A Novel Collaborative Program in Undergraduate Mechanical Engineering

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Abstract

Over the past few years, the University of Maryland (UM) and Frostburg State University (FSU) have collaborated to develop a novel undergraduate mechanical engineering degree program in western Maryland. Designed to serve the students in the region and provide engineering graduates and further engineering educational opportunities for local industries, the program utilizes both live-instruction and distance-education as the delivery modes. Students in the program officially transfer to UM for the final two years but reside at the FSU campus in western Maryland throughout the duration of the program. Students receive about 80% of the courses from FSU faculty through live instruction and the remaining 20%, in the last two years, from the UM faculty via interactive television. The program was initiated in 1997 after a needs assessment prompted the two institutions to collaborate in establishing quality undergraduate programs in mechanical and electrical engineering, with UM designated as the degree-granting institution. After graduating our first students in 2001, the programs were reviewed by ABET in 2002 and consequently an accreditation status was awarded in 2003. In this paper, we present an overview of the development of mechanical engineering program, including a description of the concept and the role of distance learning, and discuss the evolution of the assessment philosophy developed for the purpose of accreditation.

I. Introduction.

The purpose of this paper is to describe our experience in developing and sustaining a novel program in mechanical engineering. The program described utilizes both live- and distance-education modes for delivery and is developed jointly by the University of Maryland (UM), College Park, and Frostburg State University (FSU).

The University of Maryland, in College Park, is a major public research university[1] located on 1,500 acres of rolling land along the Baltimore-Washington, D.C. corridor, offering undergraduate and graduate academic programs of high quality[2]. Designated the flagship campus of the University System of Maryland, UM has a student population of more than 35,000[1]. The A. James Clark School of Engineering, one of the thirteen colleges and schools in the university, offers 13 graduate programs and 10 undergraduate degree programs. The Department of Mechanical Engineering is one of the seven departments within the School, offering B.S., M.S., and Ph.D. degrees, and ranks highly in the discipline. FSU, on the other hand, is located in western Maryland and is a smaller, regional university. Founded in 1898, it is the University System of Maryland's only four-year institution west of the Baltimore/ Washington metropolitan area. The University offers Bachelors and Masters degrees in a variety of non-engineering fields and has an average enrollment of 5,200[3] students. Undergraduate programs offered by FSU include physics, mathematics, computer science, business administration, biology, chemistry, art, and education. The Department of Physics and Engineering is one of the seventeen departments within the College of Liberal Arts & Sciences. The Department offers a B.S. degree in physics and participates in collaborative programs with other sister institutions in the University System of Maryland.

Collaboration between the two universities began nearly eight years ago to deliver ABET-accredited baccalaureate programs in mechanical and electrical engineering to the students in the western Maryland region. UM was designated to be the degree-granting institution, with FSU responsible for the general education, engineering science, and basic science courses and some upper-division courses in engineering, and UM responsible for the remaining upper-division engineering courses.

The genesis of the collaboration was based upon the lack of opportunities for local students and employees from industry to pursue undergraduate or continuing engineering education in the area. Based on the results of a needs-assessment survey, a resolution was passed to develop programs in mechanical and electrical engineering. The University System of Maryland approved the resolution and provided funding to initiate and administer the programs. The programs are located on the Frostburg campus, which is 150 miles from the main University of Maryland campus in College Park.

The programs started in the fall of 1997, with an enrollment of 39 students. In the fall of 2003, there were 29 students (13 sophomores, 8 juniors, and 8 seniors) in mechanical engineering with an additional 20 freshmen expected to choose the major. So far, 18 students have graduated in mechanical engineering, with nine more expected to graduate in 2004.

In this paper we describe the structure of this program and summarize the unique assessment philosophy developed.

II. Program Description

A. Curriculum

The curriculum for the undergraduate program in Mechanical Engineering (Table 1) is similar to its parent curriculum at the College Park campus[2], including the number of credits and prerequisite requirements. The courses build on each other and are offered in sequence such that the students can graduate in a timely manner. In designing the framework, each of the four years was structured with a purpose and a focus. The basics and the fundamentals are maintained in the first two years, while enhancing the excitement and the challenge by adding introductory courses in design. The technical knowledge to be conveyed was integrated into elements that are offered in the third year. The final year is devoted to a significant design experience and a number of technical electives that can be arranged to permit the students to shape their education so as to provide an entry to a number of different career opportunities.

The curriculum consists of the following curricular areas (Fig. 1):

A.1. Basic Sciences

This component primarily consists of 15 credit hours of mathematics (three calculus courses and one differential equations course), 12 credit hours of physics courses with a lab component, and 7 to 8 credit -hours of chemistry. The chemistry requirement is flexible and varies depending upon the chemistry background of the student. All students must take Chemistry I, which has a lab component, for gaining the associated experimental skills. Students then may take the second course in the sequence with or without the lab component. The latter option is for those, who are interested in acquiring more laboratory skills. Further, as the courses with lab component are offered every semester as opposed to the limited offering of the course without the lab component, several students prefer the latter sequence.

