MIAMI UNIVERSITY

SCHOOL OF ENGINEERING AND APPLIED SCIENCE

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

STRATEGIC PLAN

November 30, 2006

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Last Update: November 30, 2006

Overview

This document describes the Strategic Plan of the Department of Mechanical and Manufacturing Engineering (MME) and its three majors in Manufacturing Engineering, Mechanical Engineering, and Engineering Management with Manufacturing Engineering Technical Specialty.

The document includes details of the make up of our department, including unique elements (niches) that make us different, common elements that tie together the curricula of our three majors, and our values, vision, goals, and mission. This document also outlines the systematic approach for assessment, and how it is used to develop and adjust program-educational objectives and outcomes. In addition, we show the process of utilizing our constituencies' feedback, as well as other methods in establishing and evaluating educational objectives and assessing program outcomes, and means to demonstrate evidence that the results are being documented, implemented, and used for the improvement of our programs and system.

In this plan, we demonstrate the assessment process that we undertake, in performing our mission, to improve the quality of education of our undergraduate engineering students in the three majors. Assessment of the accomplishment of our mission provides us with a stimulus for continuous quality improvement. Thus, the underlying purpose of assessment in our strategic plan is improvement. To achieve that, we use multiple measures to assess student outcomes and facilitate continuous improvement. Student outcomes are achievements made by students as a result of the educational process. Student outcomes should represent value added to the student. This value added should increase continuously over time throughout the academic program.

Our strategic plan satisfies ABET Engineering Criteria 2000 in evaluating our three engineering programs to achieve our mission. The plan also furthers the strategic missions and plans of Miami University and the School of Engineering and Applied Science. Evidence of continuous improvement and interaction with our constituents in enhancing the curriculum is documented in separate portfolios.

This document is used for program reviews. It is updated on a regular basis to discuss results, to adjust plans, and to demonstrate further improvements.

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Section I: About the Department

1. Student Enrollment

The Department of Mechanical and Manufacturing Engineering, established in 1959, offers and administers three engineering programs: Manufacturing Engineering, started in 1959 (accredited), Mechanical Engineering, started in fall 2002 (accredited), and Engineering Management with Manufacturing Engineering Technical Specialty, started in fall 1991. The distribution of students in the three majors since 2000 is shown in Table 1, below. The impact of the mechanical engineering program on student enrollment in manufacturing engineering was obvious since 2002. This shift in enrollment happened also during the first few years of the introduction of the engineering management program in 1991. However, the introduction of the two programs enabled us to attract more high school students to our programs who otherwise would not apply to Miami. After the first few semesters, these same students get to experience and learn more about manufacturing engineering and hence double major in the program along with the other two engineering majors. About 10% of the students are double majors in more than one of the three majors.

Table 1. MME Student Enrollment in the past 6 Years (Data from Report #33 Fall Semester)

(Data on first and second majors is for the fall semester of each academic year.
Data on Graduates is for the whole academic year Dec, May, Aug graduates. Oxford Campus Only)

Year	**Manufacturing Engineering**			**Engineering Management - Manufacturing**			**Mechanical Engineering**		
	1st Year	Grads	Total	1st Year	Grads	Total	1st Year	Grads	Total
Fall 2006	11	8*	37	25	23*	102	56	15*	200
Fall 2005	12	19	54	23	28	120	52	23	173
Fall 2004	4	24	73	26	24	142	57	4	152
Fall 2003	5	24	95	24	24	138	40	5	117
Fall 2002	14	17	103	32	13	147	29	0	32
Fall 2001	20	23	115	38	23	139	--	--	--
Fall 2000	17	16	79	27	19	99	--	--	--

2. Faculty and Staff

The department has a one full-time (FT) chair, 8 full-time (FT) faculty, 4 part-time (PT) faculty, and 2 Visiting Professors. Other engineering faculty are available in the Departments of Computer Science and Systems Analysis, Electrical and Computer Engineering, and Paper and Chemical Engineering if needed for backup. Also, the department has an Administrative Assistant, a Program Associate, and a Technician, Lab supervisor.

The faculty represent a small group of dedicated individuals with the single goal of providing the best possible education for our students. The overall competence of the engineering faculty is excellent in terms of academic training, diversity of background, industrial and teaching experiences, interest and enthusiasm for developing effective teaching methods, level of scholarship, dedication to students' learning and welfare, and competence in engineering (more details can be found on the department web site: http://www.eas.muohio.edu/mme/Faculty-Staff.html).

3. Unique Elements of the Programs

There is a critical mass of faculty, staff, and students to offer exceptional and distinctive undergraduate programs in manufacturing engineering, engineering management with manufacturing engineering technical specialty, and mechanical engineering. It is marked by continual improvement to better serve the needs of its primary constituents: its students, the employers of those students, and society. Below, we discuss specific elements that give our programs their unique characters.

- The strength of our programs comes from Miami's tradition in providing excellence in educating undergraduate students. This education is marked by a long history of excellent liberal arts programs, strong business school, and high quality selected professional programs. With Miami's strengths in undergraduate education, and with our close ties with businesses and industry, Miami is providing a unique service to the State with its engineering programs.
- Our programs have established a tradition of interdisciplinary activities within the School and with other schools and programs at Miami including the Richard T. Farmer School of Business (the Engineering Management Program), History (joint course teaching and graduate student advising), Math & Stats (graduate student advising and research), Philosophy (joint conferences on professional ethics), Physics (senior projects, graduate student advising, Minors, and Research), and Psychology (senior projects, graduate student advising, and research).
- Our programs provide a niche in engineering related undergraduate education at Miami, with a strong liberal education flavor that serves the business and industrial sectors. For example, our Engineering Management with Manufacturing Engineering Technical Specialty, which is not duplicated at any school in our State, provides a definite niche for informed, liberally-educated engineers who can integrate business thinking with engineering practice, and who can also lead the nation in applying technology to solve complex problems while understanding the broader societal context and values as well as the economic and financial impact.
- Our programs provide broader education (see Appendix I, pp. 22-23) than in more traditional engineering schools. At Miami, the focus is on undergraduate education and developing well-rounded individuals by providing a strong emphasis on liberal education and such skills as communication and teamwork, which are the top two skills desired by industry.
- Our programs integrate, throughout the curricula, the four goals of the Miami Plan (Critical Thinking, Understanding Context, Engaging with Other Learners, and Reflecting and Acting) and ABET, a-k, Program Outcomes liberal (see Appendix II, page 24).
- Our faculty developed explicit connections across the curricula of our programs and different disciplines that give the students a more integrated learning experience through the integration of design, manufacturing, hands-on team-based lab and design activities, professional ethics, writing, and computational methods throughout the curriculum (see Appendices III-VII, pp. 25-30).
- Our students apply this integrated experience when working in interdisciplinary teams on customer-based open-ended problems in an excellent two-course capstone experience: MME 448-449 senior-design projects.

- Our students receive excellent academic advising, instruction and pedagogy, in an environment of close faculty-student interaction, and of small classes and lab sections, which are taught by faculty members (no graduate assistants teach any of our classes).

4. The Culture and Practice of Assessment in the Department

The culture and practice of assessment started in our department in the early 1990s. At that time, our School of Engineering and Applied Science, with the help of its External Advisory Council, started developing a strategic plan including an assessment plan with multiple tools to assess student-learning outcomes. As part of our School's Strategic Plan, every department in the School, including ours, was to develop and approve its own assessment plans. We developed ours in 1992 and have been using it since. In the late 1990s, and again with the help of our External Advisory Council, we incorporated our evaluation and assessment plans with its 11 methods into an overall strategic plan that covers all aspects of our department including a systematic and continuous cycle of assessment and improvement. This is shown in the flow chart of Figure 1, page 7.

The department faculty participate as a committee of the whole in executing this systematic approach for assessment, shown in Figure 1, page 7, and examples in Figure 2, page 8. This is achieved during our department meetings, which are held weekly during the academic year. The purpose of the meetings are to insure that the faculty are informed of current issues of importance to the department, school and university; and to provide a forum for faculty input, discussion, recommendations, and decision making on departmental issues. (The minutes of department meetings, which are available to all faculty, and they are posted on the School of Engineering and Applied Science Network.)

5. The Department Strategic, Evaluation and Assessment Plans

In the flow chart of Figure 1, page 7, we show the building blocks of our strategic plan; more details on specific areas such as educational objectives and outcomes are discussed in Section II, pp. 9-15. It is a systematic approach for assessment to determine, evaluate, and assess the department's overall goals, objectives, and outcomes. Below is a brief discussion of how our systematic approach of assessment works.

- The driving force behind our strategic plan is the department's constituencies (see below). Among them are graduate schools and the academic departments at Miami who are constituents of the department's service and other courses that their students attend.
  - **Program Students (**and their **parents**); students' self-assessment of growth and degree of satisfaction are sought as they progress through the program, upon graduation, and as alumni;
  - **Employers**; employer judgments are sought in assessing student performance in working as co-ops and interns, in solving design problems, and ultimately as full-time employees and graduates of the Department;
  - **The Department's Advisory Council** provide feedback on whether the Department's graduates are meeting employers', the community's, and society's needs;
  - **Professional societies**, such as the Society of Mechanical Engineers (ASME), the Society of Manufacturing Engineers (SME), the American Society of Engineering Management (ASEM), and **professional peers**, who are our faculty scholarship;
  - **ABET** (and **Miami's Academic Program Review**) judge whether the department's programs are meeting acceptable professional and academic standards; and

- **The community, and society**.

- Our constituencies provide us with necessary competencies required for our graduates, with standards to have in our programs, with important trends in the engineering fields, in general, and in manufacturing, mechanical, and engineering management, in particular. They also provide us with values that guide our performance and governance. Also, the missions of Miami and the School of Engineering and Applied Science are essential guides to our overall mission and goals.

- The department's overall vision drives our mission, and both are used to develop our programs educational objectives and outcomes (see the overall relationship in Figure 1, page 7, and with specific examples in Figure 2, page 8). Our vision is consistent with the vision of the School and Miami, including the Strategic vision of the President, "first in 2009," and the goals of the Miami Plan. The department's vision is based on careful analysis of the educational and professional needs of the engineering community: in the manufacturing, mechanical, and engineering management sectors; as communicated to us by our constituents.

- The key to our strategic plan is assessment. This is the process of evaluation leading to the improvement of quality in performing our mission. Assessment of how well our mission is being accomplished provides a stimulus for continuous quality improvement of our three engineering programs. Thus, the objective of assessment is to measure outcomes and facilitate continuous improvement. For example, student outcomes are achievements made by students as a result of the education process. Student outcomes represent value added to the student and this value added should increase continuously over time throughout the academic program.

