Interim Report

For the Mechanical Engineering Program

Contents

Preface

This interim report is to document progress made in correcting weaknesses identified in the Mechanical Engineering Program at IIT during the 2002 visit by the EAC of ABET. Weaknesses were identified in Criterion 2 and Criterion 3: specifically, that the assessment process had not been in place long enough to document refinement of program objectives and improvements to the programs as a result of applying the assessment process.

ABET does not prescribe a particular format for interim reports. This report has been structured to follow the standard EAC format for Criteria 2 and 3. In addition we include both in the body of the report and as appendices data on the nature of the institution, the department, students and the curriculum that place the assessment process in context.

As familiarity has been gained with the assessment process, the process itself has been changed to drop features that produced little or no useful data, and to add elements that we believe are more pertinent. These are also documented in this report.

The Mechanical Engineering Program (ME) is one of three accredited engineering programs offered in the department of Mechanical, Materials and Aerospace Engineering. These are: Aerospace Engineering (AE), Mechanical Engineering (ME), and Materials Science and Engineering (MSE). The three programs have a high degree of commonality, having some 80% of their coursework in common. While discipline specific faculty teach the professional component of each program, the engineering science core courses are assigned to qualified faculty regardless of his or her specific discipline. Because the programs are small and have so much in common, a common assessment process is used in order to provide better statistics.

20 June 2004

Interim Report

For the Mechanical Engineering Program

A. Background Information

1. Degree Titles

Bachelor of Science in Mechanical Engineering

2. Program Modes

Day. No alternative modes are offered. A structured co-op is available as an optional activity for students, but co-op experience does not count for academic credit in the program.

3. Contact Information

Jamal Yagoobi – Department Chair

MMAE Department, IIT, Chicago IL 60616

(312) 567 3239 yagoobi@iit.edu

John Kallend – Associate Chair

MMAE Department, IIT, Chicago IL 60616

(312) 567 3054 kallend@iit.edu

B. Accreditation Summary

1. Students

1.1 Program Demographics

See **Table I-2**

1.2 Advising

All students are advised by full-time faculty in the department. New students are assigned to a faculty advisor on enrollment, and are advised either in person, by telephone, or by e-mail correspondence during the inter-semester break prior to matriculation. The advisor has access to the student's high school record, standardized test scores and AP or IB credit prior to the advising session. Once advised, students may immediately register for courses using "Web for Students" ™. Incoming freshmen (and transfer students with less than 30 transferable credit hours) are required to take MMAE100 (Introduction to the Profession) in the Fall semester. Section sizes in this course sequence are limited to 20 (typical size is 14 - 18) and *the course instructor is the students' academic advisor for the first year*. These courses meet twice per week, ensuring excellent contact between student and advisor. Following the freshman year, students are assigned a faculty advisor who will usually stay with them for the remainder of their undergraduate career. Advisor's permission is required before a student may register for the following semester or withdraw from any course.

Faculty advisors have the following tools available to ensure that the advising process is effective:

SIS (Student Information System)™ and Web for Faculty™ : this software allows advisors to access the student's complete course schedule and official academic record from their office computer.

Mid-term grades: mid-term grades are issued for all lower division courses. Advisors have access to these grades so that intervention can occur when necessary before the course is complete.

Advising holds: students cannot register for any courses until their advisor releases a hold.

MMAE Department Advising Guidelines: a comprehensive booklet describing how the course sequence fits together, graduation requirements, etc. is provided for students and faculty advisors. These guidelines are also available on the department's web site. The booklet is updated annually.

1.3 Monitoring

Each student's progress is monitored at mid semester (1st and 2nd year courses) by the advisor, and at the end of each semester by the associate chair of the department and the associate dean of the Undergraduate College. Students whose progress is unsatisfactory due to low grades or failing to maintain 12 credit hours/semester (6 CH/semester for part time students) towards their degree are placed on academic probation and notified by letter from the dean's office. Students on probation are limited to 15 hours/semester of coursework, and may not participate in varsity sports or take office in any student organization. In severe cases, students may be asked to meet with the associate dean who will place more stringent conditions on their continued enrollment. Typical conditions may be compulsory attendance at the Academic Resource Center for tutoring, or the Student Counseling Center if learning disability or emotional problems are suspected. IIT is classified as having "selective" admissions, and student academic problems are not usually associated with insufficient ability or preparation, but more commonly with difficulty adjusting to college, inappropriate choice of major, or financial/emotional stress, and the Student Counseling Center is equipped to help is such cases.

If a student stays on academic probation for two (or more) consecutive semesters, the student may be dismissed.