Several courses in the major also contain the basic-sciences component. Two courses in the major, Statistical Methods for Product and Process Development and Numerical Methods in Mechanical Engineering, contain significant amount of mathematics. Further, as a part of the non-ME technical electives chosen in the senior year, students are required to take three-credit hours in higher-level basic sciences, which may be chosen and approved depending on the student interests and career options.

A.2. Engineering Sciences

This component consists of freshman engineering design, statics, dynamics, and mechanics of materials. The first two courses of this sequence are taken in the freshman year, while the latter two are taken in the sophomore year. Fundamentals of engineering sciences are introduced in this sequence. Problem-solving skills, basic design skills, report writing and presentation skills, teamwork, and experimental skills are emphasized to varying levels.

A.3. Major Requirements

Students begin taking the required courses in mechanical engineering in their sophomore year with Numerical Methods in Mechanical Engineering and Thermodynamics. During the junior year, the focus is on providing the strong technical base required of all students in the program. These offerings combined with those given in the second year form the mechanical engineering core that must be mastered before beginning the capstone design experience and the specialization of the final year of study. Typical core courses are fluid mechanics, heat transfer, material sciences, and vibrations. The two courses in thermofluids as well as the materials-science course have a lab component. Students are also required to take two courses in electronics and instrumentation during this year, which also have a lab component. The two-course sequence in vibrations and controls emphasizes the fundamental understanding of the topics involved and utilizes MATLAB heavily for studios and projects. Group projects and studios, both experimental and analytical, are required to be performed in several of these courses, culminating in technical presentations and reports.

Several of the mechanical engineering courses and some engineering science courses have design component to some extent through studio or term projects, providing the opportunity to introduce design topics in courses throughout all four years of the curriculum. Additionally, all students are required to take a two-course sequence in product development that provides a major design experience.

During their senior year, the students are required to take six electives, including at least one non-ME technical elective, which can be a three-credit course in basic sciences or some other approved area. A maximum of two such electives can be taken outside of mechanical engineering, thus leaving the students with the flexibility of interchanging one upper-level course between engineering courses and courses in basic sciences. Most technical electives in ME require that student projects be performed along with submission of necessary technical reports and presentations.

A.4. General Education Program

Courses in this component are chosen to complement the technical content of the engineering curriculum. For the purpose of this program, courses at FSU that are equivalent to their counterparts at UM in content are chosen to frame the General Education Program.

The different areas in the component that the students must choose courses from are:

1. fundamental studies, involving the freshman composition course and a technical writing course, which emphasize writing and communication skills, and a course in mathematics. The mathematics requirement is automatically satisfied by the ME curriculum;
2. distributive studies, involving courses in the humanities and the arts and the social sciences;
3. advanced studies, involving the ME capstone course and a non-technical elective; and
4. diversity studies, involving a course that provides diversity to the program.

Although a total of thirty-three credit hours in this category is required, because of the requirements in the major for mathematics courses, capstone course, and the non-technical elective, this component can be satisfied by taking only twenty-four credit hours of course work in this area.

B. Course Delivery

Approximately three fourths of the required courses, including those in the basic and engineering sciences, core courses in mechanical engineering that have a laboratory or a design component, and general education courses, are taught live at the FSU campus. Additionally, an advanced topics course that can be taken twice for credit as a technical elective is also taught at FSU to enable the students to learn advanced methods and pursue research. Four mechanical engineering core courses - Thermodynamics, Statistics, Vibrations, and Controls and Optimization, and technical electives are delivered via interactive television (ITV) from the College Park campus. The elective courses offered by UM vary from year to year, depending on the interests of the students.

The program requires that six electives be taken, out of which at least one should be a non-technical elective, with a limit of two non-technical electives per student. Thus, if a student chooses to take two non-technical electives and an advanced topics course two times, the number of courses he or she will receive from UM faculty will be four core courses and two technical electives – the minimum number that a student in the program can receive from UM. On the other hand, if the student chooses to take five technical electives (and no advanced topics course), he or she will receive four core courses and five technical electives – the maximum number that a student can receive from UM. The two scenarios are shown in Fig. 2.

C. Students

Students apply to FSU for admission to the collaborative engineering program. Admission is based on prevailing FSU general admission standards. Students take FSU courses and one UM course (Thermodynamics) in the first two years and are regarded as FSU students, and pay FSU tuition, during this period. After completion of 45 required credits, students apply for admission to UM as transfer students. Based on the admission standards at UM, recommendations regarding their applications are made by the faculty Coordinator at FSU to the Associate Dean for Education in the Clark School. Admitted students then become UM students and pay UM tuition.

During the first two years, students are eligible for FSU scholarships. Once they become UM students, they need to apply for scholarships and other financial aid at UM, which tends to be much more competitive. Registration and other application activities are all performed at FSU, through the office of the Administrative Specialist for the programs. This is coordinated with the Engineering Student Affairs office in the Clark School at UM.

Advising for all the students selecting mechanical engineering as their major is performed by the mechanical engineering faculty. For those who may not have declared their major, as often happens in the first semester of the freshman year, advising is performed by the Administrative Specialist at FSU.