- We developed and implemented an assessment plan that utilizes 11 methods to validate the achievement of program outcomes and educational objectives of the three majors combined as well as specific elements in each major. We document the whole process in assessment reports and notebooks, and course and teaching portfolios. These documents include qualitative and quantitative data that demonstrate clearly that the process is producing the desired results and that the results are being used to improve our program's effectiveness.

- Several components of our assessment plan depend on primary constituents' evaluation of how well the Department, in general, and the programs, in particular, is meeting their needs. The constituents see page 5, above, have been identified for both the Department and the three programs and they are included in one or more of our 11 methods. Input and feedback from all these constituencies are examined periodically, by all faculty, as part of our weekly department meetings (see Figure 2, page 8, for some examples). These quality indicators provide evidence that our efforts for improvements are producing results.

- This process of continuous improvement enables us to fulfill our vision of being a world-class department in educating undergraduate engineering students in manufacturing, mechanical, and engineering management with manufacturing engineering technical specialty.

Figure 1. Flow Chart of the MME Department's Strategic Plan Process

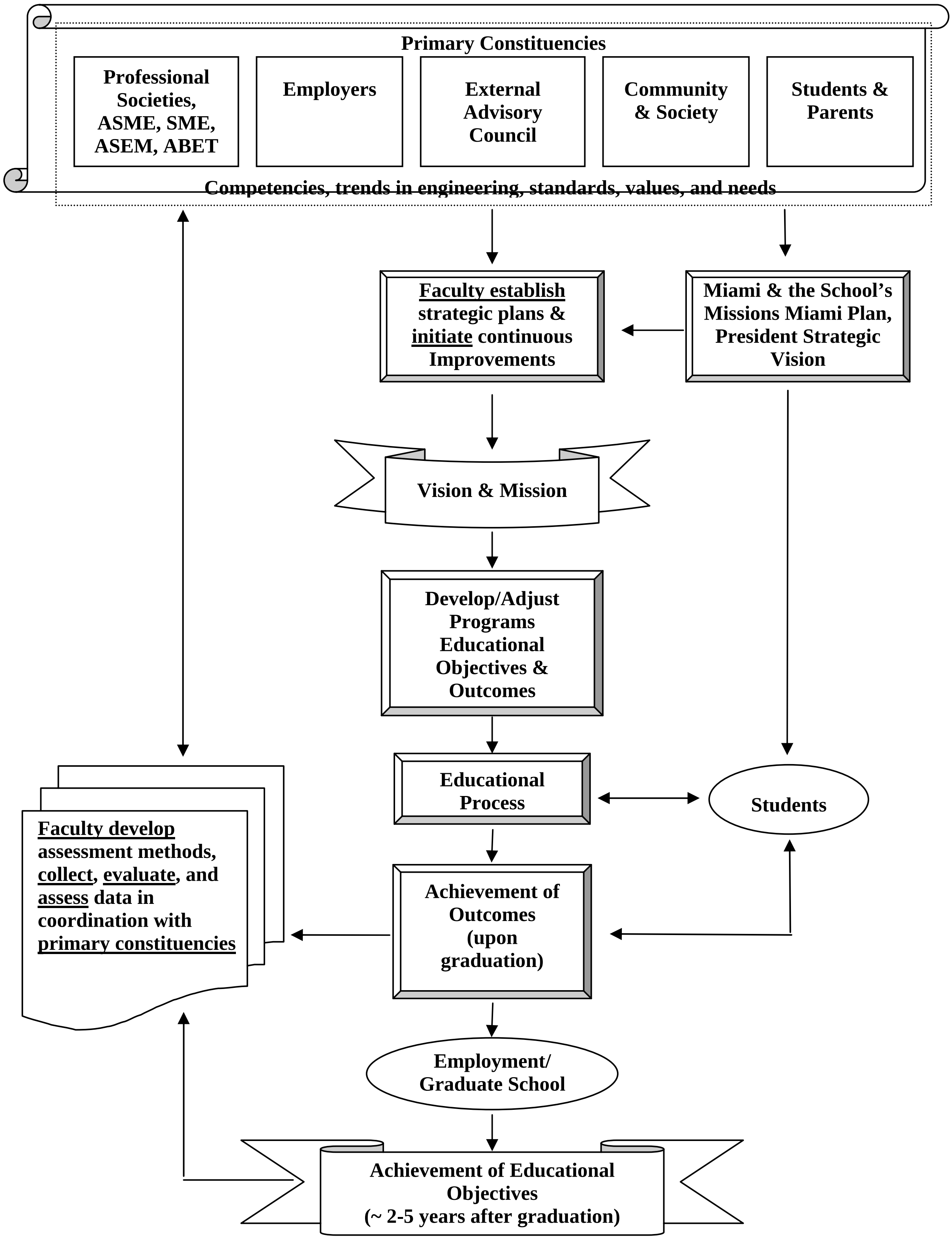
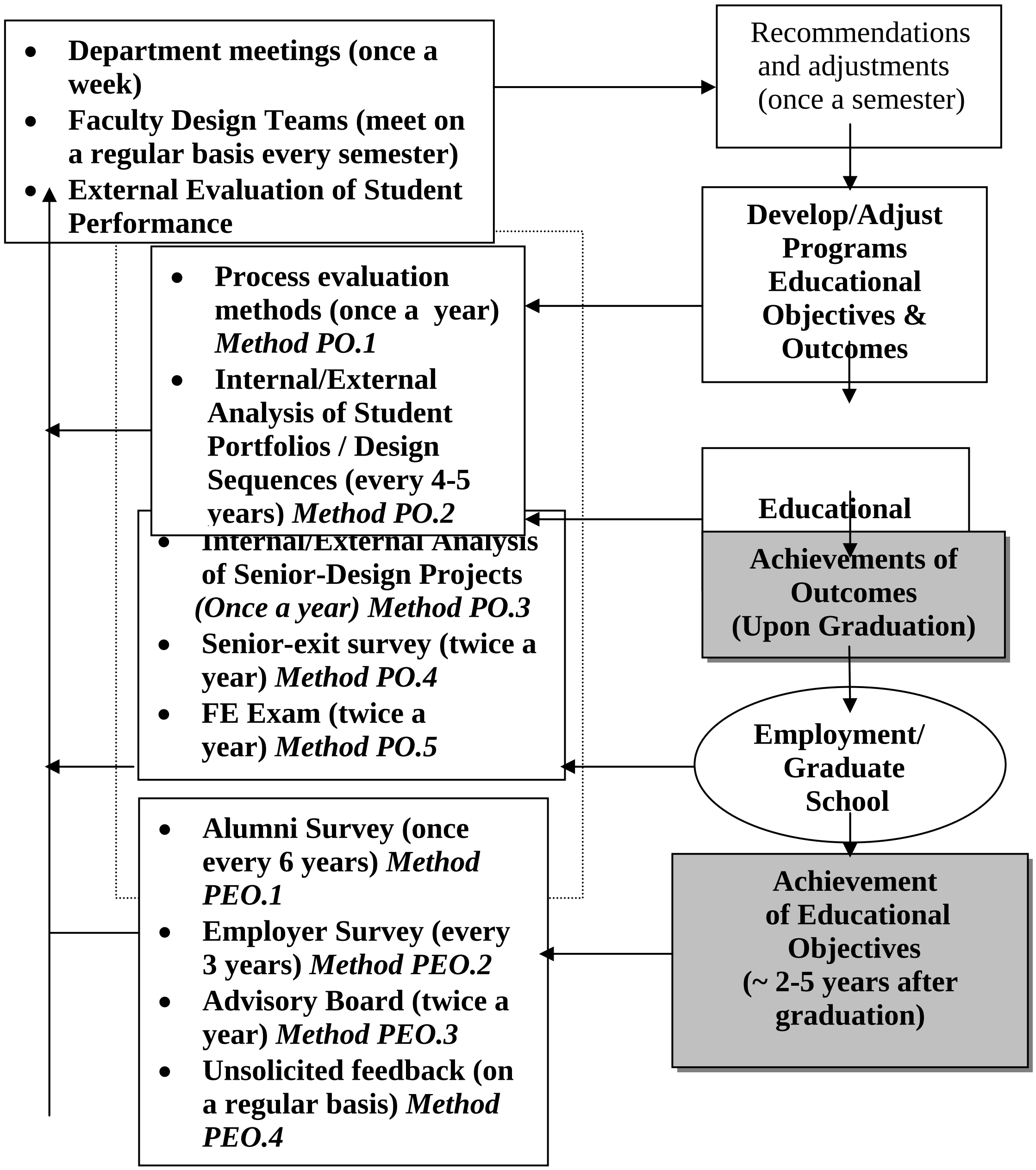


Figure 2. Specific Examples of evaluation and assessment methods and their timing and relationship to program-educational objectives and outcomes.



Section II: MME Values, Vision, Goals, Mission, Objectives, and Outcomes

1. MME Values

The MME Department values are those expressed in the School of Engineering and Applied Science (SEAS) values.

Everyone in SEAS values:

- Effective student learning and student success
- An intellectually stimulating and challenging environment
- Faculty growth and learning as teacher and scholars
- Diversity of staff, faculty, and student body
- Respect for the environment

We are committed to an environment that fosters:

- Innovation and creativity
- Ethical behavior
- Respect for others and teamwork
- International and global opportunities and perspectives
- Fact-based, collegial decision making
- Safety in all our professional endeavors

2. MME Vision

Our vision, see below, is consistent with Miami's and the School's vision. It is based on a careful analysis of the educational needs of our constituents, including our Advisory Council.

The approach to achieve our vision is based on maintaining and strengthening our unique elements (pp. 4-5) and on reaching our goals (page 10). This is accomplished by developing specific action plans, in consultation with our constituencies, which are connected to our work on classroom effectiveness, student learning, curricula, and faculty scholarly activities, in a process of continuous improvements, as shown in Figure 1, page 7. These leads to tangible results, which we highlight in Appendix VIII, and quality indicators, which we document and assess, as shown in Appendix IX.

Our vision is to become a world-class department in educating undergraduate engineering students in manufacturing, mechanical, and engineering management with manufacturing engineering technical specialty, where:

1. Our graduates posses a visionary leadership skills and behavior, a visions-engineering based ethics perspective, and opportunities to integrate skills, concepts and ability to build on courses, and breadth and depth of their education and professional/global experience;
2. Every student's understanding of the connection of his or her engineering education practice is reinforced by a meaningful professional experience;
3. Students experience a global experience / perspective through a project, independent study, workshop, internship, or co-op experience; and

4. Our faculty are known for their integrated approach to engineering education, applied research, and for high quality in serving their two most important stakeholders: students and industry.

3. MME Goals

Below are the goals that we currently strive to reach. Quality indicators, from various assessment methods and department annual report, provide evidence that our efforts for improvements are producing the desired results. These are published, every year, in the department annual report. The faculty discuss the results and determine ways for further improvements.