1.4 Evaluation

Students are evaluated using a traditional 4-point grading scale, with grades being assigned by the course instructor. All courses have stated learning objectives and instructors are expected to assign grades based on achievement of those objectives. Specific protocols have been developed for evaluating written and oral communication skills, and team skills. *Thus a passing grade in a course implies achievement of the learning objectives at a minimum acceptable level*.

2. Program Educational Objectives

The 2002 EAC of ABET visit identified the following weakness:

"The educational objectives are complete and well documented, and are closely aligned with the mission of the institution. However, there needs to be a well defined process-oriented approach to evaluating the achievement of the objectives, including input from the constituents and documented evidence of program improvement through the process"

2.1 Objectives

Three engineering programs are offered in the Department of Mechanical, Materials and Aerospace Engineering; they are: Aerospace engineering (AE), Mechanical Engineering (ME) and Materials Science and Engineering (MSE). In the statement of objectives that follows, the concordance with ABET Criteria 3(a) through 3(k) or program specific criteria is indicated in **[ ]**. Please note that following the scheduled review in 2003, there have been some changes in the objectives compared to those in place at the time of the 2002 EAC of ABET visit.

The common objectives of the three programs in the department are:

To educate students for a broad range of professional careers, provide the basis for life-long learning **[3i],** and prepare students for advanced studies at the graduate level. Recognizing the changing professional environment that graduates will encounter, our programs aim to develop graduates who:

- possess a strong foundation in mathematics, science and engineering and are proficient in the engineering sciences on which the major discipline is based **[3a, 4]**
- are able to link science and engineering principles to identify, formulate and solve engineering problems in professional practice and research and development contexts **[3b, 3c, 3e, 4]**
- are able to design and conduct experiments, as well as analyze and interpret data **[3b]**
- have proficiency working in multidisciplinary and interprofessional teams **[3d]**
- utilize effective oral, written, graphical and computational communication skills **[3g, 3k]**

- understand the economic, ethical, societal, environmental and global contexts of their professional activities **[3f, 3h, 3j, 4]**
- have a recognition of the need to remain current in their chosen field and are able to engage in lifelong, independent learning and professional development **[3i]**, and
- translate knowledge of their respective disciplines to a broad spectrum of professions **[3k]**

The ME program-specific objectives are to develop graduates who have the ability to perform engineering design and analysis of tasks using the principles of solid and fluid mechanics; manufacturing; and thermal, structural and control systems. **[program criteria, Mechanical and similarly named programs].**

These objectives are published in the *IIT Undergraduate Bulletin*, the next edition of which will be published August 2004, and on the departmental web site http://mmae.iit.edu

The clear relationship between the program objectives and the requirements of EAC of ABET criteria 3(a) through 3(k) facilitates the determination of the achievement of objectives.

2.2 Constituencies

The faculty has determined the constituencies of the program to be: the public, students, alumni of the program, program faculty, and employers of our graduates. Formal communication with these constituencies has been established by means of:

IIT Board of Trustees: The Board of Trustees represents the public interest and establishes the mission of the university. Its members are drawn primarily from community and industry leaders in the Chicago metropolitan area. The board is responsible for setting the overall mission and goals of the university. It meets twice each year.

Armour College of Engineering and Science Board of Overseers: The College overseers are drawn from industry and academia, and provide guidance to the dean on college wide issues.

MMAE Student Advisory Board: This is a self-governing entity. It conducts its own elections of officers drawn from students enrolled in the three programs within the department, spread over all four years. Secretarial support is provided by the department. This board can act on its own initiative about any issue relevant to the undergraduate programs, or may be consulted by the department head or the department undergraduate studies committee. The student advisory board also conducts a survey of graduating seniors.

It should be emphasized that the low student/faculty ratio in the ME program also results in excellent informal lines of communication between students and faculty.

MMAE External Advisory Board: This board represents alumni, employers of our graduates, and representatives of academia and the professions of mechanical, materials and aerospace engineering. Members are appointed by the department head. This board meets annually with the department faculty, and members may be consulted as appropriate.

The current (2004) membership of the External Advisory Board follows:

Adnan Akay	Lord Professor and Head, Department of ME	Carnegie Mellon University
Ted Belytschko	Professor	Northwestern University
Richard Buckius	Professor and Head, Department of ME	U of Illinois Champaign -Urbana
Skip Fletcher	Director for Aerospace	NASA Ames Research Center
Robert Footlik	President	Footlik and Associates
Les Hardison	Senior Consultant	Wheelabrator Technologies
James Korenchan	Director, Service Delivery	General Motors
Bruce Liimatainen	President	A. Finkl & Sons Company
Robert Page	Emeritus Professor	Texas A&M University
William Rogers	Director, Business Dev & Technology Application	Alcoa Engineered Products
Sushil Sharma	Group Leader -- ME/ASD, Advanced Photon Source	Argonne National Laboratory
Herb Velazquez	Research Fellow, Aesthetics Research Center	Kimberly Clark
Richard Wlezien	Program Manager, Vehicle Systems	Office of Aerospace Technology, NASA Headquarters
Ric Woldow	Advanced Materials Technology	Caterpillar Inc.