D. Resources

D.1. Faculty and Professional Staff

The mechanical engineering program currently uses a faculty consisting of UM faculty, one jointly appointed FSU faculty member, and seven adjunct faculty for required course offerings. The projected FSU faculty necessary for the mechanical engineering program has been estimated to be two, with one position filled by the program coordinator. This number, supplemented by instruction from UM faculty through use of distance learning technology will be adequate to offer the program. Recruitment is currently underway for one additional faculty member, who is expected to teach half time for mechanical engineering.

Both the ME and EE programs together are staffed with an administrative specialist, several student assistants, and a part-time technician to provide assistance with the machine-shop activities. The Administrative Specialist provides the managerial support required to support the programs. She performs activities like student advising, scheduling, sending the student work to UM and distributing the corrected work, proctoring exams for the ITV courses, interacting with the faculty at UMCP for textbook orders, keeping student records, and acting as a liaison between the Department and administrative offices, such as the office of the financial aid and office of the registrar, at FSU. The student assistants are primarily employed to facilitate a smooth delivery of the ITV courses.

D.2. Facilities

Prior to 2003, the mechanical engineering program at FSU was housed in temporary facilities. In 2003, both the mechanical and electrical engineering programs moved into a new Science and Engineering building. Besides office areas, student work areas, and classrooms, it also houses the computing and experimental laboratories. Additional space for student and faculty research has been promised by the Dean of the College of Liberal Arts and Sciences, which illustrates the level of commitment by the institution for the success of the programs.

D.3. Library Facilities

The FSU library currently possesses several textbooks, handbooks, and journal subscriptions. Based upon meetings held with the staff of UM's library system and Academic Computing, strategies for using the Internet and facsimiles for supplying requested journal articles were formulated. Library materials such as conference proceedings and full-text journal articles, not available at FSU Library, but available at UM libraries can be accessed from the electronic databases the UM libraries host, using the UNIX accounts at UM and with the help of a web browser. Students can then print these articles or save them on the local workstation. However, since articles published in the recent years only can be obtained using the electronic databases and because libraries typically do not subscribe to the entire database, students and faculty need to request an inter-library loan or make a trip to the UM library, if articles desired are not available electronically. Textbooks and other resources not available at the FSU library, but available at the UM libraries and other libraries within the University System of Maryland, can be borrowed using the inter-library loan privileges.

D.4. Laboratory Facilities

Laboratory facilities for all required courses in the program are in place at FSU. The different laboratories that students in the Mechanical Engineering program use consist of the Thermofluid Sciences Laboratory, Materials Science Laboratory, Physics Laboratories, and Engineering Computer Laboratory. All of the engineering laboratories have been funded by external grants and through funds from the University System of Maryland (USM).

The Thermofluid Sciences Laboratory is equipped to serve about 12 students at the same time for performing experiments in fluid mechanics and heat and mass transfer. The equipment for experiments in fluid mechanics include two hydraulics benches, a flow measurement device, a jet impact device, two friction losses devices, one for moderate Reynolds numbers and the other for turbulent flows, a transitional flow demonstration apparatus, a low-speed wind tunnel, two flow channels, and an air-flow bench. A 24"x24" test-section wind tunnel and a centrifugal pump test-bed are on order and expected to arrive this year. The heat transfer equipment includes a laminar/viscous flow heat exchanger unit, a boiling heat transfer unit, a cross-flow heat exchanger unit, a thermal radiation unit, a conduction heat transfer setup, a journal bearing demonstration unit, a gas turbine unit, a Rankine-cycle unit and several temperature-measuring devices. The laboratory also houses three desktop computers and two Sun Sparc workstations.

The Materials Science Laboratory consists of an ultimate tensile-testing machine, a computerized thin-cylinder apparatus, an impact testing machine, a hardness tester, a creep-measuring apparatus, a rotating fatigue measurement device, a microscope, a gas-fired furnace, an electric furnace, a hydraulic press, a rolling machine, a plastic moulder, a dynamic balancing demonstration unit, three desktop computers, and three Silicon Graphics workstations. This laboratory is primarily used to perform experiments in the Materials Science, Mechanics of Materials, and dynamics courses and accommodates about 12 students at a time.

The Electrical Engineering Laboratory has 11 student stations. Each station is equipped with basic equipment such as a function generator, a digital multimeter, a monitor, and related equipment, tools, and supplies. It also houses a computer equipped with a data acquisition system and virtual instrumentation and a Lab-volt electromechanical unit, consisting of several modular units in a dc generator/motor, a dynamometer, an induction motor, a synchronous motor/generator, and a three-phase transformer, with different resistive, inductive, and capacitive loading configurations. This laboratory is primarily used for courses in electrical engineering and for the two electronics and instrumentation courses in mechanical engineering.

The Engineering Computer Laboratory houses 20 high-end PC's with a networked laser printer. The computers are networked to the FSU campus. Currently, software is being installed to enable students to access software and email accounts at the UM campus. The computers have several software packages for engineering coursework and report writing and presentations. This laboratory is primarily used for engineering courses with computer content and also for providing the students with access to computers. In addition to the above, the Department also possesses ten more UNIX workstations and several desktop and laptop computers, for use by the engineering students.

