

FLORIDA ATLANTIC UNIVERSITY
College of Engineering & Computer Science

Design in Engineering Curricula¹

Educational objectives and core student learning outcomes of the College of Engineering & Computer Science focus upon preparation of students to enter, and continue successfully, the practice of engineering. Development of proficiency in engineering design and preparation to function effectively on multidisciplinary teams are central to this task. This document describes the role of design in the baccalaureate engineering programs of the College of Engineering & Computer Science and outlines the processes and procedures by which students are engaged in this critical educational activity.

1. Overview

Undergraduate programs in the College of Engineering & Computer Science prepare students to enter and continue the practice of engineering. Central to this task are preparation of students to function effectively on multidisciplinary teams and development of proficiency in design of engineering systems, components, and processes. Teamwork and design are prominent in the educational objectives and core student learning outcomes of the College, as indicated in Section 7.

Historically, FAU engineering curricula have featured a distributed approach to design instruction. Emphasis on teamwork and engineering design starts in the freshman year, typically with the *Fundamentals of Engineering* course, and continues throughout the curricula. It culminates in a comprehensive capstone design experience in the senior year.

This model will continue as the backbone for design instruction in the College. However, evolutionary change in the ways engineers work is placing increasing importance on student exposure to realistic projects carried out in interdisciplinary settings. In response, the College is making two fundamental changes to strengthen and update its efforts in design education. These changes, involving creation of an Engineering Design Center and modifications in the capstone design experience, are described in the following sections.

2. The Engineering Design Center (EDC)

In recognition of the prominent role of teamwork, innovation, and design in the development of engineering students, the College of Engineering & Computer Science hereby creates the Engineering Design Center (EDC). This Center will provide a focal point for design education within the College. It will help assure that College educational objectives are met and that core student learning outcomes are achieved.

The Center will develop over time. In the shorter term, it will provide administrative and facility support for College design and teamwork activities. In the longer term, the Center will provide a mechanism for

¹ Developed and approved by the ABET 2000 Taskforce and released to the faculty on 2/11/00; approved by participating departments, March 2000. This update, approved by the Taskforce in July 2001, incorporates interim developments and defines linkages to educational objectives and student learning outcomes. It also incorporates the previously separate Taskforce document, *Design Credit for Co-op Work Experience*.

collaboration with business and industry on design projects and activities. The goal is to have capstone projects based on actual problems from the workplace, with real intellectual involvement of participating companies.

A College Design Coordination Group (CDCG), with faculty representation from the academic programs, will assist with development of the Center and will have primary responsibility for its academic activities. Initially, the CDCG will consist of faculty involved with the new collaborative capstone design courses described in Section 3.

As a first step in creation of the EDC, the College has remodeled and equipped room SE 103B for instructor and student support for teamwork and design activities. This facility has seating capacity for twelve and is equipped with computers, printers, audio-visual equipment, and multimedia hardware and software. It is intended for student team meetings, for instructor meetings with teams, and for preparation of team reports and presentations. The adjacent Office of Engineering Cooperative Education schedules use of this facility.

3. The Capstone Design Experience

The capstone experience seeks to bring the totality of student knowledge and experience to bear on comprehensive engineering and design tasks representative of those encountered in business and industry. It is the keystone of design education in the College. It helps prepare students for engineering practice and serves as an effective measure of their readiness for work at the professional level.

Two steps are being taken to update and strengthen the capstone experience. First, guidelines for the capstone design experience in all engineering programs have been established. Each academic program is free to work within these guidelines to achieve program objectives and learning outcomes. Second, starting with the Spring 2001 semester, academic programs who so choose will join to provide their students a collaborative capstone design experience featuring work on projects in multidisciplinary² teams.

Guidelines for the capstone design experience follow. The collaborative design experience is described in Section 4:

- The capstone design experience shall include the newly created two-course sequence *EGN 4410C Engineering Design I* and *4411C Engineering Design II* (2 semester credits each), or their equivalents. Academic programs may add additional coursework to the capstone design experience for their students, as desired.
- The capstone sequence shall include a comprehensive capstone design project and instruction on generic topics such as the design process, project management, decision making, team dynamics, economics, and political, social, and environmental considerations. Coverage of design-related topics that are more discipline specific – ethics, safety, professional codes and standards, etc. – shall be at the discretion of individual academic programs.
- Capstone design projects must be multidisciplinary. They may originate either from within or outside the College. Projects submitted by industry, with real intellectual involvement of

² The words interdisciplinary and multidisciplinary are used interchangeably herein. Either is taken to mean involvement of knowledge or expertise from various fields of study (e.g., engineering, business, computer science, etc.), from different branches of engineering (ocean, electrical, mechanical, computer, civil), or from different major sub-disciplines within a department (e.g., circuits, controls, electromagnetics, etc.).

participating companies, are strongly encouraged. The College shall develop policies and procedures to facilitate such collaborations with industry.