Table 2. MME Goals			
	A. Common to the Three Majors		
1.	Provide our students with a cutting edge of technology experience in classes.		
2.	Transform our labs into the finest undergraduate engineering laboratories in the country.		
3.	Achieve diversity in student body consistent with society's makeup and industry's needs.		
4.	Provide opportunities for learning about globalization, foreign language, and international studies/ perspectives.		
5.	Strengthen student professional practice by providing co-op and intern positions for all students seeking such opportunities.		
6.	Increase the number of graduating seniors who take the Fundamentals of Engineering examination.		
7.	Provide undergraduate research opportunities for high ability students with research interests.		
8.	Provide a forum for faculty to share research activities with students.		
9.	Strengthen our relationship with industry.		
10.	Provide our students with opportunities for multidisciplinary education and research.		
11.	Develop a passion for life-long learning among graduates.		
	B. Specific to Each major		
	Manufacturing Engineering	**Engineering Management with Manufacturing Engineering Technical Specialty**	**Mechanical Engineering**
12.	#1 Manufacturing engineering program for schools without a Ph.D. in U.S. News and World Report Rankings	Graduate promotable graduates who have flexible thinking, right brain skills balance between qualitative and quantitative skills	Strengthen the Thermal / Fluid area of the curriculum including design integration and hands-on lab experience
13.	Improve retention rate within 60% to 70%	All students will perform service to the community during their Miami Experience.	Develop a lab for the course EGR 315 Mechanical Vibrations
14.	Increase financial opportunities for students.	Strengthen the Project Management course and linkage to other areas in the curriculum.	Develop a lab for the course EGR 414 Engineering Thermodynamics II.

4. MME Mission

Our mission supports and is consistent with Miami's and the School's missions. To demonstrate the linkage among the three missions, we organized the three missions in a format that enables us to map them against one another. This is shown in Appendix X, Table 15, and in Figure 3, page 12. In addition, and as will be discussed shortly, our objectives and program outcomes are all linked and derived from our mission and specifically the first category: ***D.1 Quality graduates to meet societal and industrial needs***.

D1. Quality graduates to meet societal and industrial needs

The primary mission of the Department of Mechanical and Manufacturing Engineering is to provide quality graduates to meet societal and industrial needs. The Department provides graduates with in-depth education in mathematics, science, engineering science, and engineering design, as well as requiring a broad education in computing, business, and liberal arts. The Department is committed to excellence in undergraduate education: student learning, classroom effectiveness, assessment, engineering design and ethics integration, opportunities for leadership, and student advising.

D2. Excellence in Undergraduate Education

Contemporary society and industry's problems are not only technical, but also social and economic. These needs are satisfied through development of superior students and faculty. The three programs of the department provide the students with additional and distinctive depth, depending on their chosen majors, in manufacturing, mechanical or engineering management with manufacturing engineering technical specialty. Furthermore, common courses among the three programs, specifically in the design threads, provide the students with a unique opportunity to experience interdisciplinary teamwork as well as understanding and learning about the other programs.

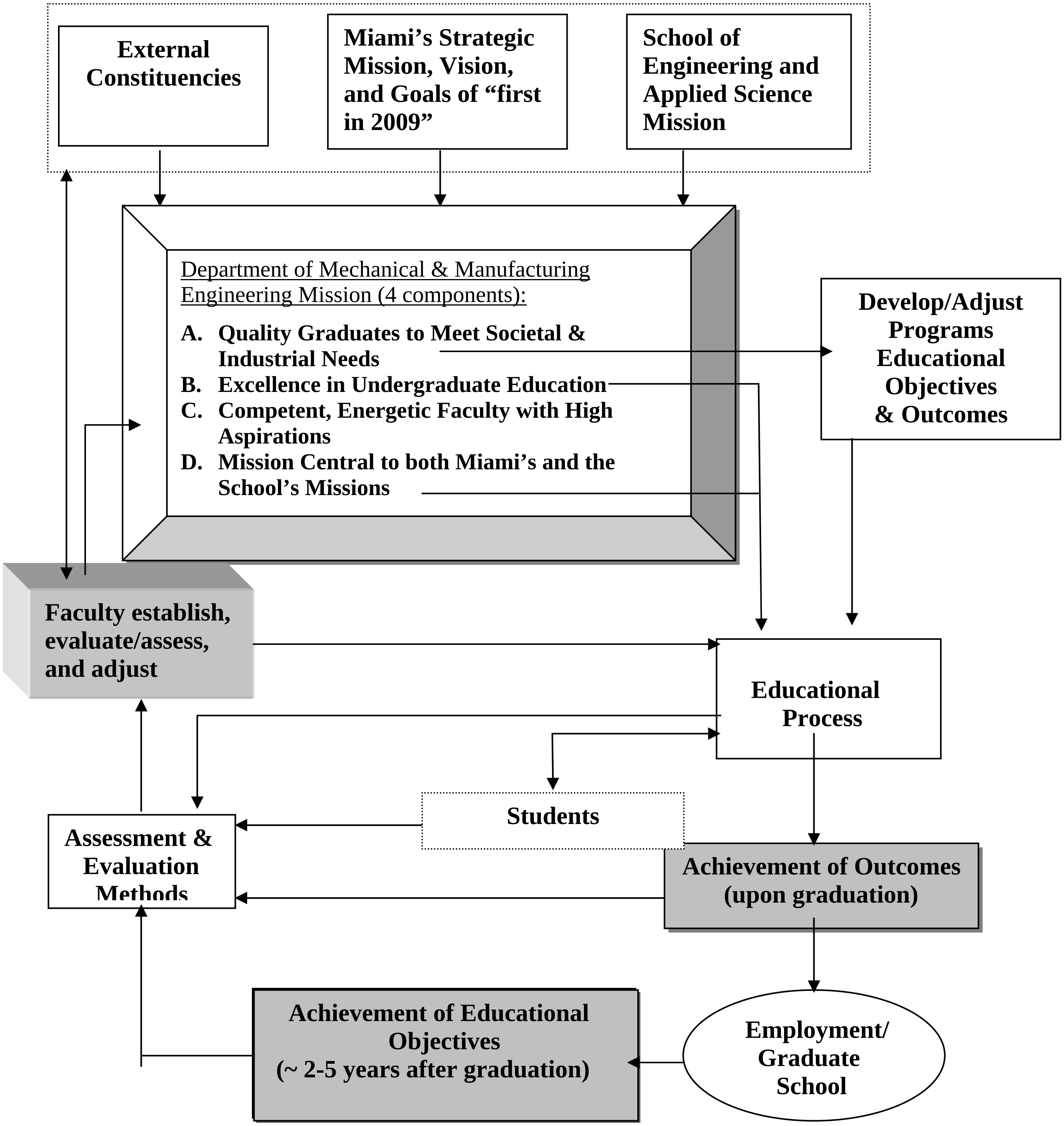
D3. Competent, Energetic Faculty with High Aspirations

In the Department of Mechanical and Manufacturing Engineering, we consider faculty development as an essential part of educating students. In order to provide our students with the best education on state-of-the-art technologies and engineering methods, our faculty regularly attend professional conferences, workshops and seminars, conduct research and participate in continuing education courses involving educational techniques and new technologies.

D4. Mission Central to both Miami's and the School's missions

The Department of Mechanical and Manufacturing Engineering is central to Miami University's mission to serve the community, state, and nation. Miami educates men and women for responsible, informed citizenship, as well as for meaningful employment. The Department provides a technology perspective for the liberal education community and supports the Miami Plan and the Honors Program by providing minors, honors and foundation courses, thematic sequences, and a capstone experience. Also, the Department has strong multidisciplinary activities with the Departments of Computer Science and Systems Analysis and Paper Science and Engineering, as well as the Business School, the Psychology Department Ergonomic Center, and other programs within the University. These activities enhance students' education and provide excellent opportunities for our faculty and students to engage with other scholars.

Figure 3. Relationship among mission, program-educational objectives, and outcomes.



5. Program-Educational Objectives

We developed our program educational objectives with the help of our Advisory Council. The objectives, as shown in Table 3, for the three majors, are **broad statements that describe the career and professional accomplishments that our specific programs are preparing our graduates to achieve 2-5 years after graduation**. The objectives focus on the capabilities of our graduates early in their careers; they have the appropriate breadth of expectations, focus on graduates' achievements, and can be clearly assessed. Broadly, they are directed toward assessing problem solving, communication, team citizenship, knowledge integration, ethics, and life-long learning achievements. Also, the objectives include verbs that relate to graduates' ability to make valuable contributions in their work environment.

Table 3. MME Educational objectives of its three Majors		
Graduates of the Program will (~ 2-5 years after graduation):		
A. Specific to Each Major		
Manufacturing Engineering	**Engineering Management with Manufacturing Engineering Technical Specialty**	**Mechanical Engineering**
1. Solve problems by applying the knowledge required for manufacturing engineers.	1. Solve problems by applying the knowledge required for engineering managers.	1. Solve problems by applying the knowledge required for mechanical engineers.
B. Common to the Three Majors		
2. Solve engineering problems by applying mathematics, basic sciences, and engineering science. 3. Solve engineering problems by applying engineering design.		
4. Verbally communicate effectively information related to their work.		
5. Write effectively information related to their work.		
6. Serve as an effective team member 7. Serve as an effective team leader. 8. Serve on multidisciplinary teams		
9. Integrate and utilize fundamental knowledge in computing, business, and liberal arts in their job.		
10. Know and practice ethical responsibility as outlined by the Engineering Code of Ethics.		
11. Engage in continuous learning and intellectual growth.		

6. Program Outcomes

The MME program outcomes **are what we expect our students to know and be able to do by the time of graduation.** Our program outcomes were developed, again in consultation with our Advisory Council, so that they describe the skills, abilities, and/or accomplishments of our students by the time of their graduation from our engineering programs.

We continue to specify two types of program outcomes:

- Broader outcomes, common to all majors, that reflects the strategic mission of the School of Engineering and Applied Science (SEAS) and the Miami Plan for Liberal Education, and
- Discipline-oriented outcomes, which are realized by the specific engineering program's scope of the curriculum.

We define both of these types of program outcomes in the following pages.