The Physics laboratories are primarily used for instructing introductory physics courses and the freshman engineering design courses. They consist of six hexagonal tables, each equipped with two computers that are interfaced with various measuring devices. The computers host a variety of mathematical and engineering software.

In addition to the above, the Department also possesses a machine shop, equipped with a numerically controlled milling machine, numerically controlled lathe, a regular milling machine, two drill presses and a precision drilling machine, a lathe, a grinding machine, and several other machine tools, power tools, and hand tools. This workshop primarily serves as the area where the students can get parts made for their projects. The Department also provides another area with hand tools to serve as an assembly/fabrication area for the design projects.

D.5. Classrooms

Several classrooms are available for instruction at FSU. Some of the mechanical engineering courses are taught in the laboratories, because of the integrated lecture and studio sessions, and some in the computer classrooms, based upon the need for computers in class. For instruction from UM via ITV, three distance-learning classrooms are available at FSU, one located within the Compton Science Center and two others within a short distance from the Department. These rooms are equipped with interactive television equipment, capable of transmitting and receiving digital data through fiber optic lines, thus providing a two-way real-time communication. They house large screen monitors, a fax machine, a document camera, a telephone, a computer, video cameras, and microphones. The Department owns several high-end laptop computers, for use by the students, should the need arise in the ITV courses.

III. Accreditation

Since the mechanical engineering program at the Frostburg campus is distinct from that at the College Park campus, a separate ABET accreditation visit was sought soon after graduating our first students in the program in May 2001. Many aspects of the preparation for this visit were similar to those for the traditional programs. Student work was gathered, organized, and exhibited; course notes and syllabi were organized for exhibit; forms were filled out; summaries and graphs were prepared; faculty were educated; however, because of the combination of traditional- and distance-education modes, some tasks were performed slightly differently. Preparation for the visit was divided into the following broad categories:

1. Defining the program educational objectives;
2. Defining the program outcomes and assessment procedures;
3. Demonstrating that the facilities, faculty, institutional support, and financial resources are adequate and applicable program criteria are met;
4. Implementing assessment methods to measure how well objectives are met;
5. Demonstrating that the curriculum and the outcomes of the established processes meet the ABET criteria;
6. Implementing continuous-improvement methods for adjusting the processes to better meet the objectives; and
7. Revising the curricular, administrative, and other processes so that their outcomes meet the objectives.

Below, we briefly describe the program objectives and assessment procedures as relevant for this program and the post-visit actions taken.

A. Educational Objectives

As stated in the 2002 Self-study Questionnaire, ABET requires institutions to have educational objectives that will outline what students learn in the course of their program of studies and to make use of outcomes assessment techniques to determine the degree to which program goals and objectives are being attained. The assessment, in turn, is to be used in an ongoing process of improving student learning through enhancements to the program.

The motivation in arriving at the program objectives was to establish a philosophical framework for a curriculum in mechanical engineering that meets the challenges of the twenty-first century and beyond. Some of the important skills that are targeted in the content and assignments as the students proceed through the program are:

- Communication Skills
- Computer skills
- Teamwork
- Design skills
- Laboratory skills
- Ethics and Social Awareness
- Quality and Reliability

With the above elements in mind, the objectives for the mechanical engineering programs were first formulated by the Undergraduate Committee within the Department of Mechanical

Engineering at UM. The Committee consisted of a diverse cross-section of the faculty and which is responsible for development and monitoring of the program. These were approved in 1999 after a thorough review and with inputs from the faculty, the officers of various student organizations, the ABET Committee within the Department, the ABET Coordinator for the School of Engineering at UM, and the Board of Advisors for the Department. Periodic reviews are planned every five years to review the objectives, using the same process, and refine or modify the objectives and consequently the curriculum, if necessary. These UM ME objectives were reviewed and reformulated for the collaborative program, as the goals of the program are slightly different from other programs offered by UM.

The program educational objectives for the program are[a]:

1. The program will prepare students for successful engineering careers.
2. Students will learn the fundamentals of mathematics and the physical sciences.
3. Students will learn engineering sciences and demonstrate the application of this knowledge to mechanical engineering problems through course sequences focused on specific, relevant mechanical engineering careers.
4. The program will provide students with practical design experiences through partnerships with industry.
5. The program will challenge the students and the faculty to improve the learning process.
6. The program will continue to raise the expectations of all constituencies, to attract a wide variety of excellent students particularly from the Appalachian region, and to be a nationally recognized model for undergraduate collaborative engineering education.
7. To provide a high quality undergraduate engineering education within a small university environment culminating in a degree in ME from a nationally recognized engineering program.
8. To facilitate and contribute to the economic development of the region.

B. Program Outcomes and Assessment

In this section, the assessment procedures that are being followed for this program are described: first, the student learning outcomes are presented; how the outcomes are related to ABET 2002 Criterion 3 and program objectives is presented next; and finally the assessment procedures currently followed are presented in brief.

