occupational health engineering

Regarding the engineering design component of the curriculum, a minimum of one-half year of engineering design is required, and design courses in the environmental engineering program should emphasize an integrated approach that considers all environmental media in the prevention and control of environmental problems. System and facility operation and maintenance should be stressed in design courses.

Regarding the laboratory experience in the environmental engineering curriculum, ABET requires that environmental engineering laboratories provide a relevant experience in the physical, chemical, and biological sciences. This experience should also include applications to processes utilized in environmental engineering.

3 Accredited BSEnE Programs in the United States

There are presently nine ABET accredited baccalaureate degrees titled Environmental Engineering [2], these programs are available at the following universities:

- California Polytechnic State University, San Luis Obispo (Cal Poly)
- Northwestern University (Northwestern)
- University of Florida (UF)
- Michigan Technological University (Michigan Tech)
- University of Central Florida (UCF)
- Montana College of Mineral Science and Technology (Montana Tech)
- New Mexico Institute of Mining and Technology (New Mexico Tech)
- Syracuse University (Syracuse)
- Rensselaer Polytechnic Institute (RPI)

It is noteworthy that the programs at the last two Universities were accredited for the first time between 1992 and 1994.

3.1 California Polytechnic State University (Cal Poly)

At Cal Poly the Environmental Engineering program is administered in the Department of Civil and Environmental Engineering, and the BSEnE curriculum is shown in Figure 1. Cal Poly is on the quarter system, and the environmental engineering program requires 210 quarter credits, which is roughly equivalent to 140 semester credits. According to the 1994-97 Catalog, the enrollment in the BSEnE program in Fall 1993 was 276 students.

3.2 Northwestern University

At Northwestern University the Environmental Engineering program is an interdisciplinary program that is administered by a faculty coordinator in the Robert R. McCormick School of Engineering and Applied Science. The BSEnE curriculum at Northwestern is shown in Figure 2. The requirement for the BSEnE degree consists of 48 courses, and since credits are not assigned to the courses, the semester-credit equivalent to this curriculum is not clear. However, assuming three credits per course, this curriculum is probably on the order of 144 semester credits.

3.3 University of Florida

All engineering students at the University of Florida spend their first two years assigned to the College of Engineering Lower-Division program. During these two years, engineering students take courses that are common to all disciplines. After completing the Lower Division program, students apply to the various engineering degree programs in the College. At the University of Florida the Environmental Engineering program is administered by the Department of Environmental Engineering Sciences. The BSEnE curriculum at the University of Florida is shown in Figure 3. The requirement for the BSEnE degree is 130 semester credits.

California Polytechnic State University (Cal Poly)

	Credits	Total
Mathematics and Basic Sciences		55
Calculus	16	
Differential Equations	4	
Statistical Methods for Engineers	3	
General Chemistry	12	
Survey of Organic Chemistry	4	
General Physics	12	
Physiology and Biological Adaptation	4	
Engineering Topics		102
Applied Descriptive Geometry	2	
Civil Engineering Fundamentals II	2	
Digital Computer Applications	2	
Engineering Statics	3	
Engineering Dynamics	3	
Strength of Materials	5	
Thermodynamics	3	
Heat Transfer	3	
Electric Circuit Theory	3	
Electric Circuit Laboratory	1	
Fundamentals of Transportation Engineering	4	
Fluid Mechanics	3	
Introduction to Environmental Engineering	3	
Water Resources Engineering	4	
Hydraulic Systems Engineering	3	
Hydraulics Laboratory	1	
Groundwater Hydraulics and Hydrology	3	
Water and Wastewater Treatment Design	3	
Water Quality Measurements	2	
Geotechnical Engineering	4	
Thermodynamics of Processes	3	
Mass Transfer Operations	3	
Advanced System Design	3	
Noise and Vibration Control	3	
Automatic Process Control	2	
Environmental Air Quality	3	
Air Quality Measurements	3	
Air Pollution Control	3	
Introduction to Hazardous Waster Management	3	
Solid Waste Management	3	
Senior Project	4	
Technical Electives	12	
Humanities and Social Sciences		53
Writing: Exposition	4	
Professional Writing	4	
Critical Thinking	3	
Critical Reading Electives	6	
Principles of Economics	3	
American and California Government	3	
History of American Ideals and Institutions	3	
Public Speaking	3	
Philosophical Classics	3	
General Psychology	3	
Modern World History	3	
Electives	15	
Total Program		210

Figure 1: BSEnE Curriculum at Cal Poly, San Luis Obispo

Northwestern University

	Courses	Total
Mathematics and Basic Sciences		13
Calculus	3	
Multiple Integration and Vector Calculus	1	
Sequences & Sreies, Linear Algebra	1	
Elementary Differential Equations	1	
General Chemistry	1	
General Inorganic Chemistry	1	
Organic Chemistry	1	
Kinetics & Spectroscopy	1	
General Physical Chemistry	1	
General Physics	2	
Engineering Topics		26
Mechanics	1	
Thermodynamics	2	
Statistics	1	
Fluid Mechanics I	1	
Electrical Science or Material Science	1	
Systems Engrg. & Analysis or Computer Sci.	1	
Computer Programming	1	
Sanitary Engineering	1	
Chemistry of the Aquatic Environment	1	
Environmental Inpact Evaluation	1	
Environmental Biology	1	
Public Health Engineering	1	
Community Air Pollution	1	
Radiation Health	1	
Engineering Design Course	1	
Engineering Value Analysis	1	
Technical Electives	4	
Unrestricted Electives	5	
Humanities and Social Sciences		9
Social Sciences/Humanities/Communications	9	
Total Program		48

Figure 2: BSEnE Curriculum at Northwestern University

University of Florida

	Credits	Total
Mathematics and Basic Sciences		34
Analytic Geometry and Calculus	12	
Elementary Differential Equations	3	
Engineering Statistics	3	
General Chemistry	8	
Physics with Calculus	8	
Engineering Topics		72
Computer Programming for Engineers	2	
Computational Methods in Environmental Engrg.	3	
Computer-Assisted Drafting and Design	3	
Engineering Mechanics- Statics	3	
Engineering Mechanics- Dynamics	2	
Materials 1	3	
Elements of Electrical Engineering	3	
Thermodynamics	3	
Hydrodynamics	4	
Hydraulic Systems Design	3	
Water and Wastewater 1	3	
Water and Wastewater 2	3	
Environmental Biology 1	2	
Environmental Biology 2	2	
Environmental Biology Laboratory	1	
Environmental Chemistry of Carbon Compounds	2	
Introduction to Water Chemistry	3	
Elements of Atmospheric Pollution	3	
Air Pollution Control Design	3	
Solid Waste Management	3	
Hazardous Waste Control	3	
Environmental Resources Management	2	
Undergraduate Seminar	1	
Technical Electives	12	
Humanities and Social Sciences		24
Composition	6	
Literature and the Arts	6	
Historical and Philosophical Studies	6	
Social and Behavioral Sciences	6	
Total Program		130

Figure 3: BSEnE Curriculum at University of Florida

Table 4: Growth of BSEnE Program at Michigan Tech

Year	BSEnE Enrollment	BSCE Enrollment
1985	-	407
1986	17	350
1987	32	364
1988	54	395
1989	83	408
1990	137	490
1991	?	440
1992	308	550
1993	?	?
1994	314	505 (est.)

3.4 Michigan Technological University

Michigan Technological University (Michigan Tech) is a state university located in Houghton, Michigan. At Michigan Tech the Environmental Engineering program is administered by the Department of Civil and Environmental Engineering. The program began in 1986 and the growth in enrollment is shown in Table 4. The BSEnE curriculum at Michigan Tech is shown in Figure 4. The requirement for the BSEnE degree is 196 quarter credits, which is equivalent to approximately 131 semester credits. Enrollment in the BSEnE program as of Fall 1993 was 300 students.

3.5 University of Central Florida

At the University of Central Florida (UCF) the Environmental Engineering program is administered by the Department of Civil and Environmental Engineering. The BSEnE curriculum at UCF is shown in Figure 5. The requirement for the BSEnE degree is 132 credits.

3.6 Montana College of Mineral Science and Technology

At the Montana College of Mineral Science and Technology (Montana Tech), the Environmental Engineering program is administered in the College by an Associate Dean of Environmental Engineering and Natural Sciences. The BSEnE curriculum at Montana Tech is shown in Figure 6. The requirement for the BSEnE degree is 145 credits.

3.7 New Mexico Institute of Mining and Technology

At the New Mexico Institute of Mining and Technology (New Mexico Tech), the Environmental Engineering program is administered by the Department of Mineral and Environmental Engineering. The BSEnE curriculum at New Mexico Tech is shown in Figure 7. The requirement for the BSEnE defree is 138 credits.

3.8 Syracuse University

At Syracuse University the Environmental Engineering program is administered by a Program Director in the College of Engineering. The Program is not assigned to any particular Department.

Michigan Technological University

	Credits	Total
Mathematics and Basic Sciences		63
Calculus and Analytic Geometry	20	
Introduction to Ordinary Differential Equations	3	
Introductory Statistics with Calculus	3	
General Chemistry	8	
General Chemistry Laboratory	2	
Organic Chemistry: An Overview	4	
General Physics	10	
General Biology I	4	
Basic Science and Mathematics Electives	9	
Engineering Topics		80
Civil Engineering II	3	
Engineering Graphics Using CAD	2	
Elements of Electric Circuits	4	
Statics	4	
Dynamics I	4	
Mechanics of Materials I	4	
Surveying I	4	
Introductory Thermodynamics	3	
Introduction to Environmental Engineering	4	
Hydromechanics	5	
Water and Wastewater Treatment	4	
Hydrology I or Hydrogeology	3	
Environmental and Water Chemistry	4	
Environmental Impact and Protection	3	
Water Distribution and Wastewater Collection	3	
Environmental Microbiology	4	
Solid Waste Management	3	
Industrial Health	2	
Emissions and Air Pollution	3	
Engineering Science and Design Electives	14	
Humanities and Social Sciences		42
Communications	12	
Humanities Electives	9	
Social Sciences Electives	12	
Upper-Division Thematic Studies	9	
Other		11
Physical Education Electives	4	
General Electives	7	
Total Program		196

Figure 4: BSEnE Curriculum at Michigan Technological University

University of Central Florida

	Credits	Total
Mathematics and Basic Sciences		35
Calculus	12	
Differential Equations	3	
Probability and Statistics for Engineers	3	
Physics for Engineers and Scientists & Lab	7	
Chemistry Fundamentals & Lab	7	
Earth Science Elective	3	
Engineering Topics		70
Statics	3	
Dynamics	3	
Mechanics of Materials	3	
Principles of Electrical Engineering	3	
Thermodynamics	3	
Materials	3	
Engineering Economics	2	
Engineering Administration	3	
Engineering and the Environment	3	
Fluid Mechanics	3	
Hydrology	3	
Hydraulics	3	
Chemical Processes	3	
Biological Processes	3	
Process Design	3	
Air Pollution	3	
Solid and Hazardous Waste	3	
Technical Elective	11	
Design Elective	9	
Humanities and Social Sciences		27
English Composition	6	
Social Science	3	
Economics	3	
Humanities/History	6	
Oral Communication	3	
Humanities Elective	3	
American Government	3	
Total Program		132

Figure 5: BSEnE Curriculum at University of Central Florida

Montana College of Mineral Science & Technology (Montana Tech)

	Credits	Total
Mathematics and Basic Sciences		54
Analytical Geometry and Calculus	10	
Elementary Differential Equations	3	
Introduction to Statistical Methods	3	
General Physics & Lab	11	
General Chemistry & Lab	9	
Survey of Organic Chemistry	3	
Survey of Physical Chemistry	3	
Biology Electives	6	
Physical Geology	3	
Ecology	3	
Engineering Topics		68
Engineering Mechanics- Statics	3	
Engineering Mechanics- Dynamics	3	
Thermodynamics	3	
Introduction to Scientific Programming	3	
Introduction to Environmental Engineering	3	
Environmental Engineering Seminar I	1	
Fluid Mechanics	3	
Fluid Mechanics Lab	1	
Surface Water Engineering	3	
Hydrogeology	3	
Water and Wastewater Treatment	3	
Water Sampling and Analysis	3	
Air Diffusion Modeling	3	
Air Sampling and Analysis	3	
Air Pollution Control Engineering I	3	
Air Pollution Control Engineering II	3	
Industrial Ventilation	3	
Hazardous Waste Engineering	3	
Land Reclamation	3	
Engineering Economy and Financial Mgmt.	3	
Environmental Laws and Regulations	2	
Environmental Design	4	
Engineering or Technical Elective	3	
Engineering Elective	3	
Humanities and Social Sciences		23
English Composition	4	
Scientific and Technical Writing	3	
Humanities Electives	6	
Social Science Electives	6	
Macroeconomics	4	
Total Program		145

Figure 6: BSEnE Curriculum at Montana Tech

New Mexico Institute of Mining and Technology (New Mexico Tech)

	Credits	Total
Mathematics and Basic Sciences		54
Calculus	12	
Applied Analysis	3	
Statistics	3	
General Physics & Lab	10	
General Chemistry & Lab	8	
Chemistry- Quantitative Analysis	2	
Organic Chemistry	3	
Physical Chemistry	3	
General Biology & Lab	4	
Cell Biology	3	
Microbiology	3	
Engineering Topics		57
Engineering Science	5	
Statics	3	
Thermodynamics	3	
Materials	3	
Electrical Engineering	3	
Soil Mechanics	2	
Introduction to Environmental Engineering	3	
Transport Processes	3	
Fluid Mechanics	3	
Water Treatment Process Design	2	
Wastewater Treatment Process Design	2	
Water and Wastewater Laboratory	1	
Groundwater Hydrology	3	
Instrumentation and Process Control	2	
Finite Element Analysis and Design	3	
Air Pollution Engineering I	2	
Air Pollution Engineering II	2	
Air Pollution Sampling	1	
Solid and Hazardous Waste Engineering	3	
Environmental Law and Regulations	2	
Engineering Economics	3	
Senior Thesis	3	
Humanities and Social Sciences		27
English	6	
Social Science	9	
Social Science/Humanities	3	
Humanities/Arts	6	
Technical Writing	3	
Total Program		138

Figure 7: BSEnE Curriculum at New Mexico Tech

The BSEnE curriculum at Syracuse University is shown in Figure 8. The requirement for the BSEnE degree is 131 credits.

3.9 Rensselaer Polytechnic Institute

At Rensselaer Polytechnic Institute (RPI) the Environmental Engineering program is administered by the Department of Civil and Environmental Engineering. The BSEnE curriculum at RPI is shown in Figure 9. The requirement for the BSEnE degree is 134 credits.

4 University of Miami BSEnE Curriculum

4.1 Course Requirements

The University of Miami BSEnE program was developed by considering: (a) the curricular content of existing ABET accredited environmental engineering programs; (b) the courses currently available and being offered at the University of Miami; and (c) our vision of the responsibilities and challenges facing an environmental engineer in the 21^{st} century.

The curricula of accredited environmental engineering programs in the United States have been reviewed in the previous section, and the common course contents identified. On reviewing the environmental courses currently available at the University of Miami, we find that most of the key environmental engineering courses are currently being offered within the Department of Civil and Architectural Engineering, primarily as part of the environmental engineering option in civil engineering. Other courses that are basic to any environmental engineering program are found principally in the Department of Mechanical Engineering (air pollution and related courses), Department of Industrial Engineering (industrial hygiene and related courses), and the Departments of Chemistry and Biology. The consensus of the group that developed the environmental engineering curriculum is that, except for a single course in air pollution that needs to be developed, there are sufficient courses already existing and being offered at the University of Miami to constitute an accreditable and relevant environmental engineering program.

An important issue that was addressed in developing our environmental engineering program was the issue that a newly created environmental engineering program will not be accredited until there are graduates from the program, and that practicing engineers cannot be licensed unless they are graduates from an accredited engineering program. This will create a problem for the initial environmental engineering graduates who complete the program prior to accreditation. We have addressed this issue by proposing, and recommending, a dual degree program in Environmental Engineering and Civil Engineering in which students complete the requirements for both degrees in nine semesters, compared with the eight semesters required for each degree. Clearly, students will have the option of choosing to pursue these degrees individually, accreditation requirements notwithstanding.

