NCA ASSESSMENT REPORT

Mechanical Engineering Undergraduate Program

Cleveland State University

July 2004

1. Program Goals/objectives

The program objectives are shown below:

(1) Practice Mechanical Engineering in Fluid & Thermal/Energy Conversion and mechanical System stems of the discipline in private, government or industrial organizations
(2) Practice mechanical engineering in environments that requires variety of roles including engineering problem identifications, application of advanced methods of analysis, problem diagnosing, solution of real-world engineering design problems that are subject to realistic constraints such as cost, safety, etc
3) Take the role of a team member or team leader in the engineering profession of their employment, in professional organizations
4) Enhance their knowledge beyond BS level, a life-long learner, and advancements in engineering and technology
5) Become an active member of the engineering profession by taking and passing the principles and practice exams and become licensed Professional Engineers

These objectives were written by the faculty, with input from the industrial advisory committee and alumni.

2. Program Outcomes

The outcomes were specified by the Engineering Accreditation Committee, with some modifications by the faculty. Upon graduation, our students should have the following skills:

a): Apply Math, Science & Engineering Knowledge

(b): Experimental Design, and Experimental Data Collection and Analysis

(c): Engineering Design (Thermal/Fluid and Machine Systems)

(d): Multidisciplinary Teamwork

e): Identification, Formulation & Solution of Engineering Problems

f): Understanding of Professional and Ethical Responsibility

(g): Communicate Effectively

(h): Understanding of Global/Social Impact of Engineering Solutions

& Contemporary Issues
(i): Need and Ability to Engage in Lifelong Learning
(j): Modern Engineering Practice

3. Research

The following assessment tools were used to assess the program's success in meeting our goals and outcomes: alumni survey (of students 2-3 years after graduation), questionnaire of the industrial advisory committee, assessment by the senior design project instructor, senior student exit survey, and course reflection forms. Each of these have been modified over the last few years to more closely correspond to the goals and outcomes.

4. Findings

The assessment results are shown here for program objectives and outcomes.

Objectives:
Three tools were used to assess the ME program's objectives. This section summarizes the results that are specifically related to program objectives.

Result of Alumni Survey

Program Objective	% of respondents that met objective avg. score
(1) Practice Mechanical Engineering in Fluid & Thermal/Energy Conversion and mechanical System stems of the discipline in private, government or industrial organizations	88.8%
(2) Practice mechanical engineering in environments that requires variety of roles including engineering problem identifications, application of advanced methods of analysis, problem diagnosing, solution of real-world engineering design problems that are subject to realistic constraints such as cost, safety, etc	83.4%
3) Take the role of a team member or team leader in the engineering profession of their employment, in professional organizations	26.5%
4) Enhance their knowledge beyond BS level, a life-long learner, and advancements in engineering and technology	55.9%
5) Become an active member of the engineering profession by taking and passing the principles and practice exams and become licensed Professional Engineers	Unknown

Analysis

We are pleased to learn that over 80% of our alumni have been practicing in the field of mechanical engineering since they graduated. 55.9% of them have been engaged in lifelong learning by taking graduate courses or attending workshops or short courses. We, however, do not know how many of our alumni have taken the Professional Engineers exam. This is because that the alumni that we surveyed are the recent graduates, defined as no more than three years after graduation, and they had to practice engineering for at least three years to be eligible for taking the PE exam.

Result of ME Advisory Committee Questionnaire

Program Objective	2003	2004	Avg.
(1) Practice Mechanical Engineering in Fluid & Thermal/Energy Conversion and Mechanical System stems of the discipline in private, government or industrial organizations	2.25/3.0	2.28/3.0	2.27/3.0
(2) Practice mechanical engineering in environments that requires variety of roles including engineering problem identifications, application of advanced methods of analysis, problem diagnosing, solution of real-world engineering design problems that are subject to realistic constraints such as cost, safety, etc	2.5/3.0	2.32/3.0	2.41/3.0
(3) Take the role of a team member or team leader in the engineering profession of their employment, in professional organizations	N/A	N/A	N/A
(4) Enhance their knowledge beyond BS level, a life-long learner, and advancements in engineering and technology	3.0/3.0	2.6/3.0	2.8/3.0
(5) Become an active member of the engineering profession by taking and passing the principles and practice exams and become licensed Professional Engineers	N/A	N/A	N/A

Analysis

The committee was not asked about objectives (2) and (4). The results met our established criteria of 2.25. Even though one participating committee member was different between 2003 and 2004, there is no significant difference in the evaluation score.