B.1. Student Learning Outcomes

Using the ABET 2002 Criterion 3 and the program educational objectives as a guide, student learning-outcomes were determined by the Undergraduate Committee, in a methodology similar to that used to create the Program Educational Objectives, as given below:

1. Knowledge of mathematics, physical science, and engineering science.
2. The specialized knowledge relevant to specific mechanical engineering careers.
3. The ability to apply mathematics, science, and engineering knowledge to solve mechanical engineering problems.
4. The ability to use state of the art engineering software, computers, and instrumentation as tools to solve engineering problems.
5. The ability to work in teams effectively to address practical engineering problems.

[a] Modified based on inputs from ABET reviewers.

6. The ability to use the product development process to design a product that meets customer needs and addresses contemporary social issues.
7. The ability to communicate effectively in presentations and in writing.
8. The ability to design and conduct experiments and to interpret and generalize from the results.
9. Recognition of the contemporary social issues that motivate engineering activities and the societal impact of engineering practice.
10. The recognition that engineers must maintain ethical and professional standards and an appreciation of these standards.
11. For interested and qualified students, the ability to conduct scholarly research.
12. The ability to engage in life-long learning and the ability to conduct research using external sources.

Since one way to assess the outcomes would be through student responses to questions addressing the learning outcomes in various courses and at various stages of the program, a comprehensive survey instrument was needed. For the collaborative program, a Student Course Evaluation survey designed by the School of Engineering at the College Park campus is being utilized, with an addendum for the ITV component. Questions from this survey are then matched to the student learning outcomes and ABET 2002 Criterion 3. The survey is comprised of three parts: 1) course content, 2) the studio/laboratory aspect, and 3) a School of Engineering version of ABET 2002 Criterion 3.

Student learning outcomes are then matched with the program educational objectives. The goal is to ensure that each of the objectives is being expressed through the learning outcomes. These relationships then guide the design and implementation of the assessment plan.

B.2. Program Assessment

The program review and assessment process for this program consists of the following activities:

1. Surveys given to students in the program, alumni, and employers of the graduates, which result in:
    a. Continuous assessment by two faculty committees, the undergraduate committee and the curriculum enhancement committee, of the teaching/learning process for all programs in Mechanical Engineering.
    b. Continuous assessment by individual faculty as well as faculty groups in specific areas.
    c. Continuous assessment by the Department Chair and the Director of Undergraduate Studies.
    d. Continuous assessment by the students.
    e. Assessment based upon input from the outside including alumni, employers, and board of advisors.
    f. Continuous assessment for the courses in engineering science by the Engineering Program Administration Committee at FSU.
2. Additional Assessment Activities were supplemented by transcript evaluation; Fundamentals of Engineering (FE) exam results; internship and research experiences;

poster and paper presentations; results from students competitions; and extra-curricular and other program-specific activities.

3. In-class assessments conducted in selected courses such as capstone design, product development, report writing in the courses, lab courses, selected junior and senior courses, and so forth. Assessment tools consist of tests, projects, reports, activity evaluations, etc. and include the instructor assessment report at the end of the course. To guide the assessment activities, educational objectives and student outcomes are identified for the program and for specific courses; summary assessments are made of student performance in regard to meeting the program objectives.
4. Focus group discussions conducted with graduating seniors in each program.

As most of the above are self-explanatory, except for the assessment procedures performed by the Undergraduate Committee, the same is now explained briefly.

The actions taken by Undergraduate Committee are:

1. Analysis of the Student Evaluation Form for course assessment
2. Analysis of Student Evaluation Form for student development assessment
3. Reconciliation the Faculty/ Student Scoring of Student Evaluation Form
4. Review of the Senior Surveys
5. Review of the Alumni Surveys

Course Assessment. In general, the procedure followed is as follows: A summary, consisting of the average of the students' responses to each of the sixteen questions in the first part the Student Evaluation Form and the departmental average for each question is prepared and examined by the Committee for all of the mechanical engineering courses. In addition to the responses to the individual questions, the Committee also prepares the overall average for each course and compares it against the department mean. The Committee reviews all the data and makes recommendations to the Peer Evaluation Subcommittee as well as to the Chair of the Department for particular courses/instructors to be monitored.

For the engineering courses taught at FSU in the live mode, a summary, as outlined above, is prepared by a Subcommittee formulated for the program, consisting of the ME faculty member at FSU and the Director of the Undergraduate Studies at UM. It is then reviewed by the Undergraduate Committee, the Director of Undergraduate Studies, and the ME faculty member at FSU. After the review, recommendations are forwarded to the Chair of the ME program at UM and the Peer Evaluation Subcommittee at UM and actions are taken accordingly. Due to space constraints examples are not provided in the paper, but are available from the authors.