4.2 Admission Requirements

Admission to the environmental engineering program is the same as for all other programs at the University of Miami. According to the University of Miami Bulletin, the Committee on Admission bases its decision as to the admission of applicants upon evidence that they have the qualifications

Syracuse University

	Credits	Total
Mathematics and Basic Sciences		31
Calculus	12	
Differential Equations and Matrix Algebra	3	
General Physics & Lab	8	
General Chemistry & Lab	8	
Engineering Topics		73
Introduction to Engrg. and Computer Science	3	
Environmental Engineering II	3	
Civil/Environmental Engineering Measurements	4	
Electrical Science I & Lab	4	
Thermodynamics	3	
Engineering Materials	3	
Statics	3	
Dynamics	3	
Mechanics of Materials	3	
Soil Mechanics and Foundations I	3	
Environmental Engineering I	3	
Environmental Chemistry and Analysis	3	
Applied Environmental Microbiology	3	
Principles of Fluid Mechanics	4	
Applied Fluid Mechanics	3	
Water Resources	3	
Air Resources	3	
Solid Wastes: Collection and Disposal	3	
Design Elective	3	
Civil and Environmental Engineering Design	4	
Economic Analysis of Large-Scale Projects	3	
Independent Study or Technical Elective	3	
Technical Elective	3	
Humanities and Social Sciences		27
Writing Studio	9	
Introductory Macroeconomics	3	
Social Science/Humanities Elective	15	
Total Program		131

Figure 8: BSEnE Curriculum at Syracuse University

Rensselaer Polytechnic Institute (RPI)

	Credits	Total
Mathematics and Basic Sciences		48
Mathematics I & II	8	
Introduction to Differential Equations	4	
Modeling and Analysis of Uncertainty	3	
Physics I & II & III	12	
Chemistry of Materials I & II	8	
Introduction to Organic Chemistry I & II	6	
Physical Chemistry I	3	
Microbiology	4	
Engineering Topics		57
Engineering Graphics and CAD	1	
Introduction to Engineering Analysis	4	
Engineering Processes	1	
Material and Energy Balances	3	
Engineering Thermodynamics	3	
Computer Science I	3	
Dynamic Systems	3	
Lab. Intro. to Embedded Control	3	
Environmental Engineering Fundamentals	3	
Environmental Systems Engineering	3	
Fluid Mechanics I	3	
Introduction to Applied Hydrology	3	
Environmental Engineering Lab. I	2	
Environmental Process Design I & II	4	
Chemical Process Control	3	
Unit Operations	3	
Air Pollution	3	
Solid and Hazardous Waste Engineering	3	
Technical Elective	6	
Humanities and Social Sciences		21
Humanities/Social Science Elective	21	
Other		8
Free Elective	6	
Physical Education or ROTC	2	
Total Program		134

Figure 9: BSEnE Curriculum at RPI

deemed necessary for academic success at the University of Miami. Principal factors in the admission decisions are: (1) secondary school record; (2) scholastic assessment test (SAT), scholastic assment test I (SAT I), and american college testing program (ACT); (3) counselor's evaluation form; and (4) an essay. Although specific criteria are not given for such measures as high school grade-point-averages and SAT scores, the College of Engineering has, on average, admitted students with the highest average SAT scores at the University. Based on our experience with these students in our existing engineering programs, we would expect that the pool of students attracted to our environmental engineering engineering program will be similarly qualified and perform adequately. A similar statement can be made regarding the quality and performance of transfer students, where it is the policy of the University that only courses passed with a grade of C$^-$ or better at an accredited college can be transferred and count towards a degree at the University of Miami.

4.3 Administration of the Program

The Environmental Engineering program is to be administered within the Department of Civil and Architectural Engineering. Concurrent with the implementation of the environmental engineering program, it would be appropriate to rename the department as the Department of Civil, Architectural, and Environmental Engineering. However, this is a separate action that is not part of this proposal.

4.4 Faculty Resources

There are several faculty within the College of Engineering who specialize in areas that are within the domain of environmental engineering. Existing faculty within the College of Engineering that teach environmental engineering courses and are trained in the breadth of environmental specialties are primarily found in the Department of Civil and Architectural Engineering, while faculty with important specializations in environmental and occupational health engineering and air pollution control engineering are found in the departments of Industrial and Mechanical Engineering respectively. These faculty are listed in Table 5. It is clear from this listing of faculty that all

Table 5: Environmental Engineering Faculty in the College of Engineering

Faculty	Rank	Specialization(s)
Shihab Asfour	Professor	environmental and occupational health
David A. Chin	Professor	water and wastewater
James D. Englehardt	Asst. Professor	water and wastewater, solid and hazardous wastes
Helena Solo-Gabriele	Asst. Professor	water and wastewater
Thomas D. Waite	Professor	water and wastewater, solid and hazardous wastes
Kau-Fui V. Wong	Assoc. Professor	air pollution control

specializations related to environmental engineering are covered by at least one full-time faculty in the College of Engineering. This is important for ownership of courses, a factor that is critically important in developing a new program. In addition to these faculty, there will obviously be several other faculty that teach courses in mathematics, basic science, and the engineering science portions of the environmental engineering curriculum.

4.5 Curriculum

The curriculum for the Bachelor of Science degree in Environmental Engineering is shown in Figure 10. As with most engineering programs, the first two years are taken up with with mathematics and basic sciences, along with core engineering science subjects such as mechanics and electric circuits. The junior and senior years of the program are made up mostly of engineering design courses related to the practice of environmental engineering. The proposed program has at least one course in each of the major specialty areas of environmental engineering, and an emphasis on the water environment. The major specialty courses are: Design of Water Quality Control Systems (CEN 440), Water Resources Engineering (CEN 430), Solid and Hazardous Waste Engineering (CEN 543), Industrial Safety Engineering (IEN 351), and Air Pollution (MEN 520, to be developed). To support these courses are a laboratory course in Water and Wastewater Analysis (CEN 345), and a variety of applied science courses such as Environmental Chemistry (CEN 540), Public Health and Environmental Microbiology (CEN 541). Students in the BSEnE program will have the flexibility to choose two elective courses in environmental engineerng and one Basic Science elective from the lists shown in Figure 11. These electives will permit the student to take advanced courses in either water and wastewater engineering (CEN 530, CEN 531, CEN 532), industrial hygiene (IEN 558, IEN 559), air quality control (MEN 521), or remote sensing and solar energy utilization (MEN 510, MEN 530). The list of basic science electives will provide the student an opportunity of more in-depth study in biology, chemistry, and the earth sciences, depending on the interests of the student. The proposed BSEnE curriculum will require 129 credits for graduation, which is fairly typical of other accredited programs in the College of Engineering. The semester-credit requirements for the proposed BSEnE program are compared with the requirements of other BSEnE programs in Table 6. Based on these data, it is clear that the credit requirements for the proposed BSEnE

Table 6: Semester-Credit Requirements of BSEnE Programs

School	Semester-Credits
Cal Poly	140
Northwestern	144
Univ. of Florida	130
Michigan Tech	131
Univ. of Central Florida	132
Montana Tech	145
New Mexico Tech	138
Syracuse	131
RPI	134

degree program are commensurate with the requirements of most accredited BSEnE programs in the United States.

In the initial stages of implementing the environmental engineering program, students will be encouraged to pursue a dual degree program in civil engineering and environmental engineering. When the environmental engineering program is accredited, then pursuit of an individual environmental engineering degree will also be encouraged. This approach is dictated by the requirement that graduation from an accredited degree program is a prerequisite for registration as a professional engineer. The dual-degree curriculum for students pursuing both the Civil Engineering and Envi-

Bachelor of Science in Environmental Engineering

Freshman Year

Fall Semester			Spring Semester		
CEN 101	Intro. to Civil/Env. Engrg.	1	CHM 112	Principles of Chemistry II	4
CHM 111	Principles of Chemistry I	4	ARC 191	Architectural Graphics	3
ENG 105	English Composition I	3	ENG 107	Writing About Science	3
MTH 110	Calculus I	5	MTH 112	Calculus II	4
SS/H/A Elective		3	PHY 205	Physics I	3
		16			17

Sophomore Year

Fall Semester			Spring Semester		
CEN 210	Mechanics of Solids I	3	CEN 211	Mechanics of Solids II	3
CEN 350	Transportation Engineering I	3	CEN 212	Structural Lab	1
MTH 211	Calculus III	3	EEN 205	Electrical Engineering I	3
PHY 206	Physics II	3	MTH 311	Ordinary Differential Equations	3
PHY 208	Physics Lab I	1	PHY 207	Physics III	3
SS/H/A Elective		3	PHY 209	Physics Lab II	1
		16	IEN 311	Probability and Statistics	3
					17

Junior Year

Fall Semester			Spring Semester		
CEN 330	Fluid Mechanics	3	CEN 301	Computer Applications	3
CEN 340	Intro. to Environmental Engrg.	3	CEN 430	Water Resources Engineering	3
CEN 345	Water and Waste Analysis	3	CEN 440	Des. Water Qual. Control Sys.	3
MEN 303	Thermodynamics I	3	Basic Science Elective		3
IEN 351	Industrial Safety Engrg.	3	SS/H/A Elective		3
		15			15

Senior Year

Fall Semester			Spring Semester		
CEN 481	Design Project I	1	MEN 520	Air Pollution	3
CEN 540	Environmental Chemistry	3	ENE Elective		3
CEN 541	Pub. Health and Enviro. Micro.	3	ENE Elective		3
CEN 543	Solid and Haz. Waste Engrg.	3	CEN 482	Design Project II	2
SS/H/A Elective		3	CEN 402	Professionalism and Ethics	3
SS/H/A Elective		3	SS/H/A Elective		3
		16			17

Figure 10: Environmental Engineering Curriculum

Bachelor of Science in Environmental Engineering

ENE Electives

CEN 530	Water and Wastewater Engrg.	3
CEN 531	Engineering Hydrology	3
CEN 532	Groundwater Engineering	3
IEN 558	Industrial Hygiene I	3
IEN 559	Industrial Hygiene II	3
MEN 510	Solar Energy Utilization	3
MEN 521	Exhaust Emission Control	3
MEN 530	Remote Sensing	3

Basic Science Electives

CHM 201	Organic Chemistry I	3
CHM 216	Chem. Equilibrium & Analysis	3
CHM 360	Physical Chemistry I	3
BIL 103	Elementary Ecology	3
BIL 110	General Biology	3
MSC 102	Intro. to Atmospheric Science	3
MSC 111	Intro. to Marine Science	3
MSC 215	Chemical Oceanography	3
MSC 230	Introduction to Marine Biology	3
GSC 120	Environmental Geology	4

Figure 11: Environmental Engineering Electives

ronmental Engineering degree programs is shown in Figure 12. The following additional courses must be taken by students in the Environmental Engineering program to satisfy the requirements of the Civil Engineering program: Structural Analysis (CEN 310), Concrete Structures (CEN 320), Steel Structures (CEN 321), Geotechnical Engineering I & II (CEN 370,CEN 470), Geotechnical Engineering Lab (CEN 371), and Transportation Engineering II (CEN 450). These courses amount to 19 credits, and therefore the curricula of both the Civil Engineering and Environmental Engineering programs can be covered in nine semesters, compared with the eight semesters required to complete these programs individually.

4.6 Resources Required

All of the courses in the environmental engineering curriculum, with the exception of a course in air pollution control, are presently being offered on a regular basis. Consequently, the faculty resources necessary to offer only the air pollution course must be provided. This course will be offered annually, and a cost of $4000 per year will be required to cover a part-time faculty to either teach the course, or relieve a full-time faculty member to teach the course.

Additional teaching assistants will not be necessary at this time, since the additional course required is a lecture course at the 500 level, and is not initially expected to have a level of enrollment to justify a teaching assistant. Additional support personnel will not be required at this time. Laboratory facilities are adequate at this time, however as the program moves into full operation it is expected that the operational costs of these laboratories will increase to reflect the increased usage that will result from the formal implementation of this program. We anticipate that approximately $8000 per year will be necessary to support a part-time laboratory technician, and around $5000 per year will be required for expendable supplies.

Library support facilities are adequate at this time, because of the significant presence that the University already has in the Environmental Engineering and Environmental Science areas.

In summary, implementation of the proposed baccalaureate degree in environmental engineering will require an initial investment of around $17,000 per year in budgetary support. We view this level of support as minimal compared with the significant monetary benefits that will accrue from implementation of this program. For example, at this level of investment, the program will break even with an enrollment of only two students, who would not otherwise have attended the University. Clearly, this program can reasonably be expected to attract significantly more students than the break-even number.

4.7 Implementation

The proposed baccalaureate program in environmental engineering is expected to substantially replace the existing and highly-successful environmental option in Civil Engineering. This is not to say that there is an intention to replace the environmental option in civil engineering, but that there will probably be overwhelming sentiment on the part of the current students in the environmental engineering option to switch over to the new dual-degree program in civil and environmental engineering, and then new students will enter this track directly. After at least three classes have graduated with the baccalaureate degree in environmental engineering, this program will be presented for accreditation. When the program becomes accredited, then the environmental engineering baccalaureate degree will be free-standing, and incoming students, as well as students

Bachelor of Science in Environmental Engineering
&
Bachelor of Science in Civil Engineering

Freshman Year

Fall Semester			Spring Semester		
CEN 101	Intro. to Civil/Env. Engrg.	1	CHM 112	Principles of Chemistry II	4
CHM 111	Principles of Chemistry I	4	ARC 191	Architectural Graphics	3
ENG 105	English Composition I	3	ENG 107	Writing About Science	3
MTH 110	Calculus I	5	MTH 112	Calculus II	4
SS/H/A Elective		3	PHY 205	Physics I	3
		16			17

Sophomore Year

Fall Semester			Spring Semester		
CEN 210	Mechanics of Solids I	3	CEN 211	Mechanics of Solids II	3
CEN 350	Transportation Engineering I	3	CEN 212	Structural Lab	1
MTH 211	Calculus III	3	EEN 205	Electrical Engineering I	3
PHY 206	Physics II	3	MTH 311	Ordinary Differential Equations	3
PHY 208	Physics Lab I	1	PHY 207	Physics III	3
SS/H/A Elective		3	PHY 209	Physics Lab II	1
		16	IEN 311	Probability and Statistics	3
					17

Junior Year

Fall Semester			Spring Semester		
CEN 330	Fluid Mechanics	3	CEN 301	Computer Applications	3
CEN 340	Intro. to Environmental Engrg.	3	CEN 430	Water Resources Engineering	3
CEN 345	Water and Waste Analysis	3	CEN 440	Des. Water Qual. Control Sys.	3
MEN 303	Thermodynamics I	3	CEN 320	Concrete Structures	3
IEN 351	Industrial Safety Engrg.	3	Basic Science Elective		3
CEN 310	Structural Analysis	3			
		18			15

Senior Year

Fall Semester			Spring Semester		
CEN 481	Design Project I	1	CEN 482	Design Project II	2
CEN 540	Environmental Chemistry	3	CEN 543	Solid and Haz. Waste Engrg.	3
CEN 321	Steel Structures	3	CEN 541	Pub. Health and Enviro. Micro.	3
CEN 370	Geotechnical Engineering I	3	CEN 470	Geotechnical Engineering II	3
CEN 371	Geotechnical Lab	1	CEN 450	Transportation Engineering	3
SS/H/A Elective		3	SS/H/A Elective		3
SS/H/A Elective		3			
		17			17

Fifth Year

MEN 520	Air Pollution	3
ENE Elective		3
ENE Elective		3
CEN 402	Professionalism and Ethics	3
SS/H/A Elective		3
		15

Figure 12: Dual Degree Program

in the degree program at that time, will no longer be strongly encouraged to pursue a dual-degree option, and will have greater freedom to concentrate solely on environmental engineering.

In terms of a time table, we expect that the University will approve the environmental engineering baccalaureate program in AY95/96 the implementation will begin in AY96/97. During AY96/97 we expect that the approximately 30 students that are currently in the environmental engineering option will immediately switch to the environmental engineering degree program, thereby immediately providing students from the Freshman to Senior level in the new environmental engineering program. The first graduates from this program should then emerge during AY97/98, and the program would then request accreditation within AY99/00. Just in time for the 21^{st} century.

5 Conclusion

This proposal has presented our case for the institution of a baccalaureate program in Environmental Engineering, to be administered by the Department of Civil and Architectural Engineering. The rationale for this program is that there currently exists significant faculty resources and infrastructure for this program in the College of Engineering, and the incremental costs associated with operating this program are far outweighed by the expected benefits. The market for this program has been demonstrated by the success of the environmental option in Civil Engineering, and the significant interest of student applicants in the profession of environmental engineering.

The job market for environmental engineers is significant and growing, and the emergence of environmental engineering as a professional discipline has recently been formalized by the institution of a separate professional registration (license) for environmental engineers. Environmental engineering is a profession that is here to stay, and there is a need in society for well trained engineers in this field. This proposal presents a program that will meet that need.