I. Broader-Desired Outcomes Common to All Majors

Broader outcomes are common to all majors. They are realized and emphasized by the strategic mission of the School of Engineering and Applied Science (SEAS) and the Miami Plan for Liberal Education. Specifically, any graduate of SEAS should be able to (**these are assessed by the MME faculty and reviewed by the SEAS Dean's Office)**:

I.1 Define and solve problems

I.2 Make ethical choices and act responsibly

I.3 Critically evaluate information

I.4 Work effectively in a team, exercise initiative, and function in a leadership role

I.5 Recognize broad societal contexts and interests

I.6 Serve clients and society with sensitivity & accountability

I.7 Interact effectively with diverse cultures

I.8 Adapt to change, recognize the value of life-long learning, & pursue further formal education

I.9 Write, speak, and listen effectively

I.10 Understand and apply mathematics and science

I.11 Understand and apply the concepts of continuous quality improvement

II. Discipline-Oriented Outcomes for Each of the Three Programs Discipline outcomes are realized by the broad scope of the program curriculum, which include courses in: mathematics, science, computing, business, engineering science, manufacturing processes and systems, engineering design, and student participation in professional practice. Specifically, any graduate of each of the three Programs should be able, upon graduation, to:			
	Mechanical Engineering	Manufacturing Engineering	Engineering Management with Manufacturing Engineering Technical Specialty
II.1	Apply knowledge of mathematics, science, and engineering		
II.2	Design and conduct experiments, as well as to analyze and interpret data		
II.3	Design a system, component, or process to meet desired needs		
II.4	Identify, formulate, and solve engineering problems		
II.5	Research concepts and application of modeling methods	Identify potential changes in behavior and properties of materials as they are altered and influenced by manufacturing processes	Know and comprehend modern manufacturing processes and practice
II.6	Simulate and test working conditions and their impact on the designed systems	Design products as well as the equipment, tooling, and environment necessary for their manufacture	Know and comprehend the engineering relationship between the management tasks in production, research, and service organizations
II.7	*Solve open-ended engineering problems* in thermal systems areas including the design and realization of such systems	Create competitive advantage by manufacturing planning, strategy, and control	Know and comprehend the stochastic nature of management systems
II.8	*Solve open-ended engineering problems* in mechanical systems areas including the design and realization of such systems	Analyze, synthesize, and control manufacturing operations using statistical and calculus based methods, simulation and information technology	Integrate management systems into technological environment
II.9		Make technical inferences about a manufacturing process by measuring process variables	

Section III: Evaluation and Assessment Plans

We developed and implemented 11 methods, grouped in three categories (see Table 4, below) that evaluate and assess the required ABET Five Criteria. The plan assumes that the primary purpose of evaluation and assessment is to provide information that will be used to improve our programs. Since a variety of components are involved in a complete description of student outcomes at various stages in the academic program and upon graduation, and his/her achievement of program educational objectives 2-5 years after graduation, it is essential that multiple measures and methods are employed. No single instrument can adequately determine the full range of student outcomes and program educational objectives desired for finding effective ways to achieve enhancement. The plan's implementation is in conjunction with the School of Engineering and Applied Science and the University Liberal Education Assessment Plans.

Table 4. Evaluation and Assessment Methods

A. Methods to evaluate Students (Criterion 1)	**B. Methods to evaluate Programs Educational Objectives (PEO) (Criterion 2)**	**C. Methods to assess Programs Outcomes (PO) (Criterion 3, 4, 8)**
Student Advising and the Miami degree-audit report (DARS) system (Method S.1)	Alumni Surveys (Method PEO.1)	Classroom-Process Evaluation Methods (Method PO.1)
Petition Committee (Method S.2)	Employer Survey (Method PEO.2)	Internal/External Analysis of Student Portfolios / Design Sequences (Method PO.2)
	Advisory Board (Method PEO.3)	Internal/External Analysis of Senior-Senior Design Projects (Method PO.3)
	Unsolicited Feedback (Method PEO.4)	Senior Exit Interviews and Surveys (Method PO.4)
		FE Exam (Method PO.5)

A. Methods to evaluate Students (Criterion 1)

Method S.1: Student Advising and the Miami degree-audit report (DARS) system

We utilize DARS to assess students' academic accomplishments and development. Every semester, students' DARS are distributed to every advisor to review and check student's progress toward meeting all degree requirements, and use in updating the student's records. In addition, the advisor check that the student is taking courses in the proper sequence. Based on the DARS review, the advisor communicates the information, as appropriate, with his or her advisees. We conduct regular sessions on students' advising the first week of every month during our weekly department meetings, in both semesters (more details are provided in the advising notebook). In these sessions, each advisor gives an update on his or her advisees and shares with us any problems, concerns, or new ideas to make the advising process more effective.

Method S.2: Petition Committee

This is a departmental committee comprised of three faculty members appointed by the department chair. This committee rules on all petitions from students regarding modification of the required curriculum as well as transfer credit for engineering courses taken at other universities. The petition committee provides summaries for action taken for review by the faculty in the regular department meetings. Records of these summaries are kept in a petition file in the main office.

B. Methods to Evaluate Program Educational Objectives (PEO) (Criterion 2)

To evaluate how well our graduates have achieved the MME three programs educational objectives (Table 3, page 13) during a period of 2-5 years after graduation, we selected the four evaluation methods discussed below.

Alumni Survey

The Alumni Survey contains two parts; a self-assessment by graduates of their education with respect to our program educational objectives and a series of questions aimed at eliciting tangible, quantifiable achievements as identified in our educational objectives. For example, the second question serves to find the nature of the alumni’s team participation; including interaction with professionals from other disciplines and the extent to which the alumnus has taken leadership responsibilities.

Employer Survey

The Employer Survey contains two parts; an assessment by our graduate’s employer of their education with respect to our program educational objectives and an open-ended section for the appraiser’s comments on special qualifications / skills of the employee (MME graduate) as well as the appraiser’s comments on development needs of the employee (MME graduate).

Advisory Council

The Advisory Council ensures a linkage between the School of Engineering and Applied Science and business, industry, government and the health professions. This partnership helps the School and its departments to learn about industry’s needs and gain invaluable insight into the currency of its programs. Each semester, the department meets with the affiliated members of the School’s Advisory Council during designated sessions for the School’s different departments. The department affiliated members represent professionals from industry with expertise in the discipline. Issues discussed include curriculum, new initiatives, student preparedness, placement, and student recruitment and retention. We utilize our Advisory Council, in a greater capacity, in discussing, evaluating, and updating our educational objectives. In the past three meetings, during 2005-06, the Board members were directly involved in updating the list of our educational objectives, and in helping us develop the surveys that evaluate them. In the upcoming meetings, the council will be helping us in evaluating the results and recommending ways, as appropriate, to utilize these results to improve the system.

Unsolicited Feedback from our alumni and their employers

Basically, the method allows us to collect direct data about our graduates as well as unsolicited feedback on their education and progress in the business world. Frequently, graduates send thank you messages, cards or letters to show their appreciation of the education they received from the department and Miami. Also, they update us on their evolving career objectives, continuing education, successes in the business world, such as promotions and changes in rank. We collect, discuss, as appropriate, and document such feedback and utilize it in the evaluation and the updating of our educational objectives. The reason we use this method is because of the unique and strong ties that our MME faculty have with current and past students. The relationships cultivated by students and faculty during the undergraduate years at Miami are long lasting; at their exit survey, all our students agree that our MME faculty have tremendous impact on their education and appreciate their close ties with them. It is precisely because of these unique types of relationships that such informal feedback is possible and can be relied upon to serve as a fourth source of evaluation data.

C. Methods to Assess Program Outcomes (PO) (Criterion 3, 4, 8)

To address the main intent of the weakness (an inadequate measures of student accomplishments and no assessment by the institution or faculty), we scrutinized all of our assessment methods and selected the five methods shown below. Although all these methods have been in existence during the time of the ABET visit in Fall 04, we included new features that correct the cited weaknesses. For example, we developed new grading and assessment rubrics, established a new procedure to assess student work by teams of faculty as well as the entire faculty, and involved external evaluators in assessing our student work. These are discussed below, in some detail, under each method with some examples that follow.

Classroom-Process Evaluation Methods

We formed teams of 3 faculty members each to be responsible for a specific course that they traditionally teach. Each team is responsible for developing an assessment rubric that assesses student-learning outcomes specified for this course (from those discussed in pp. 14-15). This is in addition to the regular grading rubrics that the faculty member uses, in the course, to evaluate student performance. (**Thus, our assessment of students' achievement of the program outcomes is not based solely on course grades.)** Each team present their results and recommendations to the faculty once each year.

Internal/External Analysis of Student Portfolios / Design Sequences

In our plan to integrate design throughout the curriculum, started in 1995, we selected specific courses that link and integrate the design experience starting in the freshman year and proceeding to integrate engineering science, manufacturing, and design courses throughout the four years (see Appendix III for more details). Each course has its own contribution (role) in the sequence in covering its basic content as well as building on the previous design and lab experience. Student work, for each course, is collected in a portfolio.

- In the past, each faculty team reviewed the portfolio and prepared a reflective essay on the design sequence, student performance, and student learning outcomes.
- In the new approach, the faculty team will be preparing an assessment rubric that systematically assess student achievement of the design sequence outcomes specified for this sequence (from those discussed in pp. 14-15). These rubrics will be utilized internally by the faculty team as well as by an external evaluator (a consultant). The frequency of this method is 4-5 years.

Senior Exit Surveys

The department conducts a survey of each graduating senior. The exit interviews address, mainly, the broader and discipline-oriented outcomes (discussed in p. 14-15), as well as other areas such as process characteristics, the strengths and areas for improvement of the program, and suggestions for further improvements. A summary of the results is shared with the faculty and discussed during department meetings. Areas for improvement and action plans to correct problems are discussed and implemented.

Internal/External Analysis of Senior-Design Projects.

We developed two rubrics: one to be used internally by the advisor (s) of the design teams, and is designed to help with the grading (we are in the process of developing a third rubric that complements this one and captures how a student's performance on the design project indicates how well he or she has attained the mechanical engineering program outcomes). The second is used, externally, by the design team customer, such as the company sponsors. Both rubrics are based on programs' outcomes discussed earlier in pp. 14-15. The faculty advisors will discuss both internal and external results and provide recommendations to the entire faculty, once a year, for enhancing student performance as well the overall senior design experience.

Fundamentals of Engineering Exam

We continue to utilize this exam as a measure of student accomplishments in specific areas of our engineering programs, especially in their knowledge and applications of math, science, and engineering science.

Section IV: Implementation Plan and Documentation

I. Implementation

To implement our evaluation and assessment plans, we utilize three steps: collecting and documenting data, discussing data, and recommending ways and action plan to improve the process and remedy problems if needed. Below is a brief discussion of each step.