For courses taught via ITV, additional review procedures are followed because of the ITV component. While the Undergraduate Committee examines the average of all questions in the Student Evaluation Form for both the live section at the College Park campus and the distance section at the Frostburg campus combined as part of the overall review, the subcommittee formulated by the Director of the Undergraduate Studies at UM and the ME faculty member at FSU examines the average evaluation responses for different questions in the evaluation form for the ITV sections only and compares them with those for the College Park campus as well as the entire class, i.e., with both sections combined. Additionally, responses to a second evaluation form that specifically addresses the effectiveness of the course delivery via the ITV are also analyzed.

If the overall averages and the averages for the ITV section for a given course are approximately equal and the ITV delivery is rated to be satisfactory by the students, only the Undergraduate Committee further examines the course and compares the overall scores for the course against the department mean, and then makes the appropriate recommendations to the Peer Evaluation Subcommittee and the Chair of the ME Department, as is done for all the other courses. If the overall averages and the averages for the ITV section are approximately equal, but the course delivery is rated to be dissatisfactory by the students, it is then communicated to the respective ITV Departments at both institutions through the Chairs of the Departments and appropriate actions are requested.

Additionally the Undergraduate Committee reviews the course as it does for all the other ME courses. If the averages for both sections together and the ITV section are not equal and the ITV transmission quality is rated to be satisfactory by the students, the Undergraduate committee and the Director of Undergraduate Studies examine the suitability of the faculty member for the ITV sections and make appropriate recommendations to the Department chair. The Committee also examines the course in comparison with the department mean and makes appropriate recommendations. In cases such as the above, if the ITV transmission quality is also rated dissatisfactory, it is also communicated to the respective departments for appropriate action.

Student-development Assessment. The Undergraduate Committee utilizes the students' responses to the questions in the second part of the evaluation form as one way to assess the collaborative program. The responses are tallied by semester, and for each student class (sophomore, junior, senior), and by question (e.g., My ability to apply mathematics has improved). Although these responses tend to be qualitative, they provide some guidance in determining what areas will need to be focused for improvement. From data from the past two years, it appears that the overall growth perceived by the students in the program has increased appreciably in the junior year. This could possibly be because of the fact that the major part of the mechanical engineering core curriculum is presented in that year. There does not appear to be any appreciable difference between the junior and senior years, which could be attributed to the fact that, while certain skills such as designing and conducting experiments are at their highest in the junior year due to the emphasis on studios in such areas, certain other skills such as ability to design a component or a system may have increased in the senior year. Thus when all the skills are combined together, it appears that the overall development appears to be at the same level. The quality of delivery of the ITV courses and the smaller range of technical electives (compared to the College Park campus) offered can possibly be another reason.

Reconciliation the Faculty/ Student Scoring. As another way to measure the coverage of the learning outcomes by the courses, faculty pre-score the courses they teach with respect to the Student Learning Outcomes. This practice helps the faculty clarify where they are focusing their efforts in the course and the program to determine the coverage of all of the Student Learning Outcomes by the courses. In order to determine appropriate action, the Undergraduate Subcommittee for the program compares the faculty scoring to the student responses provided through the course evaluation forms. If differences exist in responses, the Committee examines if these were a result of the faculty's failing in his or her intentions or whether the course objectives were not being focused on. Where discrepancies exist the faculty member is asked to provide comments and take corrective actions.

Senior and Alumni Surveys. Currently, senior and alumni surveys are obtained yearly and once every two years, respectively, using instruments designed by the School of Engineering at the UM. This is done to assess the following:

1. degree of gain in the outcome areas for the graduating seniors;
2. current levels of competence in the outcome areas for the graduating seniors;
3. perceived level of importance of each outcome area for the alumni; and
4. perceived level of competence attained in each outcome area for the alumni.

The surveys are analyzed to make appropriate recommendations. It may be expected that there will be certain areas where there may be differences between the groups of seniors and alumni surveyed, although a general agreement between the groups is likely to be found. For example, a group of alumni graduated five years earlier than another group and who may have been working since then may see some outcome areas such as management, professionalism, and social awareness as more important than those who have graduated later. This is likely to occur as they move into supervisory positions and may see some of the areas as being more important. Similarly, the more recent graduates may see skills such as engineering problem solving, creative thinking, and teamwork as more important.

In addition to the assessment procedures outlined above, surveys are now also being sent yearly to employers of the graduates as well as to other industries in the region for assessment and to get input on possible refinement of the program learning objectives. This action is being taken in response to the recommendations made by the ABET accreditation team, from the visit that occurred in October 2002.

B.3. Closing the Loop

Summaries from all of the assessment procedures are provided to different committees, at both institutions, such as the Teaching Enhancement Committee, Syllabus Evaluation Sub-committee, Learning Enhancement Committee, and Peer Evaluation Sub-committee, to take the required corrective actions and close the loop through performing the following:

1. Establish committee focus and recommendations;
2. Establish a Course Syllabus Assessment Plan and work with the undergraduate director and the course professors to improve the course design and the syllabus;
3. Analyze results from the Student Evaluation Form for course evaluation;
4. Establish a Peer Review procedure and structure: to perform sequential peer reviews of all the members in focus groups and provide constructive comments and feedback to the faculty about how they might improve their teaching format, presentation, organization, and interaction with the students.