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6 Curricula Vitae of Key Environmental Engineering Faculty

The key environmental engineering faculty who have participated in the development of the proposed environmental engineering program, and will be responsible for continued program development are as follows:

- Dr. David A. Chin, Civil Engineering (Committee Chair)
- Dr. Thomas D. Waite, Civil Engineering
- Dr. James D. Englehardt, Civil Engineering
- Dr. Helena Solo-Gabriele, Civil Engineering
- Dr. Shihab Asfour, Industrial Engineering
- Dr. Kau-Fui V. Wong, Mechanical Engineering

The curricula vitae of the aforementioned faculty are included in this appendix.

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United States Geological Survey (Miami, FL), Project Chief, 1988-1989
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PUBLICATIONS (Last 10 years)

Books and Monographs:

1. Chin, D.A. (1990). "A Method to Estimate Leakage to the Biscayne Aquifer, Dade County, Florida." U.S. Department of the Interior, United States Geological Survey, Water-Resources Investigation No.90-4135, Tallahassee, Florida.

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University of Miami, Professor, Department of Civil and Architectural Engineering, 1982-Present
University of Miami, Associate Dean, Research and Graduate Studies, 1994-Present

Non-Academic:

High Voltage Environmental Applications, Inc. (Miami, FL), President, 1990-Present
David Taylor Naval Ship R & D Center, Research Engineer, 1985-1986

PUBLICATIONS (Last 10 years)

Books and Monographs:

1. Waite, T.D. (1986). "Disinfection of Wastewater Effluents and Sludge: State-of-the-Art and Research Needs." Editor. Proceedings of a National Science Foundation Workshop, Miami, Florida.

Juried or Refereed Journal Articles:

1. Kurucz, C.N., T.D. Waite, W.J. Cooper, and M.G. Nickelsen (1995). "Empirical Models for Estimating the Destruction of Toxic Organic Compounds Utilizing Electron Beam Irradiation at Full Scale," Radiation Physics and Chemistry, in press.

2. Kurucz, C.N., T.D. Waite, and W.J. Cooper (1995). "The Miami Electron Beam Research facility: A Large Scale Wastewater Treatment Application," Radiation physics and Chemistry, in press.

3. Cooper, W.J., M. Nickelsen, D. Meacham, K. Lin, T.D. Waite, and C.N. Kurucz (1995). "Effect of Solids on the removal of Toxic Organic Compounds in Aqueous Solution Using High Energy Electron Beam Irradiation," Chemistry for the Protection of the Environment, Elsevier Press, in press.

4. Wang, T., T.D. Waite, C.N. Kurucz, and W.J. Cooper (1994). "Oxidant Reduction and Biodegradability Improvement of paper Mill Effluent by Irradiation," Water research, Vol.28, No.1, pp.237-241.

5. Nickelsen, M.G., W.J. Cooper, K. Lin, C.N. Kurucz, and T.D. Waite (1994). "High Energy Electron Beam Generation of oxidants for the Treatment of Benzene and Toluene in the Presence of Radical Scavengers," Water Research, Vol.28, pp.1227-1237.

6. Cooper, W.J., E. Cadavid, M.G. Nickelsen, K. Lin, C.N. Kurucz, and T.D. Waite (1993). "Removing THMs from Drinking Water Using High-Energy Electron-beam Irradiation," Journal American Water Works Association, Vol.85, No.9, pp.106-112.

7. Cooper, W.J., D.E. Meacham, M.G. Nickensen, K. Lin, D.B. Ford, C.N. Kurucz, and T.D. Waite (1993). "The Removal of Tri(TCE) and Tetrachloroethylene (PCE) from Aqueous Solution Using High-Energy Electrons," Journal of the Air and Waste Management Association, Vol.43, pp.1358-1366.

8. Cooper, W.J., M.G. Nickelsen, D.E. Meacham, T.D. Waite, and C.N. Kurucz (1992). "High Energy Electron Beam Irradiation: An Advanced Oxidation Process for the Treatment of Aqueous Based Organic Hazardous Wastes," Water Pollution Research Journal Canada, Vol.27, pp.69-95.

9. Farooq, S., C. Kurucz, T.D. Waite, W.J. Cooper, W. Mane, and J. Greenfield (1993). "Disinfection of Wastewater: High Energy Electrons vs. Gamma Irradiation," Water Research, Vol.27, 1993.

10. Swinwood, J., E. Bryan, D. Carlson, T.D. Waite, J. hare, and P. Kruger (1992). "Radiation Energy Treatment of water, Wastewater and Sludge, State of the Art," Environmental Engineering Division, ASCE, Publication No.IFBNO-87262-901-S.

11. Kurucz, C.N., T.D. Waite, W.J. Cooper, and M. Nickelsen (1992). "Treatment of hazardous Industrial Wastewater and Contaminated Groundwater Using Electron Beam Irradiation," Chemistry for the Protection of the Environment, Elsevier Press, New York.

12. Nickelsen, M., W.J. Cooper, C.N. Kurucz, and T.D. Waite (1992). "Removal of Benzene and Selected Alkyl Substituted Benzenes from Aqueous Solution Utilizing Continuous High Energy Electron Irradiation," Environmental Science & Technology," Vol.26.

13. Cooper, W., M. Nickelsen, D. Meacham, T.Waite, and C. Kurucz (1992). "High Energy Electron Beam Irradiation: An Innovative Process for the Treatment of Aqueous Based Organic hazardous Wastes," Journal of Environmental Science & Health, Vol.A27, No.1.

14. Kurucz, C., T. Waite, W. Cooper, and M. Nickelsen (1991). "High Energy Electron Beam Irradiation of water, Wastewater, and Sludge," Advances in Nuclear Science and Technology, Vol.22, J. Lewins and M. Becker, Editors, Plenum press.

15. Waite, T.D., W.J. Cooper, and C.N. Kurucz (1991). "Full Scale Treatment of Wastewater Effluent with High Energy Electrons," Chemistry for the Protection of the Environment, Elsevier Press, New York.

16. Al-Hoti, B., T.D. Waite, and W. Chow (1990). "Development and Calibration of a Model for Predicting Optimum Chlorination Scenarios for Biofouling Control," Water Chlornation Chemistry, Environmental Impact and health Effects," Vol.6, Lewis Publishers.

17. Platon, M., and T.D. Waite (1985). "A Predictive Model for the Destruction of Biofilms with Chlorine," Water Chlorination, Environmental Impact and Health Effects, Edited by R.L. Jolley, Ann Arbor Science Publ.

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HIGHER EDUCATION

Institutional:

University of California, Davis, Ph.D.(Civil/Environmental Engineering), 1992
Colorado State University, M.S.(Agricultural/Environmental Engineering), 1983
University of Pittsburgh, B.S.(Chemistry), 1976

Certification, Licensure:

State of Florida P.E. No. 48821

EXPERIENCE

Academic:

University of Miami, Assistant Professor, Department of Civil and Architectural Engineering, 1992-Present

Non-Academic:

Manville Corporation (Denver, CO), Research Engineer, 1983-1987
Western Filter Company (Denver, CO), Laboratory Supervisor, 1978 - 1980

PUBLICATIONS (Last 10 years)

Juried or Refereed Journal Articles:

1. Englehardt, J.D., and C. Peng (1995). "A bayesian Benefit-Risk Analysis Model Applied to the South Florida Building Code," Risk Analysis, in press.

2. Englehardt, J.D. (1995). "Predicting Incident Size from Limited Information," Journal of Environmental Engineering, Vol.121, No.6, ASCE, New York, pp.455-464.

3. Englehardt, J.D. (1994). "Identifying Promising Hazardous Waste Reduction Technologies," Journal of Environmental Engineering, Vol.120, No.3, ASCE, New York, pp.513-526.

4. Englehardt, J.D. (1993). "Pollution Prevention Technologies: A Review and Classification," Journal of Hazardous Materials, Vol.35, No.1, pp.119-150.

5. Englehart, J.D., and J.R. Lund (1992). "Information Theory in Risk Analysis," Journal of Environmental Engineering, Vol.118, No.6, ASCE, New York, pp.890-904.

6. Englehardt, J.D., and J.R. Lund (1990). "Economic Analysis of Recycling for Small Municipal Waste Collectors," Journal of Resource Management and Technology, Vol.8, No.2, pp.84-86.

7. Englehardt, J.D., and R.C. Ward (1986). "Operation and Maintenance Requirements for Small-Flow Treatment Systems," Journal Water Pollution Control Federation, Vol.58, No.10, pp.967-971.

PROFESSIONAL ORGANIZATIONS

1. Member, American Society of Civil Engineers
2. Member, Association of Environmental Engineering Professors
3. Member, Water Environment Federation

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HIGHER EDUCATION

Institutional:

Massachusetts Institute of Technology, Ph.D.(Civil/Environmental Engineering), 1995
University of Miami, M.S.(Civil Engineering), 1988
University of Miami, B.S.(Civil Engineering), 1987

EXPERIENCE

Academic:

University of Miami, Assistant Professor, Department of Civil and Architectural Engineering, 1995-Present

Non-Academic:

Hazen and Sawyer, P.C. (Miami, FL), Environmental Engineer, 1989-1990

PUBLICATIONS (Last 10 years)

Juried or Refereed Journal Articles:

1. Solo-Gabriele, H., and F.E. Perkins (1995). "Metal Transport within a Small Anthropogenically Contaminated Watershed: Part 1. Mechanisms Describing the Variability of Streamflow and Suspended Sediments," Water Resources Research, in review.

2. Solo-Gabriele, H., and F.E. Perkins (1995). "Metal Transport within a Small Anthropogenically Contaminated Watershed: Part 2. Mechanisms Describing the Variability of Metals," Water Resources Research, in review.

3. Solo-Gabriele, H., and F.E. Perkins (1995). "A Watershed-Specific Model for Streamflow, Sediment, and Metal Transport," Journal of Environmental Engineering, in review.

PROFESSIONAL ORGANIZATIONS

1. Member, American Society of Civil Engineers

2. Member, American Geophysical Union

3. Member, Water Environment Federation

4. Member, American Water Works Association

5. Member, International Association for Sediment Water Science

6. Member, Society of Women Engineers

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HIGHER EDUCATION

Institutional:

Texas Tech University, Ph.D.(Industrial Engineering), 1980
Alexandria University, M.S.(Production Engineering), 1976
Alexandria University, B.S.(Production Engineering), 1973

Certification, Licensure:

Certified Manufacturing Technologist, 1987

EXPERIENCE

Academic:

University of Miami, Professor, Department of Industrial Engineering, 1988-Present

PUBLICATIONS (Last 10 years)

Books and Monographs:

1. Asfour, S.S. (1987). "Trends in Ergonomics/Human Factors IV-A." Editor, Elsevier Science Publishers, Amsterdam, 574 pages.

2. Asfour, S.S. (1987). "Trends in Ergonomics/Human Factors IV-B." Editor, Elsevier Science Publishers, Amsterdam, 562 pages.

3. Karwowski, W., A.M. Genaidy, and S.S. Asfour (1990). "Computer Aided Ergonomics," Taylor & Francis, London, 570 pages.

Juried or Refereed Journal Articles:

1. Degani, A., S.S. Asfour, S.M. Waly, and J.G. Kosy (1993). "A Comparative Study of Two Shovel Designs," Applied Ergonomics, Vol.24, No.5, pp.306-312.

2. Boubekri, N., M.H. Schneider, and S.S. Asfour (1992). "Effects of Some Machining Variables in Lathe facing Using a Profilometer to Measure Surface Roughness," Quality Engineering, Vol.5, No.2, pp.243-253.

3. Khalil, T.M., S.S. Asfour, L.M. Martinez, S.M. Waly, R.S. Rosomoff, and H.L. Rosomoff (1992). "Streching in the Rehabilitation of Low Back Pain patients," Spine, Vol.17, No.3, pp.311-317.

4. Genaidy, A.M., S.S. Asfour, A. Mital, and S.M. Waly (1990). "Pshchophysical Models for manual Lifting Tasks," Applied Ergonomics, Vol.21, No.4, pp.295-303.

5. Asfour, S.S., S.M. Waly, and M.W. Fahmy (1991). "A Two-Dimensional Computerized Biomechanical Model," Computers in Industrial Engineering, Vol.21, No.1/4, pp.601-605.

6. Asfour, S.S., and M. Tritar (1991), "Endurance Time and Physiological Responses tp Prolonged Arm Lifting," Ergonomics, Vol.34, No.3, pp.335-342.

7. Genaidy, A.M., T.M. Khalil, S.S. Asfour, and R.C. Duncan (1990). "Human Physiological Capabilities for Prolonged Manual Lifting Tasks," IIE Transactions, Vol.22, No.3, pp.270-280.

8. Asfour, S.S., T.M. Khalil, S.M. Waly, M.L. Goldberg, R.S. Rosomoff, and H.L. Rosomoff (1990). "Biofeedback in back Muscle Strengthening," Spine, Vol.15, No.6, pp.510-513.

9. Genaidy, A.M., and S.S. Asfour (1989). "Effects of Frequency and Load of Lift on Endurance Time," Ergonomics, Vol.32, No.1, pp.51-57.

10. Abdel-Moty, E., T.M. Khalil, S.S. Asfour, R.S. Rosomoff, and H.L. Rosomoff (1988). "Functional Electrical Stimulation for the Restoration of Muscle Function in Low Back Pain Patients," Pain anagement, pp.258-263.

11. Khalil, T.M., S.S. Asfour, E. Abdel-Moty, R.N. Rosomoff, and H. Rosomoff (1988). "Ergonomics Contributions to Low Back Pain Rehabilitation," Pain Management, pp.225-230.

12. Asfour, S.S., S.M. Waly, A.M. Genaidy, and R.M. Gonzalez (1988). "Physiological Stresses Associated with Television Camera Operator Tasks," Applied Ergonomics, Vol.19, No.4, pp.275-280.

13. Genaidy, A.M., Asfour, S.S., A. Mital, and M. Tritar (1988). "Psychophysical Capacity Modeling in Frequent Manual Material Handling Activities," Human Factors, Vol.30, No.3, pp.319-337.

14. Asfour, S.S., A.M. Genaidy, and A. Mital (1988). "Physiological Guidelines for the Design of Manual Lifting and Lowering Tasks: The State of the Art," American Industrial Hygiene Association Journal, Vol.49, No.4, pp.150-160.

15. Khalil, T.M., E. Abdel-Moty, S.S. Asfour, D.A. Fishbain, R.S. Rosomoff, and H.L. Rosomoff (1988). "Functional Electric Stimulation in the Reversal of Conversion Disorder Paralysis," Archives of Physical Medicine and Rehabilitation, Vol.69, No.7, pp.545-547.

16. Kabuka, M., A.M. Genaidy, and S.S. Asfour (1988). "A Knowledge-Based System for the design of Manual Material handling," Applied Ergonomics, Vol.19, No.2, pp.147-155.

17. Khalil, T.M., S.M. Waly, A.M. Genaidy, and S.S. Asfour (1987). "Determination of lifting Abilities: A Comparative Study of Four Techniques," American Industrial Hygiene Association Journal, Vol.48, No.12, pp.951-956.

18. Genaidy, A.M., and S.S. Asfour (1987). "Review and Evaluation of Physiological Cost Prediction Models for Manual Materials Handling," Human factors, Vol.29, No.4, pp.465-476.

19. Genaidy, A.M., S.S. Asfour, and T.M. Khalil (1987). "An On-Line Microcomputer-Based Cardiac Monitoring System," International Journal of Industrial Economics, Vol.1, No.4, pp.273-283.

20. Asfour, S.S., A.M. Genaidy, and T.M. Khalil (1987). "An On-Line Microcomputer-Based Metabolic Monitoring System," International Journal of Industrial Economics, Vol.1, No.3, pp.169-177.

21. Khalil, T.M., M.L. Goldberg, S.S. Asfour, E. Moty, R.S. Rosomoff, and H.L. Rosomoff (1987). Acceptable maximum Effort (AME): A Psychophysical Measure of Strength in Back Pain Patients," Spine, Vol.12, No.4, pp.372-376.

22. Asfour, S.S., A.M. Genaidy, T.M. Khalil, and S. Muthuswamy (1986). "Physiologic Responses to Static, Dynamic and Combines Work," American Industrial hygiene Association Journal, Vol.47, No.12, pp.798-802.

23. Khalil, T.M., S.S. Asfour, S.M. Waly, L. Melean, and H.L. Rosomoff (1986). "Effects of Low Back Pain Rehabilitation Program on Muscle Functional Abilities," Journal of Biomechanics, Vol.19, No.6, pp.467.