Result of Senior Design Instructor Assessment

Program Objective	2003	2004	Avg.
(1) Practice Mechanical Engineering in Fluid & Thermal/Energy Conversion and Mechanical System stems of the discipline in private, government or industrial organizations	4.0/5.0	4.0/5.0	4.0/5.0
(2) Practice mechanical engineering in environments that requires variety of roles including engineering problem identifications, application of advanced methods of analysis, problem diagnosing, solution of real-world engineering design problems	4.5/5.0	5.0/5.0	4.75/5.0

that are subject to realistic constraints such as cost, safety, etc			
(3) Take the role of a team member or team leader in the engineering profession of their employment, in professional organizations	N/A	N/A	N/A
(4) Enhance their knowledge beyond BS level, a life-long learner, and advancements in engineering and technology	N/A	N/A	N/A
(5) Become an active member of the engineering profession by taking and passing the principles and practice exams and become licensed Professional Engineers	N/A	N/A	N/A

Analysis

The average scores listed above met the program objective criteria of 3.5. Note that the scores are consistent in the two years that we evaluated.

Conclusion and Follow-up Corrective Actions

Out of three assessment tools for the ME program outcomes, only the alumni survey has direct relevance. Relevance of the other two tools is rather remote. The program's objectives are difficult to assess once our students are graduated. Nevertheless, the fact that we have achieved our outcomes (shown later) serves as an indicator to project good likelihood of achieving our program objectives.

Note that the alumni survey result is based on the survey conducted in October 2001. The survey has the sample size of 34, which is sufficient for data analysis. We recently received the survey result conducted in Fall 2003. However, due to poor response rate, the sample size of 3 is too small to be used for statistical analysis, although the result is similar.

The 2001 alumni survey indicates that absolute majority of our alumni have been actively involved with mechanical engineering and lifelong learning. It is worthwhile to note that half of our alumni rated the ME program's overall quality as "high", while the other half rated the program as "moderate". In other words, the average score is 2.5 out of 3 (referring to Question 22 in the Alumni Survey listed in Sec. 3.7.5)

In addition to the positive alumni survey result, the assessment results from our advisory committee and senior design instructors also suggest that the criteria for our program objectives are met.

Outcomes

The results shown above have been compiled and presented on the outcome basis. Out of the five assessment tools, three are based on the scale of 1 to 5, while the remaining two are based on the scale of 1 to 3. For the sake of comparison, 1-3 is rescaled to 1-5. The outcome assessment results are summarized one by one as follows:

Outcome (a): Apply Math, Science & Engineering Knowledge

Assessment Tool / Relevance	Direct Relevance ■	Reasonable Relevance ▣	Remote Relevance ⊡	N/A ☐
Instructor's course reflection form	4.22/5.0			
Senior exit survey			4.03/5.0	
Senior design instructor assessment	4.75/5.0			
ME advisory committee questionnaire		4.02/5.0		
ME alumni survey		3.81/5.0		

Conclusions: The lowest score comes from ME advisory committee's questionnaire, although it meets the department's criterion. This perhaps has to do with the fact that it was hard for the committee evaluators to assess our senior students' ability to apply math, science to engineering by reviewing only their proposal presentations and final project presentations. Therefore, relevance is considered reasonable, rather than direct. In terms of direct relevance, two tools fall into this category. They are the instructor's course reflection forms and senior design instructor assessment. As it can be seen, they both score very high, but of course neither are very objective.

Outcome (b): Experimental Design, and Experimental Data Collection and Analysis

Assessment Tool / Relevance	Direct Relevance ■	Reasonable Relevance ▣	Remote Relevance ⊡	N/A ☐
Instructor's course reflection form	3.75/5.0			
Senior exit survey		3.65/5.0		
Senior design instructor assessment	3.5/5.0			
ME advisory committee questionnaire				☐
ME alumni survey		3.39/5.0		

Conclusions: Although all the above scores meet the program outcome, none of them is above 4.0. This seems to suggest that experimental design, data collection and analysis need to be emphasized in our curriculum.

Outcome (c): Engineering Design (Thermal/Fluid and Machine Systems)

Assessment Tool / Relevance	Direct Relevance ■	Reasonable Relevance ▣	Remote Relevance ⊡	N/A ☐

Instructor's course reflection form	4.2/5.0			
Senior exit survey		3.65/5.0		
Senior design instructor assessment	4.0/5.0			
ME advisory committee questionnaire		3.55/5.0		
ME alumni survey	3.61/5.0			

Conclusions: Once again the lowest score comes from ME advisory committee's questionnaire, although it meets the department's criterion. This perhaps has to do with the fact that it was hard for the committee evaluators to assess our senior students' ability to design a mechanical system by participating their proposal presentations and final project presentations. Through my constant discussions with the advisory committee, I believe that industrial people want to see more practical and industry sponsored senior projects. This is something that we should improve in the future, even though we had some senior projects supported by our committee members in the past. In terms of direct relevance, two tools fall into this category. They are the instructor's course reflection forms and senior design instructor assessment. As it can be seen, they both score very high.