As an on-going process, recommendations from the committees are continually carried out through appropriate action and monitored by the subcommittee for the collaborative program.

IV. Summary

The University of Maryland and Frostburg State University have collaborated to develop a novel program in mechanical engineering in western Maryland that provides opportunities in engineering graduates and further engineering educational opportunities for employees of local industries in the area. Students are FSU students for the first two years of the program and transfer to UM for the final two years, although they maintain residence at the FSU campus. The University of Maryland is the degree granting institution. .

The program has the following characteristics:

1. the program combines traditional instruction with interactive distance education;
2. the program is resident on a non-engineering college campus (FSU);
3. all courses in basic and engineering sciences, general education, mechanical engineering courses involving design or lab components, and courses in advanced topics are taught in the traditional mode; all remaining courses in mechanical engineering including the electives are taught in the distance education mode;
4. the degree is granted by the engineering school campus (UM); and
5. administration of the program is conducted by both institutions.

The program started in the fall of 1997 with a cumulative enrollment of 39 (in mechanical and electrical engineering combined). Basic infrastructure (building, library facilities, laboratories, faculty, and staff) has been established to ensure a successful program. Eighteen students have graduated since 2001 and nine are on track to graduate in 2004.

Since the program at the Frostburg campus is distinct from that at the College Park campus, a separate ABET accreditation was sought soon after graduating the first students in the program in 2001. The review occurred in October 2002, following which an accreditation status was awarded in July 2003. Based on the reviewers' recommendations and as an on-going process, a feedback mechanism for continuous improvement is being implemented.

Acknowledgements

The authors wish to acknowledge the dedication of our faculty, administrators, and staff involved in the program at both institutions, who through a process of selfless efforts, mutual education, respect, and a growing realization of how we all needed to do this work for the sake of our students, have developed and sustained this unique program.

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2. *Undergraduate Catalog 2003-2004*, University of Maryland.
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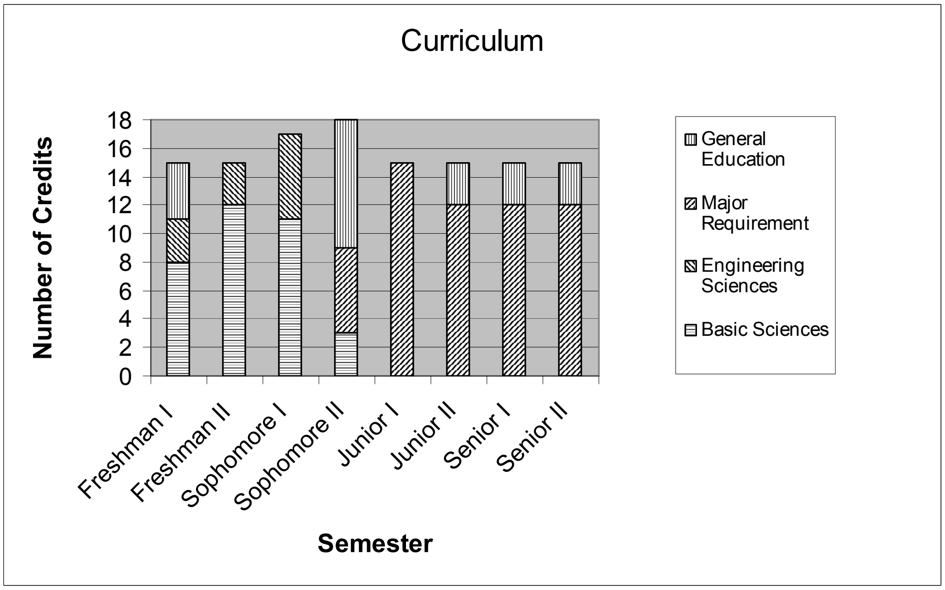

Figure 1. Mechanical Engineering curriculum – distribution of the curricular areas

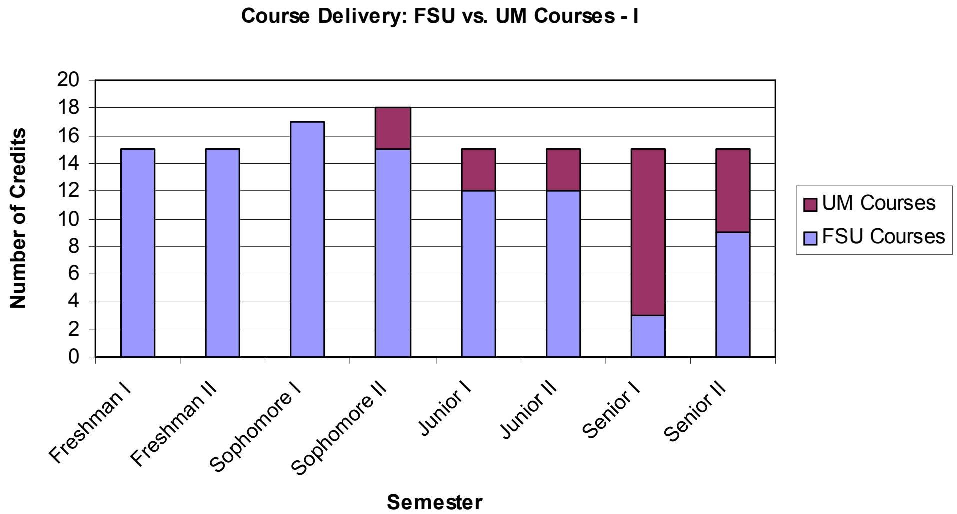

Figure 2(a). Distribution of FSU vs. UM courses for the case when a student opts for the maximum number of courses from the College Park campus.