IIT Faculty meetings and faculty committees: All new programs, as well as changes in the General Education requirements must be approved by majority vote of the full university faculty. University faculty meetings are held biannually. The *IIT Undergraduate Studies Committee* meets monthly through the academic year and is charged with reviewing programs, monitoring and recommending changes to the General Education Requirements, and approving significant changes in existing programs. The ME program has a representative on this committee.

MMAE Faculty meetings and faculty committees: Faculty meetings are held monthly. All program changes must be approved by majority vote of the faculty. An annual 1-day retreat has been established for in-depth discussion of programmatic issues. Faculty committees are appointed for various tasks: relevant to the undergraduate program are *Undergraduate Studies Committee*: this has 7 members including the department chair *ex-officio*. It is tasked with evaluating data from the assessment process, making recommendations to the faculty concerning undergraduate program improvements, and approving student petitions for special

projects, undergraduate research and course substitutions. This committee provides liaison with the Student Advisory Board. The committee meets on alternate weeks during the academic year or may be convened at any time if rapid response to an issue is required.
Laboratory Committee: this committee is charged with maintaining the plan for upgrading and improving the departmental laboratory facilities based on needs.

2.3 Establishment and Review of Program Educational Objectives

In 1994 the *National Commission for IIT* was established by the IIT Board of Trustees to chart a course for the following decade. The commission was chaired by Robert Galvin, Chairman Emeritus of Motorola, and its members were drawn from industry and academia and included members of the National Academy of Engineering, National Academy of Science, Nobel Laureates, and leaders of industry and colleges nationwide. There was also student and faculty representation. This commission recommended, *inter alia,* significant changes in IIT's mission and objectives, including an increased emphasis on inter-professional studies, communication skills, and a more global outlook. The Board of Trustees accepted the report in 1995 and mandated its implementation. (This also coincided with the release of a draft of ABET EAC Criteria 2000, which themselves indicated significant curricular change). In order to facilitate the necessary changes the university announced a $250M development campaign. The campaign ended in 2001, having raised in excess of $258M.

Extensive discussion within the faculty took place from 1995 – 97 to establish the basic framework for the necessary programmatic changes, and in 1997 the IIT faculty approved a major revision of the General Education Requirements of the university, to take effect with the entering class of 1999. Among the changes were a requirement for 6 credit hours of work on "Interprofessional Projects" (IPRO) to develop skills working with individuals from other disciplines and professions on real-world technical projects involving economic, legal, ethical and social issues. Another new requirement was for each student to take 42 credit hours of courses designated as communications-intensive (indicated with a (**C**) in the Undergraduate Bulletin), split between courses in the major and in other areas. There must be significant writing, oral presentation or graphical components in these courses.

The MMAE Department's undergraduate studies committee then drafted a proposed set of educational objectives for the department's programs. These drafts were circulated for review and comment to the student advisory board and the external advisory board. The full MMAE faculty then considered the drafts and all comments received, before final approval of the program objectives.

The program objectives are scheduled to be reviewed every three years by the faculty, and by the two advisory boards. The last review was in progress at the time of the 2002 EAC of ABET visit and was completed in Spring 2003.

2.4 Relationship of Curriculum with Program Objectives and Learning Outcomes

The curriculum was designed by the faculty to be consistent with the program objectives. In particular, there is a major emphasis on interdisciplinary studies, team skills, and open-ended problem solving emphasizing the need for life-long learning skills, and on written, oral and graphical communications skills. In keeping with the focus on interdisciplinary studies, the first two years of the program are now common with the Aerospace Engineering and Materials

Science and Engineering programs. Details and analysis of the curriculum are provided in Appendix I.

The following table indicates the relationship of the required engineering and related courses in the curriculum to the ABET criteria 3(a) through 3(k). In this table, a curriculum component receives a score of 0 through 3 according to the extent to which the particular learning objective is addressed (0 = not addressed at all, 3 = major component of the course. The table indicates coverage of all required outcomes in required courses in engineering topics. *General education courses that contribute substantially to outcomes 3(g), 3(h), 3(i), and 3(j) are not included in this table.*

This table emphasizes that all objectives are addressed in a minimum of three required courses in the curriculum, and most objectives, including all technical objectives, are addressed to some extent in at least 8 required courses.

Table 2.1 ABET outcomes 3(a) - 3(k) addressed in required courses in the ME curriculum. Mathematics, basic science and general education courses *excluded*. All courses are MMAE unless otherwise specified.

