UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Department of Mechanical Science and Engineering
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**James W. Phillips**
*Professor and Associate Head*

Dr. John C. Ory, Director
Center for Teaching Excellence
249 Armory, MC-528
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August 11, 2008

Dear Mr. Ory,

On behalf of the faculty in the Department of Mechanical Science and Engineering, I wish to submit the following plan for assessing and improving our degree programs.

As a preamble to the report, I would like to explain that our unit is named **Mechanical Science and Engineering (MechSE)**, which was formed in August 2006 by combining two other College of Engineering units—**Theoretical and Applied Mechanics (TAM)** and **Mechanical and Industrial Engineering (MIE)**. Also at that time, the Industrial Engineering part of Mechanical and Industrial Engineering was transferred to another newly combined unit called **Industrial and Enterprise Systems Engineering (IESE)**.

As a consequence of these College reorganizations, the undergraduate and graduate programs in Mechanical Engineering, as well as the undergraduate program in Engineering Mechanics and the graduate program in Theoretical and Applied Mechanics, are now administered by MechSE.

# Unit Plan for Assessing and Improving Student Learning in Degree Programs

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| Unit: | **Mechanical Science and Engineering** |
| Unit Head approval: | **Huseyin Sehitoglu/JWP** |
| Date: | **August 11, 2008** |

## *Section 1: Past Assessment Results*

*Brief description of changes or improvements made in your unit as the result of assessment results since 2000.*

Undergraduate curricula in the College of Engineering are regularly reviewed by the Accreditation Board for Engineering and Technology (ABET), which has been recognized by the Council for Higher Education Accreditation (CHEA) since 1997. The curricula in Engineering

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Mechanics and in Mechanical Engineering underwent ABET review in 2001 and again in 2007, immediately following the College reorganization.

**Engineering Mechanics**

The assessment of the Engineering Mechanics program during the 2001 accreditation process was highly positive, with no weaknesses or deficiencies cited in the ABET final report. That report did mention two concerns: a small number of students in the program led to a concern about long-term viability of the program, and the importance of institutional support for recruitment and retention of faculty was emphasized.

By 2007, however, the number of undergraduate students in the Engineering Mechanics program had grown, from 29 in Fall 2001 to 62 in Fall 2006. This increase was a result of concerted efforts by the TAM and MechSE Departments to recruit students into the program. Recruiting efforts now include mailings of brochures about Engineering Mechanics to high school students with strong ACT scores, and departmental scholarship offers to the most qualified students who are admitted as freshmen. Faculty and current Engineering Mechanics students also volunteer to contact any prospective student by phone if an applicant requests this interaction by means of a returned postcard. As a result, the number of new freshmen in Engineering Mechanics has averaged 17.8 over the years 2001–2007, compared with 4.7 for the six years before that. These efforts have substantially increased the viability of the program.

The picture for faculty recruitment and retention has also improved dramatically with the merger of TAM and ME to form the new MechSE Department. While TAM had 17 FTE faculty in 2001, MechSE had 52 tenured or tenure-track professors and two full-time lecturers in 2007. Within the department there is no distinction between ME and TAM faculty members. Instead, teaching assignments are made in light of each faculty member's technical expertise, teaching experience, and teaching preferences. During the first year of the merger, 17 different MechSE faculty members taught TAM courses, and many more expressed interest in teaching TAM courses in the future. Thus, a large body of faculty members can now be called on to teach the courses of the Engineering Mechanics curriculum. Additionally, the MechSE department has been very active in faculty recruiting, hiring four new professors during the 2006–2007 recruiting cycle, three of whom would have been TAM faculty members in the pre-merger organizational scheme by virtue of their expertise and research interests.

The 2007 ABET review of the Engineering Mechanics program was also favorable, and as a result the Engineering Mechanics program is accredited for the period 2007–2013.

**Mechanical Engineering**

The ABET assessment of the Mechanical Engineering program during the 2001 accreditation process was also highly positive, and cited the high caliber of students, the well-designed curriculum, the commitment and enthusiasm of the faculty, and the world-class facilities as program strengths.