24. Khalil, T.M., A.M. Genaidy, S.S. Asfour, and T. Vinciguerra (1985). "Physiological Limits in Lifting," American Industrial Hygiene Association Journal, Vol.46, No.4, pp.220-224.

PROFESSIONAL ORGANIZATIONS

1. Member, Ergonomics Research Society
2. Member, Human Factors Society
3. Member, International Foundation for Industrial Economics and Safety Research
4. Member, Institute of Industrial Engineers
5. Member, Society of Manufacturing Engineers

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HIGHER EDUCATION

Institutional:

Case Western Reserve University, Ph.D.(Mechanical/Aerospace Engineering), 1977
Case Western Reserve University, M.S.(Mechanical Engineering), 1975
University of Malaya, B.S.(Mechanical Engineering), 1973

Certification, Licensure:

State of Florida P.E.

EXPERIENCE

Academic:

University of Miami, Associate Professor, Department of Mechanical Engineering, 1983-Present

Non-Academic:

National Elect. Board (Malaysia), Research/Generation Planning Engineer, 1976-1979

PUBLICATIONS (Last 10 years)

Books and Monographs:

1. Wong, K.V. (1991). "Proceedings of Waste to Energy Workshop," Editor, Tallahassee, Florida.

Juried or Refereed Journal Articles:

1. Wong, K.V., and D. Guerrero (1995). "Quantitative Analysis of Shoreline Protection by Boom Arrangements," Spill Science and Technology Bulletin, Vol.2. No.1.

2. Brown, D., and K.V. Wong (1995). "A Knowledge-Based System for Residential Energy Conservation in a Sub-Tropical Climate," Computers in Education.

3. Wong, K.V., and N. Paradiso (1995). "A Decision Support System to Assist in Selecting a Chemical Oil Spill Dispersant," Computers in Education, Jan-March.

4. Wong, K.V., R. Narasimhan, R. Kashyap, and J. Fu (1994). "Medical Waste Characterization and Front-End Analysis," Journal of Environmental Health, July/August.

5. Wong, K.V., and Y. Zhu (1994). "Using a Combustion Expert System to Help Combat Oil Spills," Computers in Education, Vol.XIV, No.4.

6. Zhang, L., and K.V. Wong (1994). "Expert System for Cryogenic Piping Systems," ASHRAE Transactions, Vol.100, Part 2.

7. Miller, M., and K.V. Wong (1993). "Prediction of Vulnerable Zones for Reactive Substances," Journal of Environmental Health, October.

8. Rashid, A., and K.V. Wong (1992). "Computer-Aided Modelling of Heterogeneous, Two-Dimensional, Ground-Water System," Computers & Geosciences, Vol.18, No.9.

9. Rashid, A., and K.V. Wong (1992). "A Neural Network Approach to the Determination of Aquifer Parameters by the Type-Curve Matching Method," Journal of Ground Water, March-April.

10. Gill, G., and K.V. Wong (1991). "Passive Solar Design for Windows Using a Neural Network," ASHRAE Transactions, Vol.97, Part 2.

11. Wong, K.V., and Z. Niu (1991). "Thermodynamic Optimization of the Boiler and Turbine with Condenser," ASHRAE Transactions, Vol.97, Part 2.

12. Wong, K.V., and Z. Niu (1991). "User-Modifiable Heat Exchanger Expert System," ASHRAE Transactions, Vol.97, Part 2.

13. Wong, K.V. (1990). "Innovation in the Senior Fluids and Thermal Sciences laboratory," ASME Curriculum Innovation Paper.

14. Ferrano, F., and K.V. Wong (1990). "Prediction of Thermal Storage Loads Using a Neural Network," ASHRAE Transactions, Vol.96, Part 2.

15. Ding, Y., and K.V. Wong (1990). "Control of a Simulated Dual Temperature Hydronic System Using a Neural Network Approach," ASHRAE Transactions, Vol.96, Part 2.

16. Wong, K.V., and F. Ferrano (1990). "Availability-Based Computer Management of a Cold Thermal Storage System," ASHRAE Transactions, Vol.96, Part 1.

17. K.V. Wong (1990). "Easy Referencing in Mechanical Engineering Topics," Computers in Education, Vol.X, No.3.

18. Wong, K.V., and A. Rashid (1990). "A Mathematics Consultant for Engineering Undergraduates," Computers in Education, Vol.X, No.4.

19. Wong, K.V., and D. Houston (1988). "Software System Design for Surface water permitting," International Journal of Applied Engineering Education, Vol.4, No.3.

20. Wong, K.V. (1988). "Three shells Used for Hydrocarbon Identification in Engineering," Computers in Education, Vol.VIII, No.1.

21. Sengupta, S., K.V. Wong, N.L. Nemerow, H.P. Gerrish, E. Daly, and A. Tilles (1987). "An Environmental Characterization Study of a Proof-of-Concept Municipal Solid waste Digestion Plant: Pompano Beach, Florida," Conservation and Recycling, Vol.10, No.4, pp.281-298.

22. Wong, K.V., G. Yeh, and E. Davis (1987). "Predictive Application of a ORNL Geohydrology Model," Journal of Ground Water, Vol.25, No.3.

23. Wong, K.V., and G. yeh (1986). "Field Validation of the Contaminant Transport Model, FEMA," Journal of Applied Mathematical Modelling, Vol.3, June.

24. Wong, K.V., G. Yeh, and E. Davis (1985). "Field Validation of the Geohydrology Simulation Model FEWA," Journal of Applied Mathematical Modelling," Vol.9.

PROFESSIONAL ORGANIZATIONS

1. Member, American Society of Mechanical Engineers
2. Member, Water Environment Federation
3. Member, Air and Waste Management Association
4. Member, AIAA

CDFHI

UNIVERSITY OF Miami

FACULTY SENATE

SEP 2 0 1995

Date: September 29, 1995

To: Kamal Yacoub, Chairman
Faculty Senate

From: M. Lewis Temares, Dean
College of Engineering

Subject: New Baccalaureate Degree Program

Attached is a proposal for a new baccalaureate degree program in the College of Engineering, Bachelor of Science in Environmental Engineering. This proposal was approved unanimously by the Faculty of the College of Engineering on 27 September, 1995.

I fully endorse this proposal, including the proposed annual budget of $17,000. Please initiate the process of Faculty Senate consideration of this new degree program. In addition, because of the importance of this new degree program to the Strategic Plan of the College of Engineering, and the necessity of promoting this program in our Spring recruiting activities, I request *early approval* of this program. It is highly desirable that this program be approved in time to be published in the AY96 University Bulletin.

The new Environmental Engineering program is to be administered by the Department of Civil and Architectural Engineering, and Dr. David A. Chin is the department Chair. Please contact Dr. Chin with any questions on the proposed degree program, and for follow-up action in response to the Senate requests for any additional materials. Thank you in advance for your efforts on our behalf.

cc: Dr David A. Chin, Chairman, Department of Civil and Architectural Engineering
Dr. Samuel S. Lee, Associate Dean
Dr. Thomas D. Waite, Associate Dean for Research and Graduate Studies

Barbara,
This has been delivered to Dr. Yacoub @ ECE today. Frances

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UNIVERSITY OF Miami

FACULTY SENATE

Faculty Senate Meeting

November 27, 1995

REGULAR MEETING

The Chair called the regular session to order at 5:10 p.m. and presented the minutes of October 30, 1995 for approval. The minutes were approved as submitted. Excused absences were approved for Professors Belgrave, Chandar, Hector, Lopez-Gottardi, Malinin, Mangrum, Rogers, Schwartz, Serafini, Whelan and Zame.

Proposal for a B.S. in Environmental Engineering - (First Reading)

Professor Yacoub announced that Professor Michael Gaines, Chair of the Department of Biology and Director of the Environmental Science Program, was asked to chair the ad hoc committee to review the proposal for a B.S. in Environmental Engineering. Also serving on the committee were Professor James Nearing, Department of Physics and Professor Jerry Catz, Department of Mechanical Engineering. Professor David Chin, Chair of the Department of Civil and Architectural Engineering, presented the proposal and gave its rationale. Professor Gaines spoke about the pedagogical aspects of the program and stated that his committee recommended the proposed program. Several questions were raised about the curriculum and, following discussion, the Chair asked for a motion suggesting that a second reading of the proposal be scheduled for the January 22 meeting, provided that Professor Chin will forward a copy of the proposal to the Environmental Science Committee for comments and that he will also discuss the proposal with the appropriate faculty from the Division of Applied Marine Physics at RSMAS. The Chair's suggestion was *moved*, and seconded. The *motion carried.*

Academic Calendar for 1996-97

Dr. Yacoub explained that because of certain peculiarities in the 1996-97 calendar, Dean Orehovec's office prepared two possible versions of the academic calendar (early versus late start). At the Academic Deans' Policy Council, preference was voiced for the late start even though it has only one evening between the last final and the time grades are due. Dr. Yacoub explained that he had been working with the Registrar to find ways to extend that period to 36 hours. Following discussion of the advantages and disadvantages of the early versus the late start, it was agreed that the Dean of Enrollments will consult further with the Academic Standards Committee and the Academic Deans' Administrative Council before finalizing the 1996-97 academic calendar.

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system at the Medical School, the President explained that hardware, software and five years of operation made up the expense. The new system would allow patient billing and records to be centralized.

B.S. in Environmental Engineering Degree Program - (Second Reading)

The Chair summarized the background of the proposal for a B.S. in Environmental Engineering Degree Program. Professor David Chin, Chair of the Civil and Architectural Engineering Department, indicated that he had complied with the Senate's request to forward a copy of the proposal to the Environmental Science Steering Committee, chaired by Professor Michael Gaines. The Committee discussed the proposal and has enthusiastically endorsed it. The Senate also requested that Professor Chin receive full input from the faculty at RSMAS. Representatives from several divisions at RSMAS met with Professor Chin to discuss the proposal and it was agreed that the proposal could go forward in its present form. Professor Brown withdrew his objection to the mathematics requirement in the proposal after reviewing the curricula of competing programs around the country. Upon closer review of competing programs, Professor Brown also discovered that several of them contain a more thorough treatment of environmental science in preparation for the engineering portion of the curriculum. However, those schools required far more credits for graduation than the University of Miami. It was agreed that a faculty member from RSMAS would be appointed to an oversight committee to review the curriculum annually. It was *moved* and seconded to approve the proposal. The *motion carried unanimously*.

Budget Committee Update

The Vice Chair reported that a web page containing the *Faculty Senate Manual* is underway thanks to a computer donation by Information Resources. As Budget Committee chairman, Professor Green stated that a report will be prepared on the state of salaries at the University based on figures made available through the Provost. He also announced that the President and Provost were able to recommend an increase in faculty raises above that reported at the last Senate meeting. The recommendation adopted by the Board regarding faculty salaries was a 4 1/4% overall pool to be distributed to the deans. In addition, there is another 1/4% retained in the Provost's Office that will be made available if there are no indications of a budget shortfall. These monies will then be distributed on individual petition for special circumstances. Professor Green thanked the President and Provost for their efforts on behalf of the faculty.

UNIVERSITY OF Miami

MEMORANDUM

CDFHI

TO: Kamal Yacoub
Chair, Faculty Senate

FROM: Michael S. Gaines MSG
Chair, Department of Biology

DATE: November 2, 1995

SUBJECT: PROPOSED NEW DEGREE PROGRAM IN ENVIRONMENTAL ENGINEERING

Our committee met on November 2, 1995, to discuss the new program proposed by the School of Engineering. The committee was impressed with the thoroughness of the proposal. The proposed curriculum is similar in content to that of other Environmental Engineering Programs around the country. Our only query is why there is no computer science in the curriculum.

MSG/dw
cc: James Nearing, Dept. of Physics
Jerome Catz, Dept. of Mechanical Engineering

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UNIVERSITY OF
Miami

MEMORANDUM

DATE: 9 November, 1995

TO: Dr. Kamal Yacoub
Chair, Faculty Senate

FROM: Dr. David A. Chin, Chairman
Department of Civil & Architectural Engineering

SUBJECT: Proposed New Degree Program in Environmental Engineering

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On behalf of the faculty in the Department of Civil and Architectural Engineering I would like to thank the Ad-hoc Committee for their efforts in reviewing our BSEnE proposal. Such dedicated service to the University frequently goes unrecognized.

In response to the Committee's query regarding the lack of a computer programming/science course in the proposed curriculum, I direct your attention the attached copy of the BSEnE curriculum. In the Spring semester of the Junior year, CEN 301 (Computer Programming Applications) is a computer programming/science course. As indicated in the attached syllabus for CEN 301, Fortran Programming and Numerical Methods constitute approximately 75% of this course.

If either the Ad-hoc Committee or yourself have any further questions regarding the content of the BSEnE curriculum, please do not hesitate to contact me. I look forward to this item being taken up by the Faculty Senate on 27 November. Thanks again for your efforts.

DAC/oc
Attachments
c: Dean M. Lewis Temares, College of Engineering
Prof. Michael Gaines, Department of Biology
Prof. James Nearing, Department of Physics
Prof. Jerome Catz, Department of Mechanical Engineering

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COURSE DESCRIPTION

AEN/CEN 301 - Computer Applications in Civil / Architectural Engineering
Fall 1995

1994/1995 Catalog Data:	3 credits. Exploration and modeling of Civil/Architectural systems. Topics will include numerical analysis, constrained and unconstrained optimization, systems analysis, and software evaluation. Students will solve problems using existing packages and software developed by them. Prerequisite: MTH 211, CEN 210.
Textbooks:	Koffman, E.B. and Friedman, F.L. (1993). *FORTRAN With Engineering Applications*, 5th Edition, Addison-Wesley Publishing Company, New York. *The Student Edition of MATLAB*, Prentice Hall, Englewood Cliffs, NJ.
Coordinator:	Dr. Ahmad H. Namini, Associate Professor of Civil and Architectural Engineering, Room 320, McArthur Engineering Building
Goals:	During the course, the student will become familiar with the analytical modeling and solution of engineering problems with the aid of student-developed Fortran programs and MATLAB.
Prerequisites by Topics:	MTH 211 (Calculus III) CEN 210 (Mechanics of Solids I)

Topics:

1. Introduction (1-2 classes)
2. Fortran Programming (13-15 classes)
3. Matrix Algebra (3-4 classes)
4. Numerical Methods (13-15 classes)
5. Computer Graphics (3-4 classes)

Lab Projects: None

Computer Usage: Extensive use of Fortran compiler and MATLAB.

Grading Policy:

Examination #1	25%
Examination #2	25%
Computer Assignments	50%

For Distribution to All Senators

SELECTED PORTIONS OF

A Proposal for a New Degree Program: Bachelor of Science in Environmental Engineering

Department of Civil and Architectural Engineering

Contents

Executive Summary

The Department of Civil and Architectural Engineering is proposing the establishment of a baccalaureate program in environmental engineering. This program fits in well with the depth of faculty resources and infrastructure that exist within the College of Engineering.

In 1992, the Department of Civil and Architectural Engineering established an environmental option within the baccalaureate program in Civil Engineering. This option has been very successful in attracting about 10 - 15 students per year since 1992. As a result of the demonstrated popularity of environmental engineering at the University of Miami, and the relatively small cost of changing from an environmental engineering option to a free-standing environmental engineering degree, the Department of Civil and Architectural Engineering is proposing the establishment of a baccalaureate program in environmental engineering. Many of the students currently enrolled in the environmental engineering option of the Civil Engineering program have expressed a preference for a baccalaureate degree in environmental engineering and we infer that, by establishing this program, potential students who are presently choosing not to attend the University of Miami because they are interested primarily in an environmental engineering degree will now have the opportunity to study at the University of Miami.

Accreditation is a central issue in any engineering program, since most States require graduation from an accredited program as a prerequisite for registration (licensure) as a professional engineer. Reviews of the accreditation criteria that apply to the proposed environmental engineering degree program, and the curricula of all accredited environmental engineering programs in the United states are presented in this proposal.

The curriculum for the baccalaureate program in environmental engineering has been designed on the basis of the accreditation requirements for environmental engineering programs, the curricular content of existing accredited environmental programs in the United States, a review of related courses at the University of Miami, and our own vision of the educational content of a modern environmental engineering program.

Institution of a baccalaureate program in environmental engineering is expected to cost the University a modest $20,000 per year in increased operational costs. This cost is primarily associated with the need to add a new course in air pollution, a part-time technician in the environmental engineering laboratory, and the recurring cost of technical supplies generated by increased laboratory usage. We expect that these marginal costs will be more than offset by the increased revenue generated by increased student enrollment. In fact, the break-even point seems to be an incremental enrollment of only two students into the program. Given that there are presently only nine accredited baccalaureate environmental engineering programs in the United States, and the unfulfilled demand for environmental engineering professionals in society, we have no doubt that the incremental costs of this program will be more than offset by increased revenues from *new* student enrollment.