Outcome (d): Multidisciplinary Teamwork

Assessment Tool / Relevance	**Direct Relevance** ■	**Reasonable Relevance** ▣	**Remote Relevance** ⊡	**N/A** ☐
Instructor's course reflection form			3.67/5.0	
Senior exit survey		3.6/5.0		
Senior design instructor assessment	4.75/5.0			
ME advisory committee questionnaire				☐
ME alumni survey	3.88/5.0			

Conclusions: The instructors' reflection forms scored the lowest, which is understood and expected because some of our courses are fundamental and single disciplined. Generally speaking, junior and senior courses involved with design projects required teamwork. Our senior design instructors gave high scores, so did our alumni who had good teamwork experience while they were in school. Our advisory committee was not asked about the teamwork.

Some examples of multi-disciplinary teamwork projects are such as the Hulett project that required collaboration between mechanical engineering (for machine design)and electrical engineering (for control), and the mini Baha Car that required collaboration between mechanical engineering and business (for cost analysis and cost management).

Outcome (e): Identification, Formulation & Solution of Engineering Problems

Assessment Tool / Relevance	Direct Relevance ■	Reasonable Relevance ▣	Remote Relevance ⊡	N/A ☐
Instructor's course reflection form	4.18/5.0			
Senior exit survey		3.85/5.0		
Senior design instructor assessment	4.75/5.0			
ME advisory committee questionnaire				☐
ME alumni survey	3.97/5.0			

Conclusions: The scores are all high, especially from the senior design instructors. The instructors' course reflection forms also received high score. It's interesting to note that our alumni believed that they could properly identify, formulate and solve engineering problems.

Outcome (f): Understanding of Professional and Ethical Responsibility

Assessment Tool / Relevance	Direct Relevance ■	Reasonable Relevance ▣	Remote Relevance ⊡	N/A ☐
Instructor's course reflection form		4.58/5.0		
Senior exit survey		3.7/5.0		
Senior design instructor assessment	4.5/5.0			
ME advisory committee questionnaire				☐
ME alumni survey	3.34/5.0			

Conclusions: Understanding of professional and ethical responsibilities can be better observed when the students are working on their senior design projects, and when our alumni engage in engineering practice. In regular courses, other than senior design, instructors often mentioned the importance of professional and ethical responsibility. In addition, all engineering students are required to take a Philosophy course entitled "Engineering Ethics".

In terms of professional responsibility, many of our students join ASME, and some join SME and AIAA. ASME is perhaps most active, which constantly holds meetings and give members plant tours.

Outcome (g): Communicate Effectively

Assessment Tool / Relevance	Direct Relevance ■	Reasonable Relevance ▣	Remote Relevance ⊡	N/A ☐
Instructor's course reflection form		3.92/5.0		
Senior exit survey		3.65/5.0		
Senior design instructor assessment	4.75/5.0			
ME advisory committee questionnaire	3.85/5.0			
ME alumni survey	3.53/5.0			

Conclusions: Engineering students are generally perceived to be lack of good communication skills. Communication can be divided into two categories: oral communication and written communication. The ME department recognized the need to enhance our students' writing skills as early as possible by requiring the freshmen course entitled "Technical Writing and Communication". This course was implemented in 1999. As a result, our faculty often mentioned that they were pleased with our students' writing and presentation skills.

In addition, we started to implement the "Pro Skills", formerly known as "WriteTalk" program in as early as 2002. This program complements our technical writing course by enhancing our students' writing, and in particular, oral presentation skills. More details of this program are given later.

Outcome (h): Understanding of Global/Social Impact of Engineering Solutions & Contemporary Issues

Assessment Tool / Relevance	Direct Relevance ■	Reasonable Relevance ▣	Remote Relevance ⊡	N/A ☐
Instructor's course reflection form		3.33/5.0		
Senior exit survey			3.65/5.0	
Senior design instructor assessment				☐
ME advisory committee questionnaire				☐
ME alumni survey		3.05/5.0		

Conclusions: All assessment tools indicate that perhaps we need to do more in this category, even though they met the criterion of the outcome, except that the score is a little lower than expected from our alumni survey. We do not believe that this outcome has a direct link to the quality of our curriculum. Understanding of global/social solution and contemporary issues are perceived as more informational than fundamental.