One program concern was cited: that the culminating major design experience might not incorporate an adequate range of realistic constraints. The department traced the source of this concern to the content of the senior capstone design projects. Projects that were submitted by industry tended to involve a wide range of realistic constraints, while some of the projects

submitted by faculty had a research orientation, and involved fewer constraints. Since 2001 we have tried several strategies to increase the number of industry-sponsored design projects in our capstone design course. Due to the size of our undergraduate body, we need approximately 45 design projects each year. The most effective strategy has been to hire a half-time Senior Design Project Coordinator, an academic professional with a strong engineering background, whose primary job is to solicit design projects from industry. We employed our first coordinator from June 2005 to July 2006, and he was quite successful at increasing the number of industry-sponsored design projects. The project coordinator was not immediately replaced when he left in July 2006, and the number of industry projects declined through Fall 2006 and Spring 2007. In early Spring 2007, the department initiated a search for a new Senior Design Project Coordinator. A well-qualified individual, Dr. Emad Jassim, was hired in June 2007. As a consequence, virtually all senior projects are now again sponsored by industrial firms.

The 2007 ABET review of the Mechanical Engineering program was also favorable, and as a result the Mechanical Engineering program is accredited for the period 2007–2013.

## *Section 2: Revised Assessment Plan*

### (a) Process

*Brief description of the process followed to develop or revise this assessment plan.*

The assessment plan outlined by ABET is very thorough and is considered adequate for evaluating our undergraduate programs in Engineering Mechanics and in Mechanical Engineering. Eleven student outcomes, as detailed in Section 2(b) below, are identified and then assessed by the faculty using tools that have quantitative measure.

Revisions to the assessment plan are incremental in nature and involve changes in procedure or methods of data collection rather than significant changes in emphasis. For example, virtually all the Engineering Mechanics and Mechanical Engineering seniors who sign up to take the nationally administered Fundamentals of Engineering examination pass this examination during their last semester of study. Nevertheless, only a fraction of the students eligible to take the examination actually sign up for it. The MechSE Department is considering ways to encourage more graduates to take the examination, not only to improve the assessment process but also to assist these alumni in pursuing professional engineering registration later in their careers.

### (b) Student outcomes

*List Unit's student learning outcomes (knowledge, skills, and attitudes).*

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to design a system, component, or process to meet desired needs within such realistic constraints as economic, environmental, social, political, ethical, health, safety, manufacturability, and sustainability
- An ability to function on multidisciplinary teams

- An ability to identify, formulate, and solve engineering problems
- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- A recognition of the need for, and an ability to engage in, lifelong learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

## (c) Measures and methods used to measure outcomes

A combination of direct and indirect measures is used to measure and assess outcomes. Direct measures include the faculty evaluation of written student work, such as homework, hour examinations, project reports, laboratory reports, and final examinations in targeted courses, as illustrated in Table 1 for the Engineering Mechanics program. There is a similar table for the Mechanical Engineering program. In the table, a "Y" indicates that a given course could be used to evaluate the listed outcome. A gray box with a "Y" indicates that the Undergraduate Programs Committee selected the course for evaluating the outcome.

**Table 1. Mapping of courses and program outcomes (Engineering Mechanics)**

| Outcome | GE 101 | ME 300 | TAM 195 | TAM 211 | TAM 212 | TAM 251 | TAM 252 | TAM 302 | TAM 324 | TAM 335 | TAM 412 | TAM 445 | TAM 470 | DSE 1 | DSE 2 | Number of assmts for outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) An ability to apply knowledge of mathematics, science and engineering | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | 3 |
| (b) An ability to design and conduct experiments, as well as to analyze and interpret data | | Y | Y | | | | | | Y | Y | | | | | Y | 2 |
| (c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, safety, manufacturability, and sustainability | Y | Y | Y | Y | | Y | Y | Y | Y | Y | Y | | | Y | Y | 3 |
| (d) An ability to function on multi-disciplinary teams | Y | | Y | | | | | Y | Y | Y | | | | | Y | 2 |
| (e) An ability to identify, formulate, and solve engineering problems | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | 4 |
| (f) An understanding of professional and ethical responsibility | | | Y | | | | Y | Y | | | | | | | Y | 2 |
| (g) An ability to communicate effectively | Y | | Y | | | | Y | Y | Y | Y | Y | | | | Y | 2 |
| (h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context | Y | Y | Y | | | | Y | Y | | Y | | | | | Y | 3 |
| (i) A recognition of the need for, and an ability to engage in life-long learning | Y | Y | Y | | | | Y | | Y | Y | | | | | Y | 2 |
| (j) A knowledge of contemporary issues | Y | Y | Y | | | | | Y | | | | | | | Y | 3 |
| (k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | Y | Y | | | | | Y | Y | Y | Y | Y | | Y | | Y | 3 |
| Number of assessments for course | 1 | 2 | 5 | 1 | 0 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 4 | 29 |

This faculty-centered approach to establishing grading rubrics and performance criteria leads to some variation among the assessments. However, it has a number of advantages. It creates wide involvement by the department faculty, and encourages all faculty members to reflect on the relationship between their teaching and the program objectives. It allows for different approaches to assessment, so that the department benefits from the creativity of the faculty and sees some valid approaches that might not otherwise be considered. Most importantly, the resulting overall standard for meeting the program outcomes is a true composite of faculty opinions.