- Each method has a specific timing for collecting and documenting data as well as a faculty member or team responsible for the process (see Table 5, page 21).
- In all cases, we attempt to document data, indicate statistical profiles and trends, show and discuss results, and indicate recommendations for further improvements.
- To discuss the data and close the loop, we utilize three approaches: one is based on the team of faculty responsible for the method / process, second is our weekly department meetings, and third is frequent retreats where the entire faculty meet for half a day or more to discuss, among other things, the entire process, courses, group of projects, etc.
- For the weekly department meetings, and as indicated in Appendix IX, Method QI.6, page 35, we meet as a committee of the whole to discuss all aspects pertinent to the Department, as shown in Figure 1, page 7. An agenda with specific items (similar to a course syllabus) is prepared at the beginning of each semester with objectives and topics to discuss, and dates. At the beginning and end of each semester, we reflect on our accomplishments and provide feedback for further work and follow-up if needed. The School's Executive Council, chaired by the dean, is involved also in addressing and sharing many of the departmental data. This allows us to learn about and collaborate in solving problems and sharing working practices.
- Based on the actions and recommendations from above, we proceed to implement changes, address problems, and document and discuss results in department meetings. (Minutes of our accomplishments are recorded and kept in the department's main office.) For example, if the action plan was to modify course pre-requisites or topics the faculty responsible for the course is to make the required changes and present them later in another meeting.

II. Documentation

To document the process, we prepare a notebook (or more) for each group of methods shown in Table 4, page 16. Each notebook contains: an executive summary of the method, summary of data, discussion, and follow-up. Also, the notebook contains sample raw data, action plans, and specific activities that demonstrate the action taken. In some methods, we submit only samples of raw data (such as minutes, petition work, and student and company evaluations and feedback). The rest of the data are kept in folders, which are available in the department's main office.

Table 5. Assessment Methods, Frequency, and Faculty Assignment

Method	Description	Purpose	Frequency	Faculty	Responsibilities
S.1	**Student Advising**	Criterion 1	1/ semester	All Faculty	Advise students and report once a month to the faculty
S.2	**Petition Committee**	Criterion 1	1/ year	Petition Chair	Document the process and share results on a regular basis
PEO.1	**Alumni Surveys**	Criterion 2	1/cycle: Spring 2007 MFG; Spring 2008 MCH	Moller	Work with Administrative Assistant to send the surveys to our alumni, summarize the results, present them to the faculty, and update the surveys based on our discussion. At the time of our upcoming ABET or/and Program Reviews, summarize this assessment method in the self-study.
PEO.2	**Employer Survey**	Criterion 2	1/cycle: Spring 2007 MFG; Spring 2008 MCH	BVK	Work with Administrative Assistant to send the surveys to our alumni, summarize the results, present them to the faculty, and update the surveys based on our discussion. At the time of our upcoming ABET or/and Program Reviews, summarize this assessment method in the self-study.
PEO.3	**Advisory Board**	Criterion 2	1/sem	MME Chair	Keep minutes, collect and analyze data, follow up.
PEO.4	**Unsolicited Feedback**	Criterion 2	Random	MME Chair	Document and share results with the faculty
PO.1	**Internal/external analysis of student portfolio/design**	Criterion 3, 4 & 8	1/cycle: f06 – Spr. 10	Shukla	Collect student work, administer the assessment process and share the results with the entire faculty
PO.2	**Analysis of Senior design projects**	Criterion 3, 4 & 8	1 / semester	Senior Design Advisors	Meet before each semester to review the previous semester. Minutes will be maintained (AA).
PO.3	**Senior Exit Surveys**	Criterion 3, 4 & 8	1 / semester	MME Chair	Meet 1/sem to discuss results & identify 3 top issues.
PO.4	**Classroom-process evaluation methods (course notebooks)**	Criterion 3, 4 & 8	1/ cycle : 09-10	All Faculty	Each faculty collects and evaluate his/her own courses; teams of faculty assess the courses that they teach; sharing the results with the entire faculty
PO.5	**FE Exam**	Criterion 3, 4 & 8	1 / semester	Van Kuren	Document, summarizes the results with recommendations

APPENDIX I

The Curricula: Common and Specific for the Three Programs

The common and specific curricula (see Table 6, below) for the three programs consists of two primary components: first is general education, which includes liberal education, mathematics, computing, and science courses; and second is engineering, which includes engineering science, common engineering courses, engineering design, business courses, and electives. (In addition, students are encouraged to participate in professional practice, such as summer internships or co-op.) These two components achieve our common and specific program-educational objectives, discussed earlier.

Table 6. The Curricula for the Three Programs

<table>
<tr><th></th><th>Courses (credit hours)</th><th>Mechanical Engineering</th><th>Manufacturing Engineering</th><th>Engineering MGT with MFG</th></tr>
<tr><td>YEAR 1</td><td>Computing, Engineering, and Society (1)</td><td colspan="3">EAS 101</td></tr>
<tr><td></td><td>Composition & Literature (6)</td><td colspan="3">ENG 111-112</td></tr>
<tr><td></td><td>Calculus I, II (9)</td><td colspan="3">MTH 151, 251</td></tr>
<tr><td></td><td>The Physical World/ Lec. & Labs (10)</td><td colspan="3">PHY 181, 182, 183, 184</td></tr>
<tr><td></td><td>MP Fine Arts Elective (3)</td><td colspan="3">MPFA</td></tr>
<tr><td></td><td>Problem Solving & Design (3)</td><td colspan="3">EAS 102</td></tr>
<tr><td>YEAR 2</td><td>College Chemistry (5)</td><td colspan="3">CHM 141-144</td></tr>
<tr><td></td><td>Principles of Microeconomics (3)</td><td colspan="3">ECO 201</td></tr>
<tr><td></td><td>Eng. Design & Computer Graphics (3)</td><td colspan="3">MME 143</td></tr>
<tr><td></td><td>Static Modeling of Mech Systems (3)</td><td colspan="3">MME 211</td></tr>
<tr><td></td><td>Engineering Materials (3)</td><td colspan="3">MME 223</td></tr>
<tr><td></td><td>Manufacturing Processes (3)</td><td colspan="3">MME 231</td></tr>
<tr><td></td><td>Mechanics of Materials (3)</td><td colspan="3">MME 312</td></tr>
<tr><td></td><td>Differential Equati. for Engineers (3)</td><td colspan="3">MTH 245</td></tr>
<tr><td></td><td>Introduction to Statistics (4)</td><td colspan="3">STA 368</td></tr>
<tr><td></td><td>Humanities Elective OR
Principles of Macroeconomics (3)</td><td colspan="2">MPH</td><td>ECO 202</td></tr>
<tr><td></td><td>Intro to Managerial Accounting (3)</td><td colspan="2"></td><td>ACC 222</td></tr>
<tr><td></td><td>MP US Culture Course (3)</td><td colspan="3">MPUSC</td></tr>
<tr><td>YEAR 3</td><td>Electric Circuit Analysis (3)</td><td colspan="3">ECE 205</td></tr>
<tr><td></td><td>Dynamic Modeling of Mech. Sys. (3)</td><td colspan="2">MME 311</td><td rowspan="2"></td></tr>
<tr><td></td><td>Fluid Mechanics (3)</td><td colspan="2">MME 313</td></tr>
<tr><td></td><td>Operations Management (3)</td><td colspan="2" rowspan="2"></td><td>MGT 302</td></tr>
<tr><td></td><td>Principles of Marketing (3)</td><td>MKT 291</td></tr>
<tr><td></td><td>Engineering Economics (3)</td><td colspan="3">MME 341</td></tr>
<tr><td></td><td>Technical Writing (3)</td><td colspan="3">ENG 313</td></tr>
<tr><td></td><td>Computer-Aided Experimentation (4)</td><td colspan="3">MME/ECE 303</td></tr>
<tr><td></td><td>Engineering Thermodynamics (3)</td><td colspan="3">MME 314</td></tr>
<tr><td></td><td>Quality Planning & Control (3)</td><td></td><td colspan="2">MME 334</td></tr>
<tr><td></td><td>Mechanical Vibrations (3)</td><td>MME 315</td><td colspan="2" rowspan="2"></td></tr>
<tr><td></td><td>Discrete Math (3)</td><td>MTH 231</td></tr>
<tr><td></td><td>MP Humanities Elective (3)</td><td colspan="2">MPH</td><td>COM 135</td></tr>
<tr><td></td><td>Organizational Behavior & Theory (3)</td><td colspan="2" rowspan="2"></td><td>MGT 291</td></tr>
<tr><td></td><td>Project Management (3)</td><td>EGM/MGT 311</td></tr>
</table>

	Analysis of Stochastic Systems (3)			CSA 372
	MP Biological Science Elective (3)	MPBS		
	MP Thematic Sequence (9)	MP Them Sequence		
YEAR 4	Machine & Tool Design	MME 411		
	Control of Dynamic Systems (3)	MME 436		
	Advanced Manufacturing (3)		MME 434	
	Computer-Integrated Manuf. Sys. (3)		MME 437	
	Senior Design Projects (4)	MME 448/449		
	Technical or MGT Electives (6)	Technical Electives		MGT Electives
	MP World Cultures (3)	MPWC		
	Manufacturing Topics (3)		MME 435	
	Advanced Thermodynamics (3)	MME 414		
	Heat Transfer (3)	PSE 403		
	Advanced Mechanics of Materials (3)	MME 412		

APPENDIX II. Table 7: The Four Goals of the Miami Plan Mapped against ABET Criterion 3

Coverage of the four goals of the Miami Plan for Liberal Education is evident in MME engineering courses;
Each course defines, clearly, each goal in the context of the course's content and pedagogy;
Each course demonstrates clearly how it will foster (and integrate) each of the four goals as part of its classroom activities;
Each course should provide an assessment plan that, among other things, enables one to measure the achievement of student learning outcomes; and
ABET Program Outcomes correlate directly or indirectly to the goals of the Miami Plan.

Specifically, any MME engineering student should be able, upon graduation, to:

MP 4 Goals	ABET Criterion 3
Critical Thinking	(a) Apply knowledge of mathematics, science, and engineering (b) Design and conduct experiments, as well as to analyze and interpret data (c) Design a system, component, or process to meet desired needs (e) Identify, formulate, and solve engineering problems
Understanding Context	Consider realistic constraints, when solving problems, that include technical and economical factors, social implications, environmental considerations, safety, and aesthetics (h) The broad education necessary to understand the impact of engineering solutions in a global and societal context (j) A knowledge of contemporary issues
Engaging with Other learners	(d) Function in multi-disciplinary teams (g) Communicate effectively Serve clients and society with sensitivity & accountability
Reflecting and Acting	(f) Understanding of professional and ethical responsibility Conduct open-ended engineering problems and research that foster ability to adapt to change (i) A recognition of the need for, and ability to engage in life-long learning (k) Use the techniques, skill & modern engineering tools necessary for engineering practice

APPENDIX III. Integration of Design Throughout the Curricula

Engineering design is a strategy and method for applying concepts from engineering and other disciplines to guide decisions and solve applied problems. As has been demonstrated in this document, the MME department places a high importance on the learning of engineering design. Nearly all the outcomes and several of the objectives for the three MME programs relate to engineering design.