Outcome (i): Need and Ability to Engage in Lifelong Learning

Assessment Tool / Relevance	Direct Relevance ■	Reasonable Relevance ▣	Remote Relevance ⊡	N/A ☐
Instructor's course reflection form			3.8/5.0	
Senior exit survey			3.8/5.0	
Senior design instructor assessment				☐
ME advisory committee questionnaire				☐
ME alumni survey	3.18/5.0			

Conclusions: The alumni survey scored the lowest, a little lower than the criterion of 3.25. We can try to convince our seniors of the importance of lifelong learning perhaps by encouraging them to do literature search through internet. This outcome, indeed, is very difficult to assess even when students are still in school. The relevance is either remote or not applicable in every assessment tool.

Outcome (j): Modern Engineering Practice

Assessment Tool / Relevance	Direct Relevance ■	Reasonable Relevance ▣	Remote Relevance ⊡	N/A ☐
Instructor's course reflection form	4.0/5.0			
Senior exit survey			3.9/5.0	
Senior design instructor assessment		4.75/5.0		
ME advisory committee questionnaire	4.02/5.0			
ME alumni survey		3.75/5.0		

Conclusions: The scores are all high, especially from senior design instructor assessment and ME advisory committee questionnaire. Our alumni also thought that they have been engaging modern engineering practice since they graduated. The department is very pleased to learn that our advisory committee consisting of technical managers or group leaders in industry gave high remarks on our seniors' ability to practice modern engineering.

5. Review

Overall, the results from all five assessment tools indicate that the ME curriculum has met the program's outcomes, set forth by the department. To strengthen some weakness, the following actions have been taken:

(A) Faculty Retreats on ABET Issues

To help faculty understand ABET EC2000 criteria, the department held two retreats: one in August 2002 and the other one in January 2003. The first one focused on the ME program's outcomes and objectives, and the assessment tools. The second one was more specific about how to assess each course using the "Course Reflection Form", and how to identify the strength and weakness of the student learning ability. At the end, the department's ABET representative explained how the entire ABET evaluation process worked. He also gave the participating faculty an illustrative example. In the second meeting, some faculty mentioned that the *Technical Writing and Communication* course (MCE 102) that the department implemented several years ago seemed to have improved our students' communication skills. The engineering dean, Dr. Alexander, was invited to make a speech in each of the two retreats. He briefly mentioned that he was pleased to see that the ME department had started to implement the "ProSkills" program which has been used as a corrective action.

(B) Faculty Meetings on ABET Issues

In the past two years, ABET related issues have been discussed from time to time in faculty meetings. In particular, during the past academic year (2003-04), the department chair had allocated approximately 20 to 30 minutes in each faculty meeting to discuss ABET related issues such as developing and modifying the assessment tools, reviewing the assessment results, and taking corrective actions.

6. Actions

(a) Implementation of ProSkills Program

ProSkills is a communication and other non-technical skill development program designed to address many of the most important communication and interpersonal skills required for successful careers in engineering. It is based on the experience of the application of the WRITETALK Program and is being incorporated into an integrated design environment (IDE) with knowledge capture at the Fenn College of Engineering.

As an expansion of WRITETALK, ProSkills includes the development of skills for studying, reading, listening, writing, speaking, time management, ethics, networking, project management, teamwork, business principles, diversity, interpersonal relationships, career management, and other appropriate topics as an integrated part of the technical undergraduate education. A consultant provides on-site lectures and hands-on activities for selected courses. For each designated course, this typically involves about ½ of one class lecture period during the semester. The consultant also provides resources and student assignments, evaluates student work, and gives feedback to students.

The department started the program with just one course in the academic year of 2002-03, as a pilot study. In year 2003-04, we implemented the program in four courses. As a result, the program helps the department in strengthening our weakness in Outcome (f): Understanding of Professional and Ethical Responsibility, Outcome (h): Understanding of Global/Social Impact of Engineering Solutions and Contemporary Issues, and Outcome (i): Need and Ability to Engage on Lifelong Learning. To help our students understand ethical responsibility, we require them to take a course entitled "Engineering Ethics". In addition, in the ProSkills program instructor asked the participating students to do an ethical dilemma exercise. To strengthen outcomes (h) and (i), the ProSkills program asked the students to attend society meetings or ASME, SAE seminars and write a report. We think that these activities could help our students better understand the global/social impact of engineering solutions and the need to engage in lifelong learning.