1 Introduction

1.1 Global Perspective

The American Academy of Environmental Engineers (AAEE) is the lead society for the accreditation of environmental engineering programs in the United States, and they define environmental engineering as "...the application of engineering principles to the management of the environment for the protection of human health; for the protection of nature's beneficial ecosystems and for environment related enhancement of the quality of human life."

The modern field of environmental engineering evolved from the field of sanitary engineering, which was concerned primarily with the design and analysis of water and wastewater systems. The name-change ocurred during the late 1960's [7]. Today, environmental engineering is one of the most popular specialties in the civil engineering profession, and it is not uncommon to poll undergraduate civil engineering students and find over 50% with a primary interest in environmental engineering. These students often want a degree that is a combination of water-related engineering and environmental science [8].

The rapidly increasing knowledge base required to specialize in environmental engineering is driving the evolution of environmental engineering as a separate discipline. This evolution is currently being accomodated by graduate programs, which tend to offer relatively elementary courses in the environmental field, and have resulted in a master's degree being the basic degree requirement to practice environmental engineering. Most master's degree programs in environmental engineering are within the civil engineering discipline, although there are some within the mechanical and chemical engineering disciplines [6]. Civil engineers primarily focus on the design of water distribution and sewer systems, mechanical engineers tend to focus on air pollution, and chemical engineers tend to focus on the reduction of wastes generated by industrial facilities.

With the emergence of new baccalaureate programs in environmental engineering, some practitioners see this as an opportunity to elevate environmental engineering graduate courses to levels that are more state-of-the-art than are presently feasible, given the level of preparation of entering graduate students from traditional disciplines [5]. The sub-disciplines (i.e. professional fields) within environmental engineering are recognized to be: air quality, water quality, solid waste management, and industrial hygiene [7]. Within these sub-disciplines are such multi-media specialty areas as hazardous waste management and wastewater engineering.

Combined with the strong demand in the marketplace for environmental engineers, it has been suggested [1] that the strongest argument in favor of increased environmental engineering undergraduate education is that the great majority (approximately 95%) of the B.S. level engineers in the United States are being educated in fields that do not provide a good foundation for further development, through education or practice, in the environmental engineering field. This concern is particularly relevant since the National Council of Examiners for Engineering (NCEE) has recently introduced (1993) a separate Environmental Engineering examination for registration as a professional engineer, which in effect recognizes environmental engineering as a separate discipline. Clearly, the baccalaureate degree in environmental engineering will ultimately become the primary professional degree for becoming licensed as a practicing environmental engineer.

There seems to be little doubt that graduates with baccalaureate degrees in environmental engineering will have ample job opportunities [1, 5]. In fact, there are indications that unprecedented demand for environmental engineers in the 1990s and beyond is causing many universities to increase the curricular presence of environmental engineering at the baccalaureate level [1].

dicate that an independent free-standing environmental engineering program is viable, and, besides attracting the current pool of students who are also interested in civil engineering, this program will additionally attract those students that are interested only in environmental engineering. Informal polls of students currently in the environmental engineering option show that there is almost unanimous support for the development of a baccalaureate program in environmental engineering. The proposed environmental engineering program will also be attractive for transfer students from engineering programs at junior colleges, with the environmental engineering degree requiring approximately two years of additional study.

The issue of accreditation for any new engineering program is critical, since engineers cannot be licensed unless they are graduates from an accredited engineering program. This consideration must somehow be accomodated within the reality that engineering programs are not permitted to request accreditation unless they have produced graduates. We realize that it would not be responsible to admit students to a program that is not accredited, since this would limit their professional opportunities, therefore we are proposing that in the interim period between the environmental engineering baccalaureate program being adopted by the University and being put up for accreditation, we will encourage students to do a dual-degree program in which they will be granted baccalaureate degrees in both civil engineering and environmental engineering in nine semesters, compared with the eight semesters that it takes to do these degree programs separately. Students in this dual-degree track will have a fully accredited civil engineering degree and can become licensed professionals. After approximately three graduating classes, the environmental engineering baccalaureate program will be put up for accreditation, and then subsequent classes will be encouraged to pursue this degree as a separate track.

2 Program Requirements for Accreditation

Engineering programs in the United States are accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET), and many states require graduation from an accredited engineering program as a prerequisite for becoming a licensed professional engineer.

Environmental Engineering programs are accredited at either the Basic Level (undergraduate) or Advanced Level (graduate), however, the Engineering Dean's Council opposes dual accreditation of both undergraduate and graduate programs [5]. Currently, most graduate environmental engineering programs are not accredited, and accreditation has been mostly sought at the undergraduate level. The criteria for ABET accreditation fall into two categories: general criteria and program-specific criteria; and all accredited programs must meet both sets of criteria. These criteria for ABET accreditation of all engineering programs in the United States are published annually by ABET. The latest requirements may be found in [2, 3].

2.1 General Criteria

The general criteria for accreditation of undergraduate programs fall within the following categories: (1) Faculty; (2) Curricular Objective; (3) Curricular Content; (4) Student Body; (5) Administration; (6) Institutional Facilities; and (7) Institutional Commitment. The salient features of these requirements are described in the following sections.

advanced chemistry or physics may be used to satisfy the basic science requirement, as appropriate for various engineering disciplines.

Courses in engineering topics include subjects in the engineering sciences and engineering design. Engineering sciences have their roots in mathematics and basic sciences, but carry knowledge further towards creative application. Such subjects include: mechanics, thermodynamics, electrical and electronic circuits, materials science, transport phenomena, and computer science (other than computer programming skills). Engineering design is the process of devising a system, component, or process to meet desired needs. The engineering design component of a curriculum must include the following features: development of student creativity, use of open-ended problems, development and use of modern design theory and methodology, formulation of design problem statements and specifications, consideration of alternative solutions, feasibility considerations, production processes, concurrent engineering design, and detailed system descriptions. It is also essential to include a variety of realistic constraints, such as economic factors, safety, reliability, aesthetics, ethics, and social impact.

Courses in the humanities are concerned with man and his culture, while courses in the social sciences are concerned with individual relationships in and to society. Examples of traditional subjects in these areas are: philosophy, religions, history, literature, fine arts, sociology, psychology, political science, anthropology, economics, and languages other than English or a student's native language. The humanities and social science courses contained within an engineering program must provide both breadth and depth, and not limited to the selection of unrelated introductory courses.

Besides meeting the course requirements in mathematics, basic sciences, engineering topics, social sciences, and humanities, each educational program must include a meaningful, major engineering design experience that builds upon the fundamental concepts covered in these courses. Furthermore, each program must have an appropriate amount of laboratory experience such that the students develop a competence to conduct hands-on experimental work such as that expected of engineers in the discipline represented by the program. All engineering programs must have an appropriate amount of computer-based experience, evidenced by a knowledge of the application and use of digital-computation techniques for specific engineering problems.

2.1.4 Student Body

Student body criteria relate to the admission, retention, and scholastic work of students, and the records of graduates both in further académic study and in professional practice.

2.1.5 Administration

Administration criteria relate to the attitude and policy of the administration of the College of Engineering toward teaching, research, and scholarly production, and the quality of leadership at all levels of administration of the College.

2.1.6 Institutional Facilities

Institutional facilities criteria state that an engineering program must be supported by adequate physical facilities, including office and classroom space, laboratories, and shop facilities suitable for the scope of the program's activities. Other criteria relate to library and computer facilities.

4 University of Miami BSEnE Curriculum

4.1 Course Requirements

The University of Miami BSEnE program was developed by considering: (a) the curricular content of existing ABET accredited environmental engineering programs; (b) the courses currently available and being offered at the University of Miami; and (c) our vision of the responsibilities and challenges facing an environmental engineer in the 21^{st} century.

The curricula of accredited environmental engineering programs in the United States have been reviewed in the previous section, and the common course contents identified. On reviewing the environmental courses currently available at the University of Miami, we find that most of the key environmental engineering courses are currently being offered within the Department of Civil and Architectural Engineering, primarily as part of the environmental engineering option in civil engineering. Other courses that are basic to any environmental engineering program are found principally in the Department of Mechanical Engineering (air pollution and related courses), Department of Industrial Engineering (industrial hygiene and related courses), and the Departments of Chemistry and Biology. The consensus of the group that developed the environmental engineering curriculum is that, except for a single course in air pollution that needs to be developed, there are sufficient courses already existing and being offered at the University of Miami to constitute an accreditable and relevant environmental engineering program.

An important issue that was addressed in developing our environmental engineering program was the issue that a newly created environmental engineering program will not be accredited until there are graduates from the program, and that practicing engineers cannot be licensed unless they are graduates from an accredited engineering program. This will create a problem for the initial environmental engineering graduates who complete the program prior to accreditation. We have addressed this issue by proposing, and recommending, a dual degree program in Environmental Engineering and Civil Engineering in which students complete the requirements for both degrees in nine semesters, compared with the eight semesters required for each degree. Clearly, students will have the option of choosing to pursue these degrees individually, accreditation requirements notwithstanding.

4.2 Admission Requirements

Admission to the environmental engineering program is the same as for all other programs at the University of Miami. According to the University of Miami Bulletin, the Committee on Admission bases its decision as to the admission of applicants upon evidence that they have the qualifications deemed necessary for academic success at the University of Miami. Principal factors in the admission decisions are: (1) secondary school record; (2) scholastic assessment test (SAT), scholastic assment test I (SAT I), and american college testing program (ACT); (3) counselor's evaluation form; and (4) an essay. Although specific criteria are not given for such measures as high school grade-point-averages and SAT scores, the College of Engineering has, on average, admitted students with the highest average SAT scores at the University. Based on our experience with these students in our existing engineering programs, we would expect that the pool of students attracted to our environmental engineering engineering program will be similarly qualified and perform adequately. A similar statement can be made regarding the quality and performance of transfer students, where it is the policy of the University that only courses passed with a grade of C or better at an accredited

Bachelor of Science in Environmental Engineering

Freshman Year

Fall Semester			Spring Semester		
CEN 101	Intro. to Civil/Env. Engrg.	1	CHM 112	Principles of Chemistry II	4
CHM 111	Principles of Chemistry I	4	ARC 191	Architectural Graphics	3
ENG 105	English Composition I	3	ENG 107	Writing About Science	3
MTH 110	Calculus I	5	MTH 112	Calculus II	4
SS/H/A Elective		3	PHY 205	Physics I	3
		16			17

Sophomore Year

Fall Semester			Spring Semester		
CEN 210	Mechanics of Solids I	3	CEN 211	Mechanics of Solids II	3
CEN 350	Transportation Engineering I	3	CEN 212	Structural Lab	1
MTH 211	Calculus III	3	EEN 205	Electrical Engineering I	3
PHY 206	Physics II	3	MTH 311	Ordinary Differential Equations	3
PHY 208	Physics Lab I	1	PHY 207	Physics III	3
SS/H/A Elective		3	PHY 209	Physics Lab II	1
		16	IEN 311	Probability and Statistics	3
					17

Junior Year

Fall Semester			Spring Semester		
CEN 330	Fluid Mechanics	3	CEN 301	Computer Applications	3
CEN 340	Intro. to Environmental Engrg.	3	CEN 430	Water Resources Engineering	3
CEN 345	Water and Waste Analysis	3	CEN 440	Des. Water Qual. Control Sys.	3
MEN 303	Thermodynamics I	3	Basic Science Elective		3
IEN 351	Industrial Safety Engrg.	3	SS/H/A Elective		3
		15			15

Senior Year

Fall Semester			Spring Semester		
CEN 481	Design Project I	1	MEN 520	Air Pollution	3
CEN 540	Environmental Chemistry	3	ENE Elective		3
CEN 541	Pub. Hlth. & Env. Microbiology	3	ENE Elective		3
CEN 543	Solid and Haz. Waste Engrg.	3	CEN 482	Design Project II	2
SS/H/A Elective		3	CEN 402	Professionalism and Ethics	3
SS/H/A Elective		3	SS/H/A Elective		3
		16			17

Figure 10: Environmental Engineering Curriculum

To support these courses are a laboratory course in Water and Wastewater Analysis (CEN 345), and a variety of applied science courses such as Environmental Chemistry (CEN 540), Public Health and Environmental Microbiology (CEN 541). Students in the BSEnE program will have the flexibility to choose two elective courses in environmental engineerng and one Basic Science elective from the lists shown in Figure 11. These electives will permit the student to take advanced courses in either water and wastewater engineering (CEN 530, CEN 531, CEN 532), industrial hygiene (IEN 558, IEN 559), air quality control (MEN 521), or remote sensing and solar energy utilization (MEN 510, MEN 530). The list of basic science electives will provide the student an opportunity of more in-depth study in biology, chemistry, and the earth sciences, depending on the interests of the student. The proposed BSEnE curriculum will require 129 credits for graduation, which is fairly typical of other accredited programs in the College of Engineering. The semester-credit requirements for the proposed BSEnE program are compared with the requirements of other BSEnE programs in Table 6. Based on these data, it is clear that the credit requirements for the proposed BSEnE

Table 6: Semester-Credit Requirements of BSEnE Programs

School	Semester-Credits
Cal Poly	140
Northwestern	144
Univ. of Florida	130
Michigan Tech	131
Univ. of Central Florida	132
Montana Tech	145
New Mexico Tech	138
Syracuse	131
RPI	134

degree program are commensurate with the requirements of most accredited BSEnE programs in the United States.

In the initial stages of implementing the environmental engineering program, students will be encouraged to pursue a dual degree program in civil engineering and environmental engineering. When the environmental engineering program is accredited, then pursuit of an individual environmental engineering degree will also be encouraged. This approach is dictated by the requirement that graduation from an accredited degree program is a prerequisite for registration as a professional engineer. The following additional courses must be taken by students in the Environmental Engineering program to satisfy the requirements of the Civil Engineering program: Structural Analysis (CEN 310), Concrete Structures (CEN 320), Steel Structures (CEN 321), Geotechnical Engineering I & II (CEN 370,CEN 470), Geotechnical Engineering Lab (CEN 371), and Transportation Engineering II (CEN 450). These courses amount to 19 credits, and therefore the curricula of both the Civil Engineering and Environmental Engineering programs can be covered in nine semesters, compared with the eight semesters required to complete these programs individually.

4.6 Resources Required

All of the courses in the environmental engineering curriculum, with the exception of a course in air pollution control, are presently being offered on a regular basis. Consequently, the faculty

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1.2 Local Perspective

The University of Miami does not currently offer any degrees in environmental engineering, however there are two programs in the College of Engineering that offer options in environmental engineering. Environmental options are offered within the baccalaureate programs in Mechanical Engineering and Civil Engineering. Within the Mechanical Engineering program, the environmental option is not a popular high-profile track, say on par with the aerospace option in Mechanical Engineering and, unlike the aerospace option, students are not enrolled and mentored in the environmental option from the time they are freshmen. The situation is much different in the Civil Engineering program, where the environmental option is a popular high-profile option in which students are enrolled and mentored from the time they are freshmen. The environmental option in Civil Engineering as a separate track was adopted by the Department of Civil and Architectural Engineering in 1992, and immediately began enrolling students. A few students that were already in the general civil engineering program chose to switch immediately to the the environmental engineering track, however, the majority of growth in this option has been from new incoming freshmen. The enrollment in the environmental engineering option over the last five years, as well as the enrollment in the general civil engineering program is shown in Table 1. This table clearly

Table 1: Enrollment Trends

Year	Environmental Engrg.	General Civil Engrg.
1990	0	105
1991	0	104
1992	3	92
1993	10	81
1994	20	75
1995 est.	30	80

demonstrates the increasing popularity of the existing environmental engineering option in civil engineering. A superficial look at Table 1 would support the hypothesis that the pool of students enrolled in the environmental engineering option are being drawn from the civil engineering pool, and therefore do not reflect a new pool of students. However, given the new-student enrollment per year in the civil engineering program during the 1990-1994 period, shown in Table 2, and noting

Table 2: New Student Enrollment

Year	Civil Engrg. (non-environmental)
1990	26
1991	46
1992	57
1993	43
1994	49

that the environmental engineering enrollment has come almost entirely from new freshmen, then these data indicate that the environmental engineering option is not growing at the expense of the civil engineering program.

The growth of the environmental option demonstrated by the enrollment figures in Table 1 in-

dicate that an independent free-standing environmental engineering program is viable, and, besides attracting the current pool of students who are also interested in civil engineering, this program will additionally attract those students that are interested only in environmental engineering. Informal polls of students currently in the environmental engineering option show that there is almost unanimous support for the development of a baccalaureate program in environmental engineering. The proposed environmental engineering program will also be attractive for transfer students from engineering programs at junior colleges, with the environmental engineering degree requiring approximately two years of additional study.