In our department, the learning of engineering design is developed in a coordinated way throughout the curricula. Part of the design plan implementation has involved grouping MME courses together according to common themes (as shown in Table 8). In many cases, these groups include courses which are prerequisites to other courses with the group. For each group, faculty teams meet on a regular basis to articulate and plan the progression in student knowledge and skills in both design and engineering concepts.

Table 8. Design Integration Throughout the Curricula of MME Majors

	Mechanical Engineering	Manufacturing Engineering	Engineering Management With Manufacturing Technical Specialty
Common to the Three Majors	EAS 101: Computing, Engineering, and Society		
	EAS 102 Problem Solving & Design		
	MME 211 Static Modeling of Mechanical Systems		
Group 1. Design of Mechanical Systems	MME 311		
	MME 312		
	MME 315		
	MME 411		
	MME 412		
Group 2. Design for Manufacturing: A Materials and Processing Approach		MME 223 Engineering Materials	
		MME 231 Manufacturing Processes	
		MME 334 Quality Planning & Control	
		MME 434 Advanced Manufacturing	
		MME 437 Computer-Integrated Manuf. Systems	
Group 3. Design of Thermal / Fluid Systems	MME 313		
	MME 314		
	PSE 403		
	MME 414		
Group 4	MME 448/MME 449 Senior Design Projects		

Course Titles:

MME 311 Dynamic Modeling of Mechanical Sys., MME 312 Mechanics of Materials,
MME 313 Fluid Mechanics, MME 314 Engineering Thermodynamics, MME 315 Mechanical Vibration,
MME 411 Machine & Tool Design, MME 412 Advanced Mechanics of Materials,
MME 414 Engineering Thermodynamics II, PSE 403 Heat Transfer

APPENDIX IV. Integration of Hands-on lab Experiences Throughout the Curricula

The MME department places a high importance on enhancing learning by providing meaningful hands-on laboratory experiences. This is accomplished by regular investment in laboratory facilities as well as careful planning of laboratory usage. The laboratory experiences may involve design activities, experiments, or combination. In each MME program, many courses involve engineering design. This is summarized below.

Total courses with Design and credit hours: Manufacturing: 19 out of 21 (91%) total credit hours = 16.5; Mechanical:19 out of 21 (91%) total credit hours = 14.75; and Engineering Management: 14 out of 16 (88%) total credit hours = 12.25

The hands-on experiences begin with introductory courses and continue through to the students' last semester. The activities occur in the numerous laboratories within MME and cognate departments. These are summarized in Table 9

<table>
<tr><th colspan="5">Table 9. Integration of Hands-on Lab Experiences Throughout the Curricula</th></tr>
<tr><th>Courses</th><th>Design Credit hour</th><th>Mechanical Engineering</th><th>Manufacturing Engineering</th><th>Engineering Management With Manufacturing Technical Specialty</th></tr>
<tr><td>EAS 101</td><td>0.5</td><td colspan="3">Computer Lab and Paper Machine</td></tr>
<tr><td>EAS 102</td><td>0.5</td><td colspan="3">Computer Lab</td></tr>
<tr><td>MME 143</td><td></td><td colspan="3">Computer-Aided Design (CAD) Lab</td></tr>
<tr><td>ECE 205</td><td>1.0</td><td colspan="3">Electrical and Electronics Circuit (EEC) Lab</td></tr>
<tr><td>MME 211</td><td>0.5</td><td colspan="3">Computer Lab</td></tr>
<tr><td>MME 223</td><td>0.5</td><td colspan="3">Engineering Materials (EM) Lab</td></tr>
<tr><td>MME 231</td><td>0.5</td><td colspan="3">Manufacturing Processes (MP) Lab</td></tr>
<tr><td>MME/ECE 303</td><td>1.0</td><td colspan="3">Computer-Aided Experimentation (CAX) Lab</td></tr>
<tr><td>EGM/MGT 311</td><td>0.5</td><td colspan="2"></td><td>Computer Lab</td></tr>
<tr><td>MME 311</td><td>0.5</td><td colspan="2">Computer Lab</td><td></td></tr>
<tr><td>MME 312</td><td>0.5</td><td colspan="3">Computer Lab</td></tr>
<tr><td>MME/PSE 313</td><td>0.25</td><td colspan="2">Computer Lab</td><td></td></tr>
<tr><td>MME/PSE 314</td><td>0.25</td><td colspan="3">Computer Lab</td></tr>
<tr><td>MME 315</td><td>0.5</td><td>Mechanical Vibrations (MV) Lab</td><td colspan="2"></td></tr>
<tr><td>MME 334</td><td>0.5</td><td></td><td colspan="2">Quality Planning and Control (QPC) Lab</td></tr>
<tr><td>MME/PSE 341</td><td></td><td colspan="3">Computer Lab</td></tr>
<tr><td>PSE 403</td><td>0.25</td><td>Computer Lab</td><td colspan="2"></td></tr>
<tr><td>MME 411</td><td>2</td><td colspan="2">Computer-Aided Design (CAD) Lab</td><td></td></tr>
<tr><td>MME 412</td><td>0.5</td><td>Computer Lab</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>MME 414</td><td>0.5</td><td>Computer Lab</td></tr>
<tr><td>MME 434</td><td>1.0</td><td rowspan="2"></td><td colspan="2">Robotics (Rs) Lab</td></tr>
<tr><td>MME 435</td><td>1.0</td><td>Computer Lab</td><td rowspan="2"></td></tr>
<tr><td>MME 436</td><td>1.0</td><td colspan="2">Programmable-Logic Controller (PLC) Lab</td></tr>
<tr><td>MME 437</td><td>1.0</td><td></td><td colspan="2">Computer-Integrated Manuf. Systems (CIMS) Lab</td></tr>
<tr><td>MME 448/449</td><td>2/2</td><td colspan="3">All Labs and according to the project</td></tr>
</table>

APPENDIX V. Integration of Professional Ethics Throughout the Curricula

The MME Department is committed to integrate ethics into its curriculum and in students learning experience. We are dedicating specific courses throughout the student four years of study at Miami to address ethical issues, which arise in a technologically based society. Also, it allows the students to become more aware of the role of ethics in the engineering profession. Our objectives are to allow the students to learn that one of the cornerstones of the engineering profession is its sense of professional responsibility; and an understanding of the engineer's ethical responsibility to society is implicit in being an engineer. Also, fundamental to the engineer's ethical responsibility is awareness of a "circle of competence" in providing services only in the areas of his or her technical expertise according to current standards of technical competence.

Specifically, the following are our objectives in covering professional ethics:

- Increase student awareness of professional responsibility and ethics,
- Address the influence of a world view on ethical standards,
- Raise students awareness of ethical dilemmas that they may face as professionals,
- Discuss strategies to confront problems, and
- Make links between professional standards and academic work.

THE MODEL

The model that is being used to integrate professional ethics into the curricula of the three majors is shown below. Each year, we carry a specific theme that attempts to build on previous coverage as well as proceed in more depth in specific topic. We include the ethics coverage in the course syllabus as well as part of its objectives, to state the specific purpose of covering ethics in this course. In this way, changing the instructor won't change objectives. Also, the coverage is documented as part of the course's notebook.

Table 10. Integration of Ethics Throughout the Curricula

Mechanical Engineering	Manufacturing Engineering	Engineering Management With Manufacturing Technical Specialty
EAS 101 (BVK, Ettouney, Hamilton)		
EAS 102 (Hamilton, Setlock)		
MME 143 (Koo, Shukla)		
MME 223 (BVK, Khan, Moller)		
MME 231 (BVK, Moller)		
MME 312 (Dollár, Setlock)		
	MME 434 (BVK, Hamilton)	
MME 448/449 (Ettouney and all design team advisors)		

APPENDIX VI. Integration of Writing Throughout the Curricula

Introduction: Identifying the Need

Engineering positions in academia and industry are undergoing evolutionary changes vis-à-vis the level of interaction and written communication that has become integral to the job profile. For instance, a highly competitive research environment with faculty competing for research funds requires that grant proposals be of high quality in regard to content and written presentation of the material. This arena also hosts specialty firms seeking small business innovation research funding from government agencies and venture capital groups. Similarly, modern practices to improve productivity in industry, such as concurrent engineering, require that engineers from various disciplines interact with each other, and, furthermore, communicate effectively with other divisions such as marketing and quality control. The erosion of *divisional islands* means tasks are no longer just being handed over the cubicle wall. A higher level of personal involvement in the form of presentations and preparation of reports has become a corollary of the evolving engineering work place and, naturally, expects functional writing skills be a part of the engineering education.

Actively encouraging writing in the context of engineering subjects is often deemphasized at liberal arts schools where the process of acquiring writing skills is considered by engineering departments to be a corollary of activities in the humanities. The anticipated synergistic benefits of learning writing outside the engineering curriculum often do not materialize since students are not often fully exposed to the genres of writing encountered in engineering and the natural sciences. The Department of Mechanical and Manufacturing Engineering is interested in pursuing avenues for improving the technical writing proficiency of its students. This has been precipitated by the need to improve communication skills and introduce measures for assessing progress in writing. Indeed, with existing course activities requiring considerable report writing for design projects, it would be true to say that the existing curriculum engages students in technical writing. However, there is a need to align these activities to provide the students consistent instruction and feedback pertaining to writing which is undertaken in various courses. To that end, the department has collaborated extensively with the Center for Writing Excellence to consider means of integrating writing and prepare faculty for potential changes in the preparation and grading of writing based assignments. The next step focuses on the incorporation of writing assignments into existing course activities in a manner that enhances technical pedagogy and develops the department's vision of improving written communication skills.

Implementation of Writing within the Curriculum

The existing structure of design threads (mechanical system, manufacturing process etc.), and more specifically the capstone design course (MME 448/449), provides opportunities to engage students in critical thinking and communication through writing assignments. However, the department has been actively examining it's curriculum to identify directions of evolutionary change that will improve the quality of the program. Writing based assignments clearly bolster the 'Critical Thinking' and 'Engaging with Other Learners' goals of the Miami Plan, and are well aligned with specific ABET criteria as well. The following is a sampling of activities/practices which have be identified for facilitating the development of student writing skills.

1) Progressive feedback and exposure to multiple genres: In several courses, responses to reading assignments or case studies will be required in short-report format directed at for

instance a project manager, external agency or colleague. This would instill facility in flexible writing as students prepare memos, reports, proposals targeted at various audiences.