Other direct measures include the fraction of graduates passing the Fundamentals of Engineering examination, as mentioned previously.

Indirect measures include the *Chancellor's Senior Survey on the Undergraduate Experience at UIUC* and regular input from the department's Student Leadership Board, which consists of the presidents of such undergraduate societies as the American Society of Mechanical Engineers, the Society for Experimental Mechanics, Society of Automotive Engineers, Pi Tau Sigma (honorary society), Society of Women Engineers, and Society of Hispanic Professional Engineers.

## *Section 3: Plans for Using Results*

### (a) Plans

*Brief description of plans to use assessment results for program improvement.*

The Undergraduate Programs Committee meets regularly to study the effectiveness of the Engineering Mechanics and Mechanical Engineering programs.

For example, in a 2007 review of the mathematics preparation of the Engineering Mechanics students for advanced undergraduate courses and graduate study, the Undergraduate Programs Committee voted to replace Math 380, Advanced Calculus, with Math 442, Partial Differential Equations, as a required course. A change was needed because the Mathematics Department had determined that the subject matter in Math 380 was now being covered in the third calculus course, Math 241. Similarly, in a 2008 review of the structure of the Mechanical Engineering curriculum, a proposal that will likely lead to a more flexible curriculum with fewer hours required for graduation—a directive that is expected from the College of Engineering—has been proposed.

### (b) Timeline for implementation

Issues raised by, or submitted to, the Undergraduate Programs Committee are usually resolved over the period of an academic year, with proposals then forwarded to the College of Engineering for approval and submission to campus administration. The mathematics change in the Engineering Mechanics curriculum, for example, has been approved by the College and forwarded, to be effective for freshmen entering in Fall 2008. Changes in the statistics technical elective in the Mechanical Engineering curriculum are following the same timeline. The proposed change in the structure of the Mechanical Engineering program will be formalized in the Fall 2008 semester and forwarded to the College for implementation with an anticipated effective date of Fall 2009. A study of the reduction in the number of hours required for the

Engineering Mechanics degree is also expected in Fall 2008. Implementation could be as early as Fall 2009.

In a related effort carried out in cooperation with the Department of Industrial and Enterprise Systems Engineering, the effectiveness of the Manufacturing Minor in the College of Engineering was assessed in Spring 2008. It was found that this minor, which enjoyed some popularity among Engineering students in the 1990s, is not widely pursued today. As a consequence, a recommendation was made by the MechSE and IESE Departments to eliminate the Manufacturing Minor and selected manufacturing courses, effective Fall 2008, and this recommendation was subsequently endorsed by the College of Engineering.

## *Closure*

This Unit Plan for Assessing and Improving Student Learning in Degree Programs has emphasized the undergraduate programs in the MechSE Department. A significant ongoing effort has also been made by the department's Graduate Programs Committee to assess and improve the learning experience for students pursuing master's and doctoral degrees in Theoretical and Applied Mechanics and in Mechanical Engineering. For example, in the graduate program in Mechanical Engineering, a detailed assessment of the topical areas for the Qualifying Examination and a uniform standard for evaluating proficiency in these areas was developed and implemented in the 2006–2007 and 2007–2008 academic years.

Currently, the department's graduate course offerings in Fluid Mechanics and Thermal Sciences, Dynamics and Controls, Solid Mechanics and Materials, Biomechanics, and Nanomechanics are under study by faculty committees specifically appointed to examine relevance, overlap, and cross-listing in each of these areas. An October 2008 deadline has been set for committee reports, with recommendations to be forwarded to the Graduate Programs Committee and the entire faculty for action in late Fall 2008 or early Spring 2009. A model example of this committee effort was the recent development of two new courses, ME 481—Whole-Body Musculoskeletal Biomechanics, and ME 482—Musculoskeletal Tissue Mechanics, both based on previously offered special-topics courses, which have since been approved for cross-listing by the new Bioengineering Department in the College of Engineering.

Sincerely yours,

James W. Phillips, Ph.D., P.E.
Associate Head for Undergraduate Programs
Chief Advisor, Engineering Mechanics
Chief Advisor, Mechanical Engineering
Formerly, Associate Head for Mechanics Programs