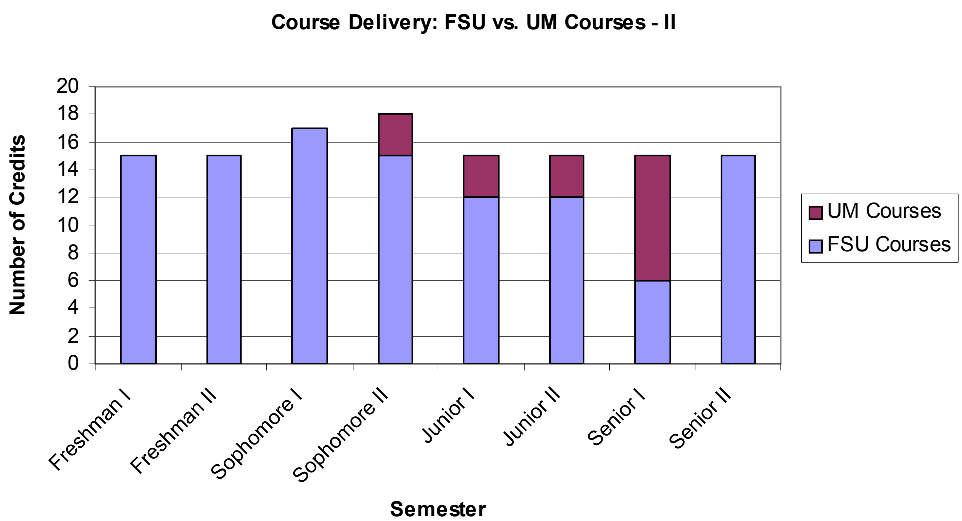

Figure 2(b). Distribution of FSU vs. UM courses for the case when a student opts for the minimum number of courses from the College Park campus.

Table 1: Undergraduate Program in Mechanical Engineering - Curriculum (125-126 credits)

FRESHMAN YEAR

Fall Courses	Credits	Spring Courses	Credits
Intro. to Higher Education – **General Education**	1	Calculus II - **Basic Sciences**	4
Calculus I – **Basic Sciences**	4	Principles of Physics II - **Basic Sciences**	4
Principles of Physics I - **Basic Sciences**	4	Statics – **Engineering Sciences**	3
Introduction to Engineering Design – **Engineering Sciences**	3	General Chemistry **- Basic Sciences**	4
Freshman Composition - **General Education**	3		
TOTAL FALL	15	TOTAL SPRING	15
TOTAL FRESHMAN YEAR CREDITS = 34			

SOPHOMORE YEAR

Fall Courses	Credits	Spring Courses	Credits
Calculus III **- Basic Sciences**	4	Differential Equations - **Basic Sciences**	3
Principles of Physics III - **Basic Sciences**	4	Numerical Methods in Mechanical Engineering – **Major Requirement**	3
Mechanics of Materials – **Engineering Sciences**	3	**General Education** courses	9
Dynamics – **Engineering Sciences**	3	Thermodynamics **– Major Requirement**	3
General Chemistry II - **Basic Sciences**	3-4		
TOTAL FALL	17-18	TOTAL SPRING	18
TOTAL SOPHOMORE YEAR CREDITS = 35-36			

JUNIOR YEAR

Fall Courses	Credits	Spring Courses	Credits
Differential Equations	3	Electronics and Instrumentation II – **Major Requirement**	3
Fluid Mechanics – **Major Requirement**	3	Transfer Processes – **Major Requirement**	3
Electronics and Instrumentation I – **Major Requirement**	3	Vibration, Controls and Optimization I – **Major Requirement**	3
Product Engr. & Mfg. – **Major Requirement**	3	Engr. Materials & Mfg. Processes – **Major Requirement**	3
Statistical Methods – **Major Requirement**	3	Technical Writing **General-Education Course**	3
TOTAL FALL	15	TOTAL SPRING	15
TOTAL JUNIOR YEAR CREDITS = 30			

SENIOR YEAR

Fall Courses	Credits	Spring Courses	Credits
Vibration, Controls and Optimization II – **Major Requirement**	3	Integrated Product & Process Development II – **Major Requirement**	3
Technical Electives – **Major Requirement**	9	Technical Electives – **Major Requirement**	6
General-Education course	3	Non-Technical Elective – **Major Requirement**	3
		General-Education course	3
TOTAL FALL	15	TOTAL SPRING	15
TOTAL SENIOR YEAR CREDITS = 30			

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