The issue of accreditation for any new engineering program is critical, since engineers cannot be licensed unless they are graduates from an accredited engineering program. This consideration must somehow be accomodated within the reality that engineering programs are not permitted to request accreditation unless they have produced graduates. We realize that it would not be responsible to admit students to a program that is not accredited, since this would limit their professional opportunities, therefore we are proposing that in the interim period between the environmental engineering baccalaureate program being adopted by the University and being put up for accreditation, we will encourage students to do a dual-degree program in which they will be granted baccalaureate degrees in both civil engineering and environmental engineering in nine semesters, compared with the eight semesters that it takes to do these degree programs separately. Students in this dual-degree track will have a fully accredited civil engineering degree and can become licensed professionals. After approximately three graduating classes, the environmental engineering baccalaureate program will be put up for accreditation, and then subsequent classes will be encouraged to pursue this degree as a separate track.

2 Program Requirements for Accreditation

Engineering programs in the United States are accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET), and many states require graduation from an accredited engineering program as a prerequisite for becoming a licensed professional engineer.

Environmental Engineering programs are accredited at either the Basic Level (undergraduate) or Advanced Level (graduate), however, the Engineering Dean's Council opposes dual accreditation of both undergraduate and graduate programs [5]. Currently, most graduate environmental engineering programs are not accredited, and accreditation has been mostly sought at the undergraduate level. The criteria for ABET accreditation fall into two categories: general criteria and program-specific criteria; and all accredited programs must meet both sets of criteria. These criteria for ABET accreditation of all engineering programs in the United States are published annually by ABET. The latest requirements may be found in [2, 3].

2.1 General Criteria

The general criteria for accreditation of undergraduate programs fall within the following categories: (1) Faculty; (2) Curricular Objective; (3) Curricular Content; (4) Student Body; (5) Administration; (6) Institutional Facilities; and (7) Institutional Commitment. The salient features of these requirements are described in the following sections.

2.1.1 Faculty

ABET requires that an undergraduate engineering program have no fewer than three full-time-equivalent faculty members. These faculty members must be able to demonstrate professional competence by a variety of means, such as a reputable publication record, and registration as a professional engineer.

2.1.2 Curricular Objective

The curricular objective criteria relate to the extent to which a program develops the ability to apply pertinent knowledge to the practice of engineering in an effective an professional manner. Specific objectives required by ABET are the development of:

1. The capability to delineate and solve in a practical way the problems of society that are suseptible to engineering treatment;
2. A sensitivity to the socially-related technical problems which confront the profession;
3. An understanding of the ethical characteristics of the engineering profession and practice;
4. An understanding of the engineer's responsibility to protect both occupational and public health and safety; and
5. The ability to maintain professional competence through life-long learning.

These objectives are normally met by embedding these objectives within the program curricula, or by providing specific courses fulfill these objectives.

2.1.3 Curricular Content

The curricular content required of all engineering programs is divided into the following three areas: (1) Mathematics and Basic Science; (2) Engineering Topics; and (3) Humanities and Social Sciences. The minimum requirements in these subject areas, in terms of semester credit hours, are given in Table 3. Besides fulfilling these numerical guidelines, programs must provide an integrated

Table 3: General ABET Course Requirements for Engineering Programs

Subject Type	Semester Credits Required
Mathematics and Basic Sciences	32
Engineering Topics (Science and Design)	48
Humanities and Social Sciences	16

experience aimed at preparing the graduate to function as an engineer.

Courses in mathematics must include differential and integral calculus, and differential equations. Additional work is encouraged in one or more of the subjects of probability and statistics, linear algebra, numerical analysis, and advanced calculus. Courses in the basic sciences must include general chemistry and calculus-based general physics, with at least a two-semester (or equivalent) sequence of study in either area. Additional work in life sciences, earth sciences, and

advances chemistry or physics may be used to satisfy the basic science requirement, as appropriate for various engineering disciplines.

Courses in engineering topics include subjects in the engineering sciences and engineering design. Engineering sciences have their roots in mathematics and basic sciences, but carry knowledge further towards creative application. Such subjects include: mechanics, thermodynamics, electrical and electronic circuits, materials science, transport phenomena, and computer science (other than computer programming skills). Engineering design is the process of devising a system, component, or process to meet desired needs. The engineering design component of a curriculum must include the following features: development of student creativity, use of open-ended problems, development and use of modern design theory and methodology, formulation of design problem statements and specifications, consideration of alternative solutions, feasibility considerations, production processes, concurrent engineering design, and detailed system descriptions. It is also essential to include a variety of realistic constraints, such as economic factors, safety, reliability, aesthetics, ethics, and social impact.

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2.1.4 Student Body

Student body criteria relate to the admission, retention, and scholastic work of students, and the records of graduates both in further academic study and in professional practice.

2.1.5 Administration

Administration criteria relate to the attitude and policy of the administration of the College of Engineering toward teaching, research, and scholarly production, and the quality of leadership at all levels of administration of the College.

2.1.6 Institutional Facilities

Institutional facilities criteria state that an engineering program must be supported by adequate physical facilities, including office and classroom space, laboratories, and shop facilities suitable for the scope of the program's activities. Other criteria relate to library and computer facilities.

2.1.7 Institutional Commitment

Institutional commitment criteria relate to the commitment of the institution, both financially and philosophically, to the engineering program. This commitment is evidenced by the relationship of the College of Engineering to the institution as a whole, by the fiscal policy toward and the financial resources available to the College of Engineering, and by the suitability of facilities including laboratories, libraries, and computer facilities.

2.2 Program Criteria

Program-specific criteria are requirements for specific programs that take precedence over general program requirements. For each specific engineering program, there is a lead professional society that is responsible for developing the program-specific requirements. The American Academy of Environmental Engineers (AAEE), sponsored by twelve professional societies including ASCE, is the lead society in ABET accreditation of Environmental Engineering programs. Program-specific accreditation criteria for Environmental Engineering programs are in the areas of: (a) faculty qualifications; and (b) curriculum. These requirements are described in the following sections.

2.2.1 Faculty Qualifications

Program-specific criteria for environmental engineering requires that the majority of the engineering members of the environmental engineering faculty should be registered (licensed) professional engineers or should be Engineers-in-Training.

2.2.2 Curriculum

ABET currently requires that, as a minimum, at least two areas of environmental engineering must be provided in the curriculum from amoung the following four areas [2]:

- air pollution control engineering
- water and wastewater engineering
- solid and hazardous wastes engineering
- environmental and occupational health engineering

Regarding the engineering design component of the curriculum, a minimum of one-half year of engineering design is required, and design courses in the environmental engineering program should emphasize an integrated approach that considers all environmental media in the prevention and control of environmental problems. System and facility operation and maintenance should be stressed in design courses.

Regarding the laboratory experience in the environmental engineering curriculum, ABET requires that environmental engineering laboratories provide a relevant experience in the physical, chemical, and biological sciences. This experience should also include applications to processes utilized in environmental engineering.

3 Accredited BSEnE Programs in the United States

There are presently nine ABET accredited baccalaureate degrees titled Environmental Engineering [2], these programs are available at the following universities:

- California Polytechnic State University, San Luis Obispo (Cal Poly)
- Northwestern University (Northwestern)
- University of Florida (UF)
- Michigan Technological University (Michigan Tech)
- University of Central Florida (UCF)
- Montana College of Mineral Science and Technology (Montana Tech)
- New Mexico Institute of Mining and Technology (New Mexico Tech)
- Syracuse University (Syracuse)
- Rensselaer Polytechnic Institute (RPI)

It is noteworthy that the programs at the last two Universities were accredited for the first time between 1992 and 1994.

3.1 California Polytechnic State University (Cal Poly)

At Cal Poly the Environmental Engineering program is administered in the Department of Civil and Environmental Engineering, and the BSEnE curriculum is shown in Figure 1. Cal Poly is or the quarter system, and the environmental engineering program requires 210 quarter credits, which is roughly equivalent to 140 semester credits. According to the 1994-97 Catalog, the enrollment in the BSEnE program in Fall 1993 was 276 students.

3.2 Northwestern University

At Northwestern University the Environmental Engineering program is an interdisciplinary program that is administered by a faculty coordinator in the Robert R. McCormick School of Engineering and Applied Science. The BSEnE curriculum at Northwestern is shown in Figure 2. The requirement for the BSEnE degree consists of 48 courses, and since credits are not assigned to the courses, the semester-credit equivalent to this curriculum is not clear. However, assuming three credits per course, this curriculum is probably on the order of 144 semester credits.

3.3 University of Florida

All engineering students at the University of Florida spend their first two years assigned to the College of Engineering Lower-Division program. During these two years, engineering students take courses that are common to all disciplines. After completing the Lower Division program, students apply to the various engineering degree programs in the College. At the University of Florida the Environmental Engineering program is administered by the Department of Environmental Engineering Sciences. The BSEnE curriculum at the University of Florida is shown in Figure 3. The requirement for the BSEnE degree is 130 semester credits.

California Polytechnic State University (Cal Poly)

	Credits	Total
Mathematics and Basic Sciences		55
Calculus	16	
Differential Equations	4	
Statistical Methods for Engineers	3	
General Chemistry	12	
Survey of Organic Chemistry	4	
General Physics	12	
Physiology and Biological Adaptation	4	
Engineering Topics		102
Applied Descriptive Geometry	2	
Civil Engineering Fundamentals II	2	
Digital Computer Applications	2	
Engineering Statics	3	
Engineering Dynamics	3	
Strength of Materials	5	
Thermodynamics	3	
Heat Transfer	3	
Electric Circuit Theory	3	
Electric Circuit Laboratory	1	
Fundamentals of Transportation Engineering	4	
Fluid Mechanics	3	
Introduction to Environmental Engineering	3	
Water Resources Engineering	4	
Hydraulic Systems Engineering	3	
Hydraulics Laboratory	1	
Groundwater Hydraulics and Hydrology	3	
Water and Wastewater Treatment Design	3	
Water Quality Measurements	2	
Geotechnical Engineering	4	
Thermodynamics of Processes	3	
Mass Transfer Operations	3	
Advanced System Design	3	
Noise and Vibration Control	3	
Automatic Process Control	2	
Environmental Air Quality	3	
Air Quality Measurements	3	
Air Pollution Control	3	
Introduction to Hazardous Waster Management	3	
Solid Waste Management	3	
Senior Project	4	
Technical Electives	12	
Humanities and Social Sciences		53
Writing: Exposition	4	
Professional Writing	4	
Critical Thinking	3	
Critical Reading Electives	6	
Principles of Economics	3	
American and California Government	3	
History of American Ideals and Institutions	3	
Public Speaking	3	
Philosophical Classics	3	
General Psychology	3	
Modern World History	3	
Electives	15	
Total Program		210

Figure 1: BSEnE Curriculum at Cal Poly, San Luis Obispo

Northwestern University

	Courses	Total
Mathematics and Basic Sciences		13
Calculus	3	
Multiple Integration and Vector Calculus	1	
Sequences & Sreies, Linear Algebra	1	
Elementary Differential Equations	1	
General Chemistry	1	
General Inorganic Chemistry	1	
Organic Chemistry	1	
Kinetics & Spectroscopy	1	
General Physical Chemistry	1	
General Physics	2	
Engineering Topics		26
Mechanics	1	
Thermodynamics	2	
Statistics	1	
Fluid Mechanics I	1	
Electrical Science or Material Science	1	
Systems Engrg. & Analysis or Computer Sci.	1	
Computer Programming	1	
Sanitary Engineering	1	
Chemistry of the Aquatic Environment	1	
Environmental Inpact Evaluation	1	
Environmental Biology	1	
Public Health Engineering	1	
Community Air Pollution	1	
Radiation Health	1	
Engineering Design Course	1	
Engineering Value Analysis	1	
Technical Electives	4	
Unrestricted Electives	5	
Humanities and Social Sciences		9
Social Sciences/Humanities/Communications	9	
Total Program		48

Figure 2: BSEnE Curriculum at Northwestern University

University of Florida

	Credits	Total
Mathematics and Basic Sciences		34
Analytic Geometry and Calculus	12	
Elementary Differential Equations	3	
Engineering Statistics	3	
General Chemistry	8	
Physics with Calculus	8	
Engineering Topics		72
Computer Programming for Engineers	2	
Computational Methods in Environmental Engrg.	3	
Computer-Assisted Drafting and Design	3	
Engineering Mechanics- Statics	3	
Engineering Mechanics- Dynamics	2	
Materials 1	3	
Elements of Electrical Engineering	3	
Thermodynamics	3	
Hydrodynamics	4	
Hydraulic Systems Design	3	
Water and Wastewater 1	3	
Water and Wastewater 2	3	
Environmental Biology 1	2	
Environmental Biology 2	2	
Environmental Biology Laboratory	1	
Environmental Chemistry of Carbon Compounds	2	
Introduction to Water Chemistry	3	
Elements of Atmospheric Pollution	3	
Air Pollution Control Design	3	
Solid Waste Management	3	
Hazardous Waste Control	3	
Environmental Resources Management	2	
Undergraduate Seminar	1	
Technical Electives	12	
Humanities and Social Sciences		24
Composition	6	
Literature and the Arts	6	
Historical and Philosophical Studies	6	
Social and Behavioral Sciences	6	
Total Program		130

Figure 3: BSEnE Curriculum at University of Florida

Table 4: Growth of BSEnE Program at Michigan Tech

Year	BSEnE Enrollment	BSCE Enrollment
1985	-	407
1986	17	350
1987	32	364
1988	54	395
1989	83	408
1990	137	490
1991	?	440
1992	308	550
1993	?	?
1994	314	505 (est.)

3.4 Michigan Technological University

Michigan Technological University (Michigan Tech) is a state university located in Houghton, Michigan. At Michigan Tech the Environmental Engineering program is administered by the Department of Civil and Environmental Engineering. The program began in 1986 and the growth in enrollment is shown in Table 4. The BSEnE curriculum at Michigan Tech is shown in Figure 4. The requirement for the BSEnE degree is 196 quarter credits, which is equivalent to approximately 131 semester credits. Enrollment in the BSEnE program as of Fall 1993 was 300 students.

3.5 University of Central Florida

At the University of Central Florida (UCF) the Environmental Engineering program is administered by the Department of Civil and Environmental Engineering. The BSEnE curriculum at UCF is shown in Figure 5. The requirement for the BSEnE degree is 132 credits.

3.6 Montana College of Mineral Science and Technology

At the Montana College of Mineral Science and Technology (Montana Tech), the Environmental Engineering program is administered in the College by an Associate Dean of Environmental Engineering and Natural Sciences. The BSEnE curriculum at Montana Tech is shown in Figure 6. The requirement for the BSEnE degree is 145 credits.

3.7 New Mexico Institute of Mining and Technology

At the New Mexico Institute of Mining and Technology (New Mexico Tech), the Environmental Engineering program is administered by the Department of Mineral and Environmental Engineering. The BSEnE curriculum at New Mexico Tech is shown in Figure 7. The requirement for the BSEnE defree is 138 credits.

3.8 Syracuse University

At Syracuse University the Environmental Engineering program is administered by a Program Director in the College of Engineering. The Program is not assigned to any particular Department.