2) Select courses could be designated as being writing intensive. This would require that the syllabus be modified to have students submit, perhaps, ten to twelve pages in writing assignments. It is pertinent to add that the incorporation of such an activity need not detract from the quality and/or content of the course but could potentially expand the locus of learning through research and argument development for the three or four short papers.
3) Use activities such as peer-review to develop skills in critical reading, evaluation, and response preparation. Incorporating such activities into assignments that are developed in segments will allow students to progressively develop and refine their work.
4) Students can be instructed in the formatting aspects of writing by providing a style sheet at the start of a semester. Such a sheet might include instructions and examples on including references, pagination, appropriate placement of captions, etc.
5) Greater consciousness of language usage and the significance of structuring a suitable presentation format can be instilled through a short workshop on reading/writing dynamics. This could be developed with the assistance of the Center for Writing Excellence and tailored specifically towards the requirements of the engineering curriculum.

It is pertinent to state that success in implementation and continuation of any such proposed changes to the curriculum is contingent on the faculty understanding and espousing the objectives of the program. The MME faculty has been remarkably receptive of the proposed ideas as evidenced through the high level of participation in the three-semester long writing workshop held in conjunction with the CWE. Various faculty have also attended CELT seminars directed at improving classroom instruction and introducing means of assessment.

Two Takes on Assessment

It is certainly desirable to gage the efficacy of any changes/additions to the curriculum, and this would overwhelmingly be true for so expansive an endeavor as the writing program. Some preliminary practices for assessing the effectiveness of the proposed writing based assignments are expected to take the form of quantifying progress within a course and, cumulatively, throughout the curriculum.

For the former, instructors will be expected to list objectives specific to the type of writing to which students will predominantly be exposed. This could take the form of a rubric sheet that could be applied to a paper submitted at the start of the semester and towards the end to allow the growth in writing ability to be assessed.

The Senior Exit Survey provides valuable insight from a student’s perspective of the perceived effectiveness of the department’s efforts at implementing its goals. The question addressing ‘contribution of program to improvement of reading and writing ability’ has admittedly scored relatively lower in the past few years, and it is anticipated that this departmental initiative will help ameliorate this assessment.

APPENDIX VII. Proposed Integration of Computational Methods Throughout the Curricula

The MME Department recently reviewed its broader and discipline-specific program outcomes and considered ways in which it could assess student attainment of them. For some outcomes, it was found that student attainment could be more clearly demonstrated by having more coherently planned teaching and learning of computational tools and methods. Examples of relevant outcomes include, “research concepts and application of modeling methods” From the Mechanical Engineering program and “analyze, synthesize, and control manufacturing operations using statistical and calculus-based methods, simulation, and information technology” from the Manufacturing Engineering program

It is therefore proposed that one or more computational course threads (similar to those discussed earlier for design and ethics integration) be developed to provide coherent delivery of this teaching and learning. Student growth in capabilities as demonstrated in student work would demonstrate attainment of the selected program outcomes. The first thread will be developed for the Mechanical Engineering curriculum to be followed later with other threads for the Manufacturing and Engineering Management curricula.

Specifically, the desired **outcomes** of integration of computational methods in MME Curricula are that, by the time students complete the course thread, students should be able to:

- recognize contexts where numerical methods need to be used to perform engineering modeling,
- have a working familiarity with using structured programming to apply numerical methods,
- have an understanding of the mathematical underpinnings of computer-aided-engineering tools for mechanical analyses,
- have a working familiarity with selected numerical methods such as solution of PDEs, solution of systems of linear equations,
- make use of computer-aided-engineering tools to guide design decisions, and verify solutions.

THE MODEL

The pilot thread model includes the set of courses shown in Table 11, below. These courses provide opportunities for students to use computational methods and tools to guide design decisions, support the solution of homework problems, and illustrate course concepts. A faculty team, made up of those who currently teach or recently have taught these courses, is organized to plan, implement, and assess the pilot thread. Currently, this team has identified desired progression in student computational knowledge, skills, and problem-solving abilities. Next, they would formulate implementation plan that include specific description of the student activities in each course. This plan would be implemented in phases to follow student progression among the courses. As each implementation stage completes, the team will assess the results and use to improve the experience. Cumulatively, the team planning, implementation, reflection, and collection of student work will be used as evidence of attainment of student learning outcomes.

Table 11. Proposed Integration of Computational Methods Throughout the Mechanical Engineering Curricula
MME 143 (Shukla, Koo, Singh)
MME 312 (Dollár, Setlock)
MME 311 (Koo, Khan)
MME 315 (Singh, Koo, Shukla)
MME 411 (Moller, Shukla)
MME 412 (Moller, Dollár)

APPENDIX VIII. Major Developments and Accomplishments in MME since 1998

Below is a brief summary of the major changes and evolution in the past six years.

- We added a new major, Mechanical Engineering in 2002 and it was accredited by ABET in 2005. As a result, total student enrollment in the department increased from 204 in 1998 to 317 in 2005. Tenure and tenure eligible faculty increased from 6 in 1998 to 9 in 2006.
- We developed an overall strategic plan (see the discussion on page 5 and the flow chart on page 7) that integrates our systematic approach for assessment started in 1991. This plan ties together our mission with our vision, goals, program-educational objectives, and program outcomes. The evaluation and assessment plans includes 11 methods that assess program (student) outcomes and evaluate program educational objectives.
- Our plan for design integration expanded to cover all three majors in manufacturing engineering, engineering management with manufacturing technical specialty and mechanical engineering (see Appendix III, page 25). Design integration allows us to make explicit connections among our engineering courses, and provide more open-ended hands-on team-based projects and lab exercises. These are creative activities that require, among other things, critical thinking, careful synthesis, comprehensive analysis, and skillful implementation; all of which enhance the students' ability to solve problems.
- Our plan for professional ethics integration expanded to cover all three majors in manufacturing engineering, engineering management with manufacturing technical specialty and mechanical engineering (see Appendix V, page 27).
- The department added two new labs in Mechanical Vibrations and Programmable Logic Controllers. Further plans are ongoing for the addition of a Thermal/Fluids lab; see the department's lab development plan.
- With the continuous increase in our student enrollment as well as the addition of a new major (mechanical engineering), we have been discussing ways to manage student advising while maintaining our pro-active advising system, started in 1995. Also, with our shift towards more focused discovery-based faculty research and more release time for faculty, we are trying to strike a balance between effective advising, teaching, and research. In the past, we have been assigning one class (first year, sophomore, etc.) to a faculty member to advise them throughout their matriculation at Miami. Now, with these factors at hand we are revisiting our advising system to maximize our efforts without adding a heavier load to the faculty.
- On the National level, our students have faired very well in competitions. Our student design teams entered 12 national design competitions, sponsored by national professional organizations: in 4, they won first place, and in 3, they won 2nd or 3rd place. Here are their accomplishments:
  - In 2005-06, our students designed, fabricated, and participated in the Mini Baja National Competition.
  - In 2003/04, an interdisciplinary team of 4 MME students and 1 PCE student won 1st Place in the National Energy Challenge Competition, Design of a Snow Board. Also, a team of 7 MME students won the 2nd Place in the first Autonomous Lawn Mower Competition, and the best technical report and production plan.

- Between 1999 and 2004, our students entered the AIAA national competition to build and fly an airplane. Although our interdisciplinary student teams, from our department and Physics did not win first place, they faired well among their peers from other engineering schools.
- In 2001, our students won the Gold National Award (highest in class) for the Journey Competition of the Robotic International/Society of Manufacturing Engineers Student Robotic Engineering Challenge.
- In 2000, our students won First Place Award in the Robotics Industry Association Robotics Scholarship Competition for a paper discussing demanufacturing work cell design.
- In 1999, our first-year students won 3rd place in the National Design Graphics Competition, sponsored by the American Society for Engineering Education (ASEE) and affiliate: Engineering Design Graphics Freshman Programs and Design in Engineering Education; in 1998, they won 1st and 3rd places; in 1997, they won 2nd and 3rd places; and in 1995, they won 2nd place.

- We expanded opportunities for students to engage in international projects and studies. The following are examples of these opportunities. In 1997-1999, we conducted two senior design projects with the Computer Science Department at Palacky University in Olomuc, the Czech Republic; in 1999-00, we had a team of two students join the Architecture Department program in Ghana to design facilities for the local community; in 2001-02, a team of five students conducted research and open-ended design projects to connect our Computer-Integrated Manufacturing lab to a new virtual lab at MUDEC, in 2002-03, another team did a similar project with a French team at Ecole d'Ingenieurs du Pas-de-Calais (EIPC), in 2003-04, a team of students conducted feasibility studies to create new programs for engineering students in Poland; and finally, this year a team of students working with a team of computer science students at Palacky University to design and build an internet-based Seismometer between Oxford and Olomouc.

- In the spring of 2005, we started a long-term project, "Integrating Writing Throughout the Engineering Curricula," with the Center for Excellence in Writing, which will also include a comprehensive assessment plan and activities.

- The average pass rate in the Fundamentals of Engineering Exam, since 1998 is 89%; see Table 12 in page 33.

Table 12. Results of the Fundamentals of Engineering Exam											
Year	**Total Number who took the exam**	**Manufacturing Engineering Majors**		**Engineering Management with Manufacturing Specialty Majors**		**Mechanical Engineering Majors**		**Total Numbers of MME Grads**	**Total % of Class**	**Number who passed the exam**	**MME Pass %**
		Took Exam	**Passed Exam**	**Took Exam**	**Passed Exam**	**Took Exam**	**Passed Exam**				
1998	11	11	9	4 (4)	3	--	--	25	44%	9	82%
1999	18	18	17	7 (7)	7	--	--	28	64%	17	94%
2000	16	16	15	4 (4)	4	--	--	23	70%	15	94%
2001	10	10	10	6 (6)	6	--	--	19	53%	10	100%
2002	13	13	13	4 (4)	3	--	--	18	72%	12	92%
2003	13	13	13	6 (6)	6	--	--	24	54%	13	100%
2004	13	11	9	10 (8)	10	1 (1)	1	40	33%	11	85%
2005	11	11	7	1 (1)	1	4 (4)	3	32	34%	8	73%
2006	18*	2*	2*	7* (7)	7*	9* (7)	7*	45	40%	16	89%
Total =	123	105	95	49 (47)	47	14 (12)	11	254	52%	111	89%
Average =	**14**	**12**	**11**	**5**	**5**	**5**	**4**	**28**	**52%**	**12**	**89%**

* Spring only – numbers in parenthesis represent double majors

APPENDIX IX. Quality Indicators (QI) Methods of the system

Method QI.1: Pre-Post Learning of Engineering Design

Design reports generated in the course, EAS 101: Computing, Engineering, and Society, are used as a pre-learning vehicle for determining first-year students' understanding of the professional ways of knowing, reasoning, and problem solving, including problem definition, synthesis, analysis, evaluation, and presentation. These design reports of first-year students are collected, evaluated and compared to the students' work as seniors using the course, MME 448/449: Senior Design Projects. Results provide information about value added of student outcomes over their career at Miami.