- Students shall work on projects in interdisciplinary teams. To the extent possible, teams shall be diverse and shall be structured such that students are required to work with individuals outside their usual circle of friends and study partners.
- Students shall be presented, or they shall help develop, a list of suitable, possible design projects. The process used to match student teams to projects shall include a written team project proposal. Student project preferences and technical areas of interest shall be considered in the assignment process.
- Student teams shall be responsible for management of their projects, with the instructor(s) serving primarily as coach, facilitator, guide, and evaluator. Regular team meetings shall be required, with written and oral progress reports submitted at appropriate project milestones.
- Each capstone design project shall culminate with a comprehensive written report and an oral presentation suitable for a general audience. Students shall be provided guidelines for preparation of the report. The distribution list for the report shall include the Office of the Dean and Chair of each academic program represented on the project (for use in assessment activities).
- Students participating in the College's Co-operative Education program shall have the option of proposing a capstone design project based on their Co-op work assignment. Procedures and guidelines outlined in Section 6 shall apply.
- Ways in which capstone experiences support College and program educational objectives and learning outcomes (see Section 7) shall be documented through appropriate procedures of assessment. A copy of the assessment results shall be submitted to the Office of the Dean for use in College assessment activities.

4. The Collaborative Capstone Design Experience

Starting with the Spring 2001 semester, academic programs who so choose will join to provide their students a collaborative capstone design experience featuring work on projects in multidisciplinary teams. This collaborative effort includes the capstone design courses *EGN 4410C* and *EGN 4411C*, which span two consecutive semesters and involve a team of instructors. Careful planning and coordination of efforts are required. To this end:

- Students are expected to complete the *EGN 4410C Engineering Design I* and *EGN 4411C Engineering Design II* sequence in consecutive semesters. The student's academic department shall handle possible exceptions to this requirement. Resources permitting, a new course sequence will begin each Fall, Spring, and Summer semester.
- Each academic program participating shall schedule and assign an instructor for a section of *EGN 4410C* and *4411C*. (This will enable student credit hours generated to accrue to the proper unit.) The various sections of each course shall meet at a common time and place, as one combined class.
- The group of instructors assigned to *EGN 4410C* and *EGN 4411C* initially will serve as the College Design Coordination Group (CDCG); see Section 2. This group will serve as a focal

point for design education within the College and shall be responsible for development of a plan of operation and delivery for these two courses.

- The CDCG shall develop an instructional plan that utilizes effectively the faculty assigned to *EGN 4410C* and *EGN 4411C*. Department chairs and the Office of the Dean shall work with the CDCG to establish appropriate faculty workload credit for these activities.
- The CDCG shall review, and approve, all potential capstone design projects (including those based on Co-op work assignments) to assure that they are multidisciplinary, appropriate for student work, suited to the time frames available, and in general compliance with the guidelines herein. A project evaluation form³ has been developed to assist with this task. A copy of this form, for each project assigned, shall be filed with the Office of the Dean for use in assessment activities.
- The CDCG shall be responsible for documenting ways in which the collaborative capstone experience supports College and program educational objectives and learning outcomes (see Section 7). An assessment form⁴ has been developed to assist with this task. This form is to be completed for each student, with copies submitted to the Office of the Dean for use in assessment activities.
- Unique cases and considerations, not covered by these administrative guidelines, shall be handled at the discretion of the CDCG.

5. Support for Capstone Design Courses/Projects

Viable capstone design activities require proper support and facilities. To this end:

- Capstone course instructors and students shall have first priority for use of the Engineering Design Center facility in room SE 103B.
- Shop and laboratory facilities, and project storage and workspace, are the responsibility of the participating departments.
- The capstone design courses *EGN 4410C/EGN 4411C* each carry a laboratory fee of \$15 per student for expendable materials and supplies. These funds are held in an account of the Office of the Dean. The CDCG shall prepare and submit a brief plan for expenditure of these funds each semester. Additional financial support may be requested from the participating departments or from the Office of the Dean, as appropriate. Such requests should be submitted in timely manner.

6. Capstone Design Projects for Co-op Students

Co-op students shall have the option of proposing a capstone design project based on their Co-op work assignment. This provision is in recognition of the value of practical work experience in the professional development of engineering students and in acknowledgment of the fact that Co-op work experiences can have much in common with capstone design projects. This provision also addresses the problem that some Co-op students otherwise will have in completing the capstone design sequence in two consecutive semesters. The following guidelines and procedures apply:

³ *Capstone Design Project Summary*, College of Engineering, September 2000.