Michigan Technological University

	Credits	Total
Mathematics and Basic Sciences		63
Calculus and Analytic Geometry	20	
Introduction to Ordinary Differential Equations	3	
Introductory Statistics with Calculus	3	
General Chemistry	8	
General Chemistry Laboratory	2	
Organic Chemistry: An Overview	4	
General Physics	10	
General Biology I	4	
Basic Science and Mathematics Electives	9	
Engineering Topics		80
Civil Engineering II	3	
Engineering Graphics Using CAD	2	
Elements of Electric Circuits	4	
Statics	4	
Dynamics I	4	
Mechanics of Materials I	4	
Surveying I	4	
Introductory Thermodynamics	3	
Introduction to Environmental Engineering	4	
Hydromechanics	5	
Water and Wastewater Treatment	4	
Hydrology I or Hydrogeology	3	
Environmental and Water Chemistry	4	
Environmental Impact and Protection	3	
Water Distribution and Wastewater Collection	3	
Environmental Microbiology	4	
Solid Waste Management	3	
Industrial Health	2	
Emissions and Air Pollution	3	
Engineering Science and Design Electives	14	
Humanities and Social Sciences		42
Communications	12	
Humanities Electives	9	
Social Sciences Electives	12	
Upper-Division Thematic Studies	9	
Other		11
Physical Education Electives	4	
General Electives	7	
Total Program		196

Figure 4: BSEnE Curriculum at Michigan Technological University

University of Central Florida

	Credits	Total
Mathematics and Basic Sciences		35
Calculus	12	
Differential Equations	3	
Probability and Statistics for Engineers	3	
Physics for Engineers and Scientists & Lab	7	
Chemistry Fundamentals & Lab	7	
Earth Science Elective	3	
Engineering Topics		70
Statics	3	
Dynamics	3	
Mechanics of Materials	3	
Principles of Electrical Engineering	3	
Thermodynamics	3	
Materials	3	
Engineering Economics	2	
Engineering Administration	3	
Engineering and the Environment	3	
Fluid Mechanics	3	
Hydrology	3	
Hydraulics	3	
Chemical Processes	3	
Biological Processes	3	
Process Design	3	
Air Pollution	3	
Solid and Hazardous Waste	3	
Technical Elective	11	
Design Elective	9	
Humanities and Social Sciences		27
English Composition	6	
Social Science	3	
Economics	3	
Humanities/History	6	
Oral Communication	3	
Humanities Elective	3	
American Government	3	
Total Program		132

Figure 5: BSEnE Curriculum at University of Central Florida

Montana College of Mineral Science & Technology (Montana Tech)

	Credits	Total
Mathematics and Basic Sciences		54
Analytical Geometry and Calculus	10	
Elementary Differential Equations	3	
Introduction to Statistical Methods	3	
General Physics & Lab	11	
General Chemistry & Lab	9	
Survey of Organic Chemistry	3	
Survey of Physical Chemistry	3	
Biology Electives	6	
Physical Geology	3	
Ecology	3	
Engineering Topics		68
Engineering Mechanics- Statics	3	
Engineering Mechanics- Dynamics	3	
Thermodynamics	3	
Introduction to Scientific Programming	3	
Introduction to Environmental Engineering	3	
Environmental Engineering Seminar I	1	
Fluid Mechanics	3	
Fluid Mechanics Lab	1	
Surface Water Engineering	3	
Hydrogeology	3	
Water and Wastewater Treatment	3	
Water Sampling and Analysis	3	
Air Diffusion Modeling	3	
Air Sampling and Analysis	3	
Air Pollution Control Engineering I	3	
Air Pollution Control Engineering II	3	
Industrial Ventilation	3	
Hazardous Waste Engineering	3	
Land Reclamation	3	
Engineering Economy and Financial Mgmt.	3	
Environmental Laws and Regulations	2	
Environmental Design	4	
Engineering or Technical Elective	3	
Engineering Elective	3	
Humanities and Social Sciences		23
English Composition	4	
Scientific and Technical Writing	3	
Humanities Electives	6	
Social Science Electives	6	
Macroeconomics	4	
Total Program		145

Figure 6: BSEnE Curriculum at Montana Tech

New Mexico Institute of Mining and Technology (New Mexico Tech)

	Credits	Total
Mathematics and Basic Sciences		54
Calculus	12	
Applied Analysis	3	
Statistics	3	
General Physics & Lab	10	
General Chemistry & Lab	8	
Chemistry- Quantitative Analysis	2	
Organic Chemistry	3	
Physical Chemistry	3	
General Biology & Lab	4	
Cell Biology	3	
Microbiology	3	
Engineering Topics		57
Engineering Science	5	
Statics	3	
Thermodynamics	3	
Materials	3	
Electrical Engineering	3	
Soil Mechanics	2	
Introduction to Environmental Engineering	3	
Transport Processes	3	
Fluid Mechanics	3	
Water Treatment Process Design	2	
Wastewater Treatment Process Design	2	
Water and Wastewater Laboratory	1	
Groundwater Hydrology	3	
Instrumentation and Process Control	2	
Finite Element Analysis and Design	3	
Air Pollution Engineering I	2	
Air Pollution Engineering II	2	
Air Pollution Sampling	1	
Solid and Hazardous Waste Engineering	3	
Environmental Law and Regulations	2	
Engineering Economics	3	
Senior Thesis	3	
Humanities and Social Sciences		27
English	6	
Social Science	9	
Social Science/Humanities	3	
Humanities/Arts	6	
Technical Writing	3	
Total Program		138

Figure 7: BSEnE Curriculum at New Mexico Tech

The BSEnE curriculum at Syracuse University is shown in Figure 8. The requirement for the BSEnE degree is 131 credits.

3.9 Rensselaer Polytechnic Institute

At Rensselaer Polytechnic Institute (RPI) the Environmental Engineering program is administered by the Department of Civil and Environmental Engineering. The BSEnE curriculum at RPI is shown in Figure 9. The requirement for the BSEnE degree is 134 credits.

4 University of Miami BSEnE Curriculum

4.1 Course Requirements

The University of Miami BSEnE program was developed by considering: (a) the curricular content of existing ABET accredited environmental engineering programs; (b) the courses currently available and being offered at the University of Miami; and (c) our vision of the responsibilities and challenges facing an environmental engineer in the 21^{st} century.

The curricula of accredited environmental engineering programs in the United States have been reviewed in the previous section, and the common course contents identified. On reviewing the environmental courses currently available at the University of Miami, we find that most of the key environmental engineering courses are currently being offered within the Department of Civil and Architectural Engineering, primarily as part of the environmental engineering option in civil engineering. Other courses that are basic to any environmental engineering program are found principally in the Department of Mechanical Engineering (air pollution and related courses), Department of Industrial Engineering (industrial hygiene and related courses), and the Departments of Chemistry and Biology. The consensus of the group that developed the environmental engineering curriculum is that, except for a single course in air pollution that needs to be developed, there are sufficient courses already existing and being offered at the University of Miami to constitute an accreditable and relevant environmental engineering program.

An important issue that was addressed in developing our environmental engineering program was the issue that a newly created environmental engineering program will not be accredited until there are graduates from the program, and that practicing engineers cannot be licensed unless they are graduates from an accredited engineering program. This will create a problem for the initial environmental engineering graduates who complete the program prior to accreditation. We have addressed this issue by proposing, and recommending, a dual degree program in Environmental Engineering and Civil Engineering in which students complete the requirements for both degrees in nine semesters, compared with the eight semesters required for each degree. Clearly, students will have the option of choosing to pursue these degrees individually, accreditation requirements notwithstanding.

4.2 Admission Requirements

Admission to the environmental engineering program is the same as for all other programs at the University of Miami. According to the University of Miami Bulletin, the Committee on Admission bases its decision as to the admission of applicants upon evidence that they have the qualifications

Syracuse University

	Credits	Total
Mathematics and Basic Sciences		31
Calculus	12	
Differential Equations and Matrix Algebra	3	
General Physics & Lab	8	
General Chemistry & Lab	8	
Engineering Topics		73
Introduction to Engrg. and Computer Science	3	
Environmental Engineering II	3	
Civil/Environmental Engineering Measurements	4	
Electrical Science I & Lab	4	
Thermodynamics	3	
Engineering Materials	3	
Statics	3	
Dynamics	3	
Mechanics of Materials	3	
Soil Mechanics and Foundations I	3	
Environmental Engineering I	3	
Environmental Chemistry and Analysis	3	
Applied Environmental Microbiology	3	
Principles of Fluid Mechanics	4	
Applied Fluid Mechanics	3	
Water Resources	3	
Air Resources	3	
Solid Wastes: Collection and Disposal	3	
Design Elective	3	
Civil and Environmental Engineering Design	4	
Economic Analysis of Large-Scale Projects	3	
Independent Study or Technical Elective	3	
Technical Elective	3	
Humanities and Social Sciences		27
Writing Studio	9	
Introductory Macroeconomics	3	
Social Science/Humanities Elective	15	
Total Program		131

Figure 8: BSEnE Curriculum at Syracuse University

Rensselaer Polytechnic Institute (RPI)

	Credits	Total
Mathematics and Basic Sciences		48
Mathematics I & II	8	
Introduction to Differential Equations	4	
Modeling and Analysis of Uncertainty	3	
Physics I & II & III	12	
Chemistry of Materials I & II	8	
Introduction to Organic Chemistry I & II	6	
Physical Chemistry I	3	
Microbiology	4	
Engineering Topics		57
Engineering Graphics and CAD	1	
Introduction to Engineering Analysis	4	
Engineering Processes	1	
Material and Energy Balances	3	
Engineering Thermodynamics	3	
Computer Science I	3	
Dynamic Systems	3	
Lab. Intro. to Embedded Control	3	
Environmental Engineering Fundamentals	3	
Environmental Systems Engineering	3	
Fluid Mechanics I	3	
Introduction to Applied Hydrology	3	
Environmental Engineering Lab. I	2	
Environmental Process Design I & II	4	
Chemical Process Control	3	
Unit Operations	3	
Air Pollution	3	
Solid and Hazardous Waste Engineering	3	
Technical Elective	6	
Humanities and Social Sciences		21
Humanities/Social Science Elective	21	
Other		8
Free Elective	6	
Physical Education or ROTC	2	
Total Program		134

Figure 9: BSEnE Curriculum at RPI

deemed necessary for academic success at the University of Miami. Principal factors in the admission decisions are: (1) secondary school record; (2) scholastic assessment test (SAT), scholastic assment test I (SAT I), and american college testing program (ACT); (3) counselor's evaluation form; and (4) an essay. Although specific criteria are not given for such measures as high school grade-point-averages and SAT scores, the College of Engineering has, on average, admitted students with the highest average SAT scores at the University. Based on our experience with these students in our existing engineering programs, we would expect that the pool of students attracted to our environmental engineering engineering program will be similarly qualified and perform adequately. A similar statement can be made regarding the quality and performance of transfer students, where it is the policy of the University that only courses passed with a grade of C^- or better at an accredited college can be transferred and count towards a degree at the University of Miami.

4.3 Administration of the Program

The Environmental Engineering program is to be administered within the Department of Civil and Architectural Engineering. Concurrent with the implementation of the environmental engineering program, it would be appropriate to rename the department as the Department of Civil, Architectural, and Environmental Engineering. However, this is a separate action that is not part of this proposal.

4.4 Faculty Resources

There are several faculty within the College of Engineering who specialize in areas that are within the domain of environmental engineering. Existing faculty within the College of Engineering that teach environmental engineering courses and are trained in the breadth of environmental specialties are primarily found in the Department of Civil and Architectural Engineering, while faculty with important specializations in environmental and occupational health engineering and air pollution control engineering are found in the departments of Industrial and Mechanical Engineering respectively. These faculty are listed in Table 5. It is clear from this listing of faculty that all

Table 5: Environmental Engineering Faculty in the College of Engineering

Faculty	Rank	Specialization(s)
Shihab Asfour	Professor	environmental and occupational health
David A. Chin	Professor	water and wastewater
James D. Englehardt	Asst. Professor	water and wastewater, solid and hazardous wastes
Helena Solo-Gabriele	Asst. Professor	water and wastewater
Thomas D. Waite	Professor	water and wastewater, solid and hazardous wastes
Kau-Fui V. Wong	Assoc. Professor	air pollution control

specializations related to environmental engineering are covered by at least one full-time faculty in the College of Engineering. This is important for ownership of courses, a factor that is critically important in developing a new program. In addition to these faculty, there will obviously be several other faculty that teach courses in mathematics, basic science, and the engineering science portions of the environmental engineering curriculum.

4.5 Curriculum

The curriculum for the Bachelor of Science degree in Environmental Engineering is shown in Figure 10. As with most engineering programs, the first two years are taken up with with mathematics and basic sciences, along with core engineering science subjects such as mechanics and electric circuits. The junior and senior years of the program are made up mostly of engineering design courses related to the practice of environmental engineering. The proposed program has at least one course in each of the major specialty areas of environmental engineering, and an emphasis on the water environment. The major specialty courses are: Design of Water Quality Control Systems (CEN 440), Water Resources Engineering (CEN 430), Solid and Hazardous Waste Engineering (CEN 543), Industrial Safety Engineering (IEN 351), and Air Pollution (MEN 520, to be developed). To support these courses are a laboratory course in Water and Wastewater Analysis (CEN 345), and a variety of applied science courses such as Environmental Chemistry (CEN 540), Public Health and Environmental Microbiology (CEN 541). Students in the BSEnE program will have the flexibility to choose two elective courses in environmental engineerng and one Basic Science elective from the lists shown in Figure 11. These electives will permit the student to take advanced courses in either water and wastewater engineering (CEN 530, CEN 531, CEN 532), industrial hygiene (IEN 558, IEN 559), air quality control (MEN 521), or remote sensing and solar energy utilization (MEN 510, MEN 530). The list of basic science electives will provide the student an opportunity of more in-depth study in biology, chemistry, and the earth sciences, depending on the interests of the student. The proposed BSEnE curriculum will require 129 credits for graduation, which is fairly typical of other accredited programs in the College of Engineering. The semester-credit requirements for the proposed BSEnE program are compared with the requirements of other BSEnE programs in Table 6. Based on these data, it is clear that the credit requirements for the proposed BSEnE

Table 6: Semester-Credit Requirements of BSEnE Programs

School	Semester-Credits
Cal Poly	140
Northwestern	144
Univ. of Florida	130
Michigan Tech	131
Univ. of Central Florida	132
Montana Tech	145
New Mexico Tech	138
Syracuse	131
RPI	134

degree program are commensurate with the requirements of most accredited BSEnE programs in the United States.

In the initial stages of implementing the environmental engineering program, students will be encouraged to pursue a dual degree program in civil engineering and environmental engineering. When the environmental engineering program is accredited, then pursuit of an individual environmental engineering degree will also be encouraged. This approach is dictated by the requirement that graduation from an accredited degree program is a prerequisite for registration as a professional engineer. The dual-degree curriculum for students pursuing both the Civil Engineering and Envi-

Bachelor of Science in Environmental Engineering

Freshman Year

Fall Semester			Spring Semester		
CEN 101	Intro. to Civil/Env. Engrg.	1	CHM 112	Principles of Chemistry II	4
CHM 111	Principles of Chemistry I	4	ARC 191	Architectural Graphics	3
ENG 105	English Composition I	3	ENG 107	Writing About Science	3
MTH 110	Calculus I	5	MTH 112	Calculus II	4
SS/H/A Elective		3	PHY 205	Physics I	3
		16			17

Sophomore Year

Fall Semester			Spring Semester		
CEN 210	Mechanics of Solids I	3	CEN 211	Mechanics of Solids II	3
CEN 350	Transportation Engineering I	3	CEN 212	Structural Lab	1
MTH 211	Calculus III	3	EEN 205	Electrical Engineering I	3
PHY 206	Physics II	3	MTH 311	Ordinary Differential Equations	3
PHY 208	Physics Lab I	1	PHY 207	Physics III	3
SS/H/A Elective		3	PHY 209	Physics Lab II	1
		16	IEN 311	Probability and Statistics	3
					17

Junior Year

Fall Semester			Spring Semester		
CEN 330	Fluid Mechanics	3	CEN 301	Computer Applications	3
CEN 340	Intro. to Environmental Engrg.	3	CEN 430	Water Resources Engineering	3
CEN 345	Water and Waste Analysis	3	CEN 440	Des. Water Qual. Control Sys.	3
MEN 303	Thermodynamics I	3	Basic Science Elective		3
IEN 351	Industrial Safety Engrg.	3	SS/H/A Elective		3
		15			15

Senior Year

Fall Semester			Spring Semester		
CEN 481	Design Project I	1	MEN 520	Air Pollution	3
CEN 540	Environmental Chemistry	3	ENE Elective		3
CEN 541	Pub. Health and Enviro. Micro.	3	ENE Elective		3
CEN 543	Solid and Haz. Waste Engrg.	3	CEN 482	Design Project II	2
SS/H/A Elective		3	CEN 402	Professionalism and Ethics	3
SS/H/A Elective		3	SS/H/A Elective		3
		16			17

Figure 10: Environmental Engineering Curriculum

Bachelor of Science in Environmental Engineering

ENE Electives

CEN 530	Water and Wastewater Engrg.	3
CEN 531	Engineering Hydrology	3
CEN 532	Groundwater Engineering	3
IEN 558	Industrial Hygiene I	3
IEN 559	Industrial Hygiene II	3
MEN 510	Solar Energy Utilization	3
MEN 521	Exhaust Emission Control	3
MEN 530	Remote Sensing	3

Basic Science Electives

CHM 201	Organic Chemistry I	3
CHM 216	Chem. Equilibrium & Analysis	3
CHM 360	Physical Chemistry I	3
BIL 103	Elementary Ecology	3
BIL 110	General Biology	3
MSC 102	Intro. to Atmospheric Science	3
MSC 111	Intro. to Marine Science	3
MSC 215	Chemical Oceanography	3
MSC 230	Introduction to Marine Biology	3
GSC 120	Environmental Geology	4

Figure 11: Environmental Engineering Electives

ronmental Engineering degree programs is shown in Figure 12. The following additional courses must be taken by students in the Environmental Engineering program to satisfy the requirements of the Civil Engineering program: Structural Analysis (CEN 310), Concrete Structures (CEN 320), Steel Structures (CEN 321), Geotechnical Engineering I & II (CEN 370,CEN 470), Geotechnical Engineering Lab (CEN 371), and Transportation Engineering II (CEN 450). These courses amount to 19 credits, and therefore the curricula of both the Civil Engineering and Environmental Engineering programs can be covered in nine semesters, compared with the eight semesters required to complete these programs individually.