Method QI.2: Employer Evaluation of Student Performance in Professional Practice

This method is based on employers' evaluations of our student on-the-job performance during the student's co-op or summer internships. Some of the desired student outcome characteristics that are evaluated by the employer include: planning, problem solving abilities, job knowledge, writing and oral communication, and teamwork. The evaluations give us timely feedback on student outcomes while students are progressing through the program. The feedback is reviewed for insights on student performance that can be communicated with the student prior to graduation; and a departmental improvement that can be made.

Method QI.3: Job Placement Surveys

This assessment tool is based on the School of Engineering and Applied Science survey of each graduating class to determine students' success rate in finding a suitable position. The data is combined into statistical profile that gives a measure of satisfaction of one of our primary stakeholders: employers who hire our students. For example, the data show the classification of the primary employers who hire our graduates, their geographical location, and the positions (job titles) that they offer to our graduates. Also, the data indicate the students' success in competing in the engineering market and earning competitive salaries to those offered to engineering students from other schools.

Method QI.4: National Competitions

The department provides opportunities throughout the students study to engage in national competitions and examinations. These enable us to assess student outcomes against national standards. For example, the department has been participating, in the past five years, in the National Design Graphics Competition for first-year students, sponsored by the American Society for Engineering Education. (In 1996, our students won 2nd and 3rd place, and in 1994, they won second place.) Also, we provide every year, at least one senior design project sponsored by a national organization where teams of our students compete with students from other schools.

Method QI.5: Student Advisory Council

The purpose of the Student Advisory Council is to provide a mechanism for students to give constructive feedback on their educational experience. This partnership helps the department to communicate closely with the student body and learn first-hand their needs, concerns, and insight into their perception of the program. The chair meets regularly with the student advisory council, at least three times a semester. At each meeting, issues are discussed to improve student learning and assess progress in achieving the desired student outcome characteristics and process characteristics. The chair shares and discusses student input with faculty, and collectively we address ways to implement student recommendation where appropriate. These meetings provide valuable qualitative information on the educational process of our students and program.

Method QI.6: Department Weekly Meetings

Department meetings are held weekly during the academic year. The purpose of the meetings are to insure that the faculty are informed of current issues of importance to the department, school and university; and to provide a forum for faculty input, discussion, recommendations and decision making on departmental issues. Examples of topics discussed regularly during department meetings are: design coverage, course content, ABET requirements, lab plans, advising, and assessment. These meetings are chaired by the Department Chair or designate. All faculty and staff are expected to attend unless excused by the Chair. The Chair establishes the agenda, and any member of the Department may propose items for the agenda. Prior to the meeting, the Chair distributes material relevant to major discussions. A recording secretary is appointed to keep minutes. The minutes are available to all faculty and they are posted on the School of Engineering and Applied Science Network. Hard copies are distributed to the SEAS Dean, and annually to the University Secretary.

Method QI.7: Program Reviews

Periodically, the department undergoes three different reviews to assess the process as well as the outcome characteristics of its graduates. The first review is internal and the University conducts it every six years. The review measures program quality, centrality to the mission of the University, and viability. The second review is conducted by ABET; ABET reports on program evaluation and criteria are used for improving the process and student outcomes. External consultants conduct the third review. Since 1995, we had 5 external consultants; their reviews are utilized to assess specific components in the program such as design content and its integration into the curriculum, students, faculty, and facilities. Among other things, these reviews are excellent tools to measure program quality against national and Miami standards.

Method QI.8: Educational Process Characteristics

To assess the quality of education that students receive in all SEAS programs, the school's faculty developed specific educational-process characteristics, see below; these are included in the senior-exit surveys (Questions 18-29) that are used by all SEAS departments. SEAS educational-process characteristics are consistent with our mission: ***B. Excellence in Undergraduate Education***, as shown in Figure 3, page 12. In Table 13, page 36, we map category B. of our mission with the educational-process characteristics. Seniors, before graduation, are asked to assess the following process characteristics within each program in our department:

18. The intellectual challenge of program;

19. The overall quality of teaching in courses within the department of major;

20. The quality of the laboratory experiences within the department of major;

21. Awareness and practice of safety procedures in department's laboratories;

22. The academic advising and curricular materials within the department of major;

23. The advising and career information received within the department of major;

24. Accessibility of faculty members to students within the department of major;

25. The opportunity for intellectual interaction with faculty outside the classroom;

26. Faculty helpfulness in dealing with class work;

27. The quality of the entire learning experience within the department of major;

28. The treatment of students with respect to fairness and respect; and

29. The educational environment in the department with regard to all types of prejudice.

Table 13. Excellence in Undergraduate Education and SEAS Educational-Process Characteristics	
B. Excellence in Undergraduate Education (These are derived from our mission. Achievements are evidenced by course and teaching portfolios, by faculty annual reports [which include among other things student evaluations and reflective teaching philosophies], by our advising notebook, and documentation of our teaching plan.)	Educational-Process Characteristics
B.1 Provide an educational environment that enables the students to learn how to learn on their own and learn by doing	20-21
B.2 Provide an effective and intellectually challenging classroom experience	18,
B.3 Provide an atmosphere which promotes a good relationship between the faculty and students	24-26, 28-29
B.4 Utilize student evaluations of all departmental courses, for improving teaching effectiveness	19,
B.5 Maintain a strong teaching plan, with multiple assessment tools, that enables faculty to reflect and act on their teaching	19, 27
B.6 Provide an effective and dynamic curriculum and career advising system	22, 23

Table 14. Quality Indicators Methods, Frequency, and Faculty Assignment

Method	**Description**	Purpose	Frequency	Faculty	Responsibilities
QI.1	**Pre-Post Learning of Engineering Design**	Other	every 6 yr	MME Chair	Collect student work and summarizes the results, share with the faculty
QI.2	**National Competition**	Other	1/ yr	Khan	Document and summarizes the results
QI.3	**Employer Evaluation of Professional Practice**	Other	1/sem	Hamilton	Administrative assistant collects data. Faculty review the data; summarize, discuss and follow up on action plans.
QI.4	**Student Advisory Council**	Other	1/ semester	MME Chair	Document and summarizes the results
QI.5	**Job Placement Surveys**	Other	1/ semester	Moller/Setlock	Document and summarizes the results
QI.6	**Dept. weekly meetings**	Other	1/ week	All Faculty	Collect the minutes
QI.7	**Program Reviews**	Other	Every 6 yr	All Faculty	Write the self study & discuss the results/ recommendations
QI.8	**Educational-Process Characteristics**	Other	Once a semester	Chair	Collect data as part of senior-exit survey, Questions 18-29

APPENDIX X. MME Mission mapped versus Miami's and SEAS Missions

Our mission, as shown in page 11, supports and is consistent with Miami's and the School's missions. To demonstrate the linkage among the three missions, we organized the three missions in a format that enables us to map them against one another. This is shown below and in Figure 3, page 12. Following the table, we show the three missions in easy to follow categories, without editing them, to map them against one another. <u>The underlined sentences identify the commonalities among the three missions</u>. Also, in Table 15, we identified the interrelationship among the three missions, and specifically ours, and the eight Criterion of ABET Criterions. In addition, and as shown in Figure 3, our objectives and program outcomes are all linked and derived from our mission and specifically the first category: ***A. Quality graduates to meet societal and industrial needs***. This is shown in Table 15 and in detail, as part of our mission, in page 11.

Table 15: Mapping our Department Mission with Miami's and the School's Missions

Department of Manufacturing & Mechanical Engineering Mission (see page 11)	**Miami's Mission** (see below)	**School of Engineering & Applied Science Mission** (see page 40)
A. Quality graduates to meet societal and Industrial needs (Supports ABET *Criteria 2, 4, 8*)	M.I.2, 3, M.II.1, 2, 4 M.III.1, 2	S.1
B. Excellence in Undergraduate Education (Supports ABET *Criteria 1, 3, 6, 7*)	M.I.2, 3, M.II.1, 2 M.III.3	S.2
C. Competent, Energetic Faculty with High Aspirations (Supports ABET *Criterion 5, 8*)	M.I.1, 3	S.4
D. Mission Central to both Miami's and the School's missions	M.II.3, 4, M.III.3, 4	S.3

The Mission of Miami University

I. The mission of Miami University is:

M.I.1 to preserve, add to, evaluate, and transmit the accumulated <u>knowledge</u> of the centuries;

M.I.2 to <u>develop critical thinking</u>, extend the frontiers of knowledge, and <u>serve society</u>; and

M.I.3 to provide an <u>environment</u> conducive to effective and inspired <u>teaching</u> and <u>learning</u>, promote <u>professional development of faculty</u>, and <u>encourage scholarly research</u> and creativity of <u>faculty and students</u>.

II. Miami's <u>primary concern</u> is its students. This concern is reflected in a broad array of efforts to develop the potential of each student. The University endeavors:

M.II.1 to <u>individualize the educational experience</u>. It provides personal and professional guidance; and,

M.II.2 it offers opportunities for its students to achieve understanding and appreciation not only of their own culture but of the cultures of others as well.

M.II.3 Selected undergraduate, graduate, and professional programs of quality should be offered with the expectation of students achieving a high level of competence and understanding and developing a personal value system.

M.II.4 Since the legislation creating Miami University stated that a leading mission of the University was to promote "good education, virtue, religion, and morality," the University has been striving to emphasize the supreme importance of dealing with problems related to values.

III. Miami is committed to serve the community, state, and nation.

M.III.1 It offers access to higher education, including continuing education, for those who can benefit from it, at a reasonable cost, without regard for race, creed, sex, or age.

M.III.2 It educates men and women for responsible, informed citizenship, as well as for meaningful employment.

M.III.3 It provides both disciplinary and interdisciplinary approaches to the pursuit of knowledge and to the solving of problems.

M.III.4 It sponsors a wide range of cultural and educational activities, which have significance beyond the campus and the local community.

The School of Engineering and Applied Science Mission Statement

S.1 Our mission is to serve society by providing high-quality undergraduate and graduate education in the fields of computing, engineering, and nursing.

S.2 We are committed to creating an environment for teaching, learning and scholarship that is intellectually-stimulating, interactive, and innovative and in which our faculty, staff, and students realize their full potential.

S.3 Our guiding principle is to provide professional education integrated with Miami University's traditional strength in liberal education.

S.4 We work to continually assess and improve teaching, learning, and critical thinking; to engage in scholarship of discovery, application and teaching; to contribute to the accumulated knowledge of the centuries through faculty and student research; to encourage creativity; and to promote the continuing intellectual growth of our community.