⁴ *Capstone Design Experience Evaluation Summary*, College of Engineering, September 2000.

- Students take *EGN 4410C*, during which they propose to the CDCG a capstone project based on a Co-op work assignment. If approved, students register for *EGN 4411C*, but may complete some or all of the project and course requirements off campus while on Co-op assignment. Students shall submit written and oral progress reports, as specified by the CDCG.
- Projects are approved by the CDCG and are subject to the guidelines of Section 3. In particular, they must be multidisciplinary and must involve interactions with others in a team or team-like environment at the workplace. For example, the task might involve design of an item requiring interactions with manufacturing, marketing, sales, or outside vendors. Students shall be responsible for working with the CDCG to assure that project requirements are met.
- A comprehensive written final project report and an oral project presentation to the CDCG shall be required.
- Employers must agree to permit academic evaluation and monitoring of project work and shall designate a contact person to coordinate with the CDCG in this effort. They must also agree to disclosures through student reports and presentations.
- The Division of Engineering Co-operative Education shall assist with communication and negotiation of project requirements with employers.

7. The Capstone Experience Vis-à-vis Educational Objectives and Student Learning Outcomes

Support of College and program educational objectives and student learning outcomes was a primary consideration in development of the capstone design experience described herein. This experience has three major components: the capstone design courses (*EGN 4410C* and *4411C*, or equivalents), the capstone design project, and any supplemental capstone design courses or instruction that may be provided by individual academic programs. Correlation between these three components and College educational objectives and core student learning outcomes⁵ is indicated in the following table. For convenience, College objectives and core learning outcomes also are listed here:

CORRELATION OF CAPSTONE DESIGN EXPERIENCE WITH OBJECTIVES/LEARNING OUTCOMES

Capstone Design Activity	Educational Objectives				Student Learning Outcomes					
	A	B	C	D	1	2	3	4	5	6
a. Capstone Design Courses (e.g., <i>EGN 4410C/4411C</i>)	●	●	○	●	○	●	●	●	●	●
b. Capstone Design Project	●	●	○	●	●	●	○	●	●	●
c. Supplemental Capstone Courses	●	○	●	●	●	○	●	○	●	●
● Strong Correlation ○ Good Correlation										

College Educational Objectives:

- A. Preparation for Practice:** *Graduates will be prepared for entry-level positions in their discipline and for graduate/professional studies.*

⁵ *Plan of Improvement and Assessment for Undergraduate Engineering Programs*, College of Engineering, January 2001.

- B. Tools for Creativity:** *Graduates will experience the creative and design processes and their application to typical engineering situations.*
- C. Societal Awareness:** *Graduates will receive the breadth of education necessary to integrate practice in their disciplines with the needs and interests of a diverse modern society.*
- D. Leadership Skills:** *Graduates will be prepared for leadership in their disciplines.*

Core Student Learning Outcomes:

- 1. An understanding of professional and ethical responsibility.** Graduates will be familiar with the professional and ethical underpinnings of their discipline and with their professional obligation for continuing education and professional development.
- 2. A working knowledge of fundamentals, engineering tools, and experimental methodologies.** Graduates will have knowledge of math, science and engineering fundamentals. They will be able to combine these basics with their knowledge of experimental methodologies and modern engineering tools to identify, formulate, and solve engineering problems.
- 3. An understanding of the social, economic, and political contexts in which engineers must function.** Graduates will be able to combine their knowledge of the social sciences and humanities with their own personal and professional experiences to demonstrate an understanding of the impact of engineering solutions in an increasingly diverse and technological society.
- 4. An ability to plan and execute an engineering design to meet an identified need.** Graduates will be able to use their knowledge of fundamentals, engineering techniques and tools, and project planning and management to design a system, component, or process that satisfies constraints and meets an identified need.
- 5. An ability to function on multi-disciplinary teams.** *Graduates will be able to function effectively on teams using their knowledge of team dynamics, team communication, social norms, and conflict management.*
- 6. An ability to communicate effectively.** *Graduates will be able to communicate their ideas and results to diverse audiences using their knowledge of written, oral, and graphical communication.*

8. Assessment

Assessment of capstone design projects and student outcomes is a key part of the College of Engineering & Computer Science's plan for continuous program improvement. For this purpose, the ABET Taskforce developed two assessment tools. The *CAPSTONE DESIGN PROJECT SUMMARY* documents the interdisciplinary and teaming aspect of capstone projects, as well as the various design elements involved. The *CAPSTONE DESIGN EXPERIENCE EVALUATION SUMMARY* documents student abilities demonstrated during work on capstone projects. Copies of these forms are included on the following pages. The forms also are available from the College web site (see Engineering Design under the Academic Information header).