4.6 Resources Required

All of the courses in the environmental engineering curriculum, with the exception of a course in air pollution control, are presently being offered on a regular basis. Consequently, the faculty resources necessary to offer only the air pollution course must be provided. This course will be offered annually, and a cost of $4000 per year will be required to cover a part-time faculty to either teach the course, or relieve a full-time faculty member to teach the course.

Additional teaching assistants will not be necessary at this time, since the additional course required is a lecture course at the 500 level, and is not initially expected to have a level of enrollment to justify a teaching assistant. Additional support personnel will not be required at this time. Laboratory facilities are adequate at this time, however as the program moves into full operation it is expected that the operational costs of these laboratories will increase to reflect the increased usage that will result from the formal implementation of this program. We anticipate that approximately $8000 per year will be necessary to support a part-time laboratory technician, and around $5000 per year will be required for expendable supplies.

Library support facilities are adequate at this time, because of the significant presence that the University already has in the Environmental Engineering and Environmental Science areas.

In summary, implementation of the proposed baccalaureate degree in environmental engineering will require an initial investment of around $17,000 per year in budgetary support. We view this level of support as minimal compared with the significant monetary benefits that will accrue from implementation of this program. For example, at this level of investment, the program will break even with an enrollment of only two students, who would not otherwise have attended the University. Clearly, this program can reasonably be expected to attract significantly more students than the break-even number.

4.7 Implementation

The proposed baccalaureate program in environmental engineering is expected to substantially replace the existing and highly-successful environmental option in Civil Engineering. This is not to say that there is an intention to replace the environmental option in civil engineering, but that there will probably be overwhelming sentiment on the part of the current students in the environmental engineering option to switch over to the new dual-degree program in civil and environmental engineering, and then new students will enter this track directly. After at least three classes have graduated with the baccalaureate degree in environmental engineering, this program will be presented for accreditation. When the program becomes accredited, then the environmental engineering baccalaureate degree will be free-standing, and incoming students, as well as students

Bachelor of Science in Environmental Engineering
&
Bachelor of Science in Civil Engineering

Freshman Year

Fall Semester			Spring Semester		
CEN 101	Intro. to Civil/Env. Engrg.	1	CHM 112	Principles of Chemistry II	4
CHM 111	Principles of Chemistry I	4	ARC 191	Architectural Graphics	3
ENG 105	English Composition I	3	ENG 107	Writing About Science	3
MTH 110	Calculus I	5	MTH 112	Calculus II	4
SS/H/A Elective		3	PHY 205	Physics I	3
		16			17

Sophomore Year

Fall Semester			Spring Semester		
CEN 210	Mechanics of Solids I	3	CEN 211	Mechanics of Solids II	3
CEN 350	Transportation Engineering I	3	CEN 212	Structural Lab	1
MTH 211	Calculus III	3	EEN 205	Electrical Engineering I	3
PHY 206	Physics II	3	MTH 311	Ordinary Differential Equations	3
PHY 208	Physics Lab I	1	PHY 207	Physics III	3
SS/H/A Elective		3	PHY 209	Physics Lab II	1
		16	IEN 311	Probability and Statistics	3
					17

Junior Year

Fall Semester			Spring Semester		
CEN 330	Fluid Mechanics	3	CEN 301	Computer Applications	3
CEN 340	Intro. to Environmental Engrg.	3	CEN 430	Water Resources Engineering	3
CEN 345	Water and Waste Analysis	3	CEN 440	Des. Water Qual. Control Sys.	3
MEN 303	Thermodynamics I	3	CEN 320	Concrete Structures	3
IEN 351	Industrial Safety Engrg.	3	Basic Science Elective		3
CEN 310	Structural Analysis	3			
		18			15

Senior Year

Fall Semester			Spring Semester		
CEN 481	Design Project I	1	CEN 482	Design Project II	2
CEN 540	Environmental Chemistry	3	CEN 543	Solid and Haz. Waste Engrg.	3
CEN 321	Steel Structures	3	CEN 541	Pub. Health and Enviro. Micro.	3
CEN 370	Geotechnical Engineering I	3	CEN 470	Geotechnical Engineering II	3
CEN 371	Geotechnical Lab	1	CEN 450	Transportation Engineering	3
SS/H/A Elective		3	SS/H/A Elective		3
SS/H/A Elective		3			
		17			17

Fifth Year

MEN 520	Air Pollution	3
ENE Elective		3
ENE Elective		3
CEN 402	Professionalism and Ethics	3
SS/H/A Elective		3
		15

Figure 12: Dual Degree Program

in the degree program at that time, will no longer be strongly encouraged to pursue a dual-degree option, and will have greater freedom to concentrate solely on environmental engineering.

In terms of a time table, we expect that the University will approve the environmental engineering baccalaureate program in AY95/96 the implementation will begin in AY96/97. During AY96/97 we expect that the approximately 30 students that are currently in the environmental engineering option will immediately switch to the environmental engineering degree program, thereby immediately providing students from the Freshman to Senior level in the new environmental engineering program. The first graduates from this program should then emerge during AY97/98, and the program would then request accreditation within AY99/00. Just in time for the 21^{st} century.

5 Conclusion

This proposal has presented our case for the institution of a baccalaureate program in Environmental Engineering, to be administered by the Department of Civil and Architectural Engineering. The rationale for this program is that there currently exists significant faculty resources and infrastructure for this program in the College of Engineering, and the incremental costs associated with operating this program are far outweighed by the expected benefits. The market for this program has been demonstrated by the success of the environmental option in Civil Engineering, and the significant interest of student applicants in the profession of environmental engineering.

The job market for environmental engineers is significant and growing, and the emergence of environmental engineering as a professional discipline has recently been formalized by the institution of a separate professional registration (license) for environmental engineers. Environmental engineering is a profession that is here to stay, and there is a need in society for well trained engineers in this field. This proposal presents a program that will meet that need.

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6 Curricula Vitae of Key Environmental Engineering Faculty

The key environmental engineering faculty who have participated in the development of the proposed environmental engineering program, and will be responsible for continued program development are as follows:

- Dr. David A. Chin, Civil Engineering (Committee Chair)
- Dr. Thomas D. Waite, Civil Engineering
- Dr. James D. Englehardt, Civil Engineering
- Dr. Helena Solo-Gabriele, Civil Engineering
- Dr. Shihab Asfour, Industrial Engineering
- Dr. Kau-Fui V. Wong, Mechanical Engineering

The curricula vitae of the aforementioned faculty are included in this appendix.

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United States Geological Survey (Miami, FL), Project Chief, 1988-1989
Harza Engineering Company (Chicago, IL), Hydropower Engineer, 1978-1979

PUBLICATIONS (Last 10 years)

Books and Monographs:

1. Chin, D.A. (1990). "A Method to Estimate Leakage to the Biscayne Aquifer, Dade County, Florida." U.S. Department of the Interior, United States Geological Survey, Water-Resources Investigation No.90-4135, Tallahassee, Florida.

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University of Miami, Professor, Department of Civil and Architectural Engineering, 1982-Present
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Non-Academic:

High Voltage Environmental Applications, Inc. (Miami, FL), President, 1990-Present
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PUBLICATIONS (Last 10 years)

Books and Monographs:

1. Waite, T.D. (1986). "Disinfection of Wastewater Effluents and Sludge: State-of-the-Art and Research Needs." Editor. Proceedings of a National Science Foundation Workshop, Miami, Florida.

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PUBLICATIONS (Last 10 years)

Juried or Refereed Journal Articles:

1. Englehardt, J.D., and C. Peng (1995). "A bayesian Benefit-Risk Analysis Model Applied to the South Florida Building Code," Risk Analysis, in press.

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PUBLICATIONS (Last 10 years)

Juried or Refereed Journal Articles:

1. Solo-Gabriele, H., and F.E. Perkins (1995). "Metal Transport within a Small Anthropogenically Contaminated Watershed: Part 1. Mechanisms Describing the Variability of Streamflow and Suspended Sediments," Water Resources Research, in review.

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PUBLICATIONS (Last 10 years)

Books and Monographs:

1. Asfour, S.S. (1987). "Trends in Ergonomics/Human Factors IV-A," Editor, Elsevier Science Publishers, Amsterdam, 574 pages.

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PROFESSIONAL ORGANIZATIONS

1. Member, Ergonomics Research Society
2. Member, Human Factors Society
3. Member, International Foundation for Industrial Economics and Safety Research
4. Member, Institute of Industrial Engineers
5. Member, Society of Manufacturing Engineers

KAU-FUI VINCENT WONG, Ph.D., P.E.
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HIGHER EDUCATION

Institutional:

Case Western Reserve University, Ph.D.(Mechanical/Aerospace Engineering), 1977
Case Western Reserve University, M.S.(Mechanical Engineering), 1975
University of Malaya, B.S.(Mechanical Engineering), 1973

Certification, Licensure:

State of Florida P.E.

EXPERIENCE

Academic:

University of Miami, Associate Professor, Department of Mechanical Engineering, 1983-Present

Non-Academic:

National Elect. Board (Malaysia), Research/Generation Planning Engineer, 1976-1979

PUBLICATIONS (Last 10 years)

Books and Monographs:

1. Wong, K.V. (1991). "Proceedings of Waste to Energy Workshop," Editor, Tallahassee, Florida.

Juried or Refereed Journal Articles:

1. Wong, K.V., and D. Guerrero (1995). "Quantitative Analysis of Shoreline Protection by Boom Arrangements," Spill Science and Technology Bulletin, Vol.2, No.1.

2. Brown, D., and K.V. Wong (1995). "A Knowledge-Based System for Residential Energy Conservation in a Sub-Tropical Climate," Computers in Education.

3. Wong, K.V., and N. Paradiso (1995). "A Decision Support System to Assist in Selecting a Chemical Oil Spill Dispersant," Computers in Education, Jan-March.

4. Wong, K.V., R. Narasimhan, R. Kashyap, and J. Fu (1994). "Medical Waste Characterization and Front-End Analysis," Journal of Environmental Health, July/August.

5. Wong, K.V., and Y. Zhu (1994). "Using a Combustion Expert System to Help Combat Oil Spills," Computers in Education, Vol.XIV, No.4.

6. Zhang, L., and K.V. Wong (1994). "Expert System for Cryogenic Piping Systems," ASHRAE Transactions, Vol.100, Part 2.

7. Miller, M., and K.V. Wong (1993). "Prediction of Vulnerable Zones for Reactive Substances," Journal of Environmental Health, October.

8. Rashid, A., and K.V. Wong (1992). "Computer-Aided Modelling of Heterogeneous, Two-Dimensional, Ground-Water System," Computers & Geosciences, Vol.18, No.9.

9. Rashid, A., and K.V. Wong (1992). "A Neural Network Approach to the Determination of Aquifer Parameters by the Type-Curve Matching Method," Journal of Ground Water, March-April.

10. Gill, G., and K.V. Wong (1991). "Passive Solar Design for Windows Using a Neural Network," ASHRAE Transactions, Vol.97, Part 2.

11. Wong, K.V., and Z. Niu (1991). "Thermodynamic Optimization of the Boiler and Turbine with Condenser," ASHRAE Transactions, Vol.97, Part 2.

12. Wong, K.V., and Z. Niu (1991). "User-Modifiable Heat Exchanger Expert System," ASHRAE Transactions, Vol.97, Part 2.

13. Wong, K.V. (1990). "Innovation in the Senior Fluids and Thermal Sciences laboratory," ASME Curriculum Innovation Paper.

14. Ferrano, F., and K.V. Wong (1990). "Prediction of Thermal Storage Loads Using a Neural Network," ASHRAE Transactions, Vol.96, Part 2.

15. Ding, Y., and K.V. Wong (1990). "Control of a Simulated Dual Temperature Hydronic System Using a Neural Network Approach," ASHRAE Transactions, Vol.96, Part 2.

16. Wong, K.V., and F. Ferrano (1990). "Availability-Based Computer Management of a Cold Thermal Storage System," ASHRAE Transactions, Vol.96, Part 1.

17. K.V. Wong (1990). "Easy Referencing in Mechanical Engineering Topics," Computers in Education, Vol.X, No.3.

18. Wong, K.V., and A. Rashid (1990). "A Mathematics Consultant for Engineering Undergraduates," Computers in Education, Vol.X, No.4.

19. Wong, K.V., and D. Houston (1988). "Software System Design for Surface water permitting," International Journal of Applied Engineering Education, Vol.4, No.3.

20. Wong, K.V. (1988). "Three shells Used for Hydrocarbon Identification in Engineering," Computers in Education, Vol.VIII, No.1.

21. Sengupta, S., K.V. Wong, N.L. Nemerow, H.P. Gerrish, E. Daly, and A. Tilles (1987). "An Environmental Characterization Study of a Proof-of-Concept Municipal Solid waste Digestion Plant: Pompano Beach, Florida," Conservation and Recycling, Vol.10, No.4, pp.281-298.

22. Wong, K.V., G. Yeh, and E. Davis (1987). "Predictive Application of a ORNL Geohydrology Model," Journal of Ground Water, Vol.25, No.3.

23. Wong, K.V., and G. yeh (1986). "Field Validation of the Contaminant Transport Model, FEMA," Journal of Applied Mathematical Modelling, Vol.3, June.

24. Wong, K.V., G. Yeh, and E. Davis (1985). "Field Validation of the Geohydrology Simulation Model FEWA," Journal of Applied Mathematical Modelling," Vol.9.

PROFESSIONAL ORGANIZATIONS

1. Member, American Society of Mechanical Engineers
2. Member, Water Environment Federation
3. Member, Air and Waste Management Association
4. Member, AIAA

R-41

UNIVERSITY OF Miami

FACULTY SENATE

MEMORANDUM

To: Dr. David Chin
Chair, Department of Civil and Architectural Engineering

From: Kamal Yacoub
Chair, Faculty Senate

Date: November 7, 1995

Subject: Proposed New Degree Program in Environmental Engineering

Attached is the report from the Faculty Senate Ad-hoc Committee reviewing the proposal submitted by your department for a new degree program in Environmental Engineering. As you see, the report is favorable and complimentary. However, it does raise one question concerning the lack of a computer programming course in the proposed curriculum.

I look forward to receiving your response to the Committee's query. After receiving your response, I will schedule your proposal on the Faculty Senate agenda. Please note that the agenda for the November 27 meeting and all attachments need to be mailed no later than November 20, 1995.

KY/ca

attachment

cc: Dean Lewis Temares
Prof. Michael Gaines
Prof. James Nearing
Prof. Jerome Catz

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CDFNI

UNIVERSITY OF Miami

FACULTY SENATE

SEP 2 0 1995

Date: September 29, 1995

To: Kamal Yacoub, Chairman
Faculty Senate

From: M. Lewis Temares, Dean
College of Engineering

Subject: New Baccalaureate Degree Program

Attached is a proposal for a new baccalaureate degree program in the College of Engineering, Bachelor of Science in Environmental Engineering. This proposal was approved unanimously by the Faculty of the College of Engineering on 27 September, 1995.

I fully endorse this proposal, including the proposed annual budget of $17,000. Please initiate the process of Faculty Senate consideration of this new degree program. In addition, because of the importance of this new degree program to the Strategic Plan of the College of Engineering, and the necessity of promoting this program in our Spring recruiting activities, I request *early approval* of this program. It is highly desirable that this program be approved in time to be published in the AY96 University Bulletin.

The new Environmental Engineering program is to be administered by the Department of Civil and Architectural Engineering, and Dr. David A. Chin is the department Chair. Please contact Dr. Chin with any questions on the proposed degree program, and for follow-up action in response to the Senate requests for any additional materials. Thank you in advance for your efforts on our behalf.

cc: Dr David A. Chin, Chairman, Department of Civil and Architectural Engineering
Dr. Samuel S. Lee, Associate Dean
Dr. Thomas D. Waite, Associate Dean for Research and Graduate Studies

Barbara,
This has been delivered to Dr. Yacoub @ ECE
today. Frances

College of Engineering
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