ABET Criterion ↓	**Course**						
	EG 105	**CS105**	**100**	**MS 201**	**201**	**202**	**271**
3a	1	0	2	2	2	2	3
3b1	0	0	1	0	0	0	3
3b2	1	1	2	1	1	1	3
3c	2	0	2	0	1	3	1
3d	0	0	1	0	1	0	0
3e	1	0	2	0	3	2	3
3f	1	1	2	0	1	0	1
3g	2	0	3	0	1	0	3
3h	0	0	1	1	1	0	0
3i	1	0	1	1	2	0	0
3j	1	1	1	2	1	0	0
3k	3	0	2	0	1	3	3

Table 2.1 continued

ABET Criterion ↓	Course							
	PHYS 300	306	305	310	320	321	322	350
3a	3	3	3	3	3	3	3	3
3b1	3	0	0	3	0	0	3	1
3b2	3	0	0	3	0	1	3	1
3c	3	2	2	1	0	1	1	0
3d	0	0	0	0	0	0	0	0
3e	0	2	2	2	3	3	2	3
3f	0	2	1	1	1	1	0	0
3g	0	1	1	2	1	1	3	2
3h	0	1	1	0	0	0	0	0
3i	0	2	1	1	0	0	0	1
3j	0	2	1	1	0	1	1	1
3k	3	2	2	0	3	3	2	2

Table 2.1 continued

ABET Criterion ↓	Course						
	430	**432**	**433**	**443**	**485**	**IPRO I**	**IPROII**
3a	3	3	3	3	3	2	2
3b1	3	0	0	0	0	2	2
3b2	3	1	3	0	3	2	3
3c	3	3	3	3	1	3	3
3d	1	0	0	0	0	3	3
3e	3	3	2	3	2	3	3
3f	2	2	1	0	1	3	3
3g	3	3	3	0	1	3	3
3h	2	1	2	0	0	3	3
3i	2	2	2	0	1	3	3
3j	2	2	2	3	1	2	2
3k	3	3	3	0	3	2	2

2.5 Achievement of Objectives

The assessment plan calls for a review of objectives on a three-yearly cycle. The scheduled review was in progress at the time of the 2002 EAC of ABET visit.

Alumni Surveys were sent in Spring 2002 to all students who graduated from the program in 1995 and 1998 for whom addresses were known. Approximately 15% of the surveys were returned. The only stated objective in which improvement was suggested by a substantial number was *communications skills* 100% of returned surveys indicated that the graduates of the program either had pursued an advanced degree, or had attended professional society meetings, or both, indicating a strong commitment to lifelong learning. *Note: A significant increase in communication content was placed into the curriculum in 1999, after most of the surveyed students had graduated* . The next survey is scheduled for Fall 2004.

Engineering Intern Exam Results from the State of Illinois for 2002 and 2003 indicate a pass rate of 89% and 100% for graduates of the AE, ME and MSE programs. This comfortably exceeds the national average, although the sample size is fairly small. Nevertheless, it is a strong indicator of the quality of the programs.

Employment Data are collected by the Career Development Center and made available to the department. For the years 2001 – 2003 (latest for which data are available) over 90% of program graduates were employed in their field or enrolled in graduate school within 6 months of graduation. While employers are reluctant to provide feedback on employees, many of employers return year after year to hire our graduates, indicating a high degree of satisfaction.

Input from the Student Advisory Board and Senior Surveys with respect to objectives was perhaps the most valuable source of information. Students reported positively on all objectives except familiarity with *international issues*, and the wording of the objective relating to *lifelong learning.*

2.6 Action Taken to Remedy Weakness

At the time of the 2002 EAC of ABET visit the review of objectives was in progress. Input had been solicited from alumni by way of a survey (results of this were made available to the EAC visitor in 2002). Subsequently inputs have been obtained from the Student Advisory Board and from the External Advisory Board, and data from the EI examination and employment data were also available.

These data were analyzed by the department undergraduate studies committee and recommendations were made to the faculty at its annual retreat in May 2003. Based on the quantitative information from the EI exam and employment statistics, as well as input from the alumni survey and the advisory boards the faculty concluded that the program is highly successful, in that both pass rate in the EI exam and the rate of employment or admission to graduate school comfortably exceed the national averages.

Qualitative feedback received from both alumni and the Student Advisory Board indicated that that the wording of the objectives required reworking in order accurately to reflect the actual intent of the program. In particular the following issues were identified by the Student Advisory Board:

1. The program objectives mentioned "international contexts" of professional activities, and that this was not covered in the program. The faculty agreed with this analysis, concluding that this wording implied a political context that was not, and was not intended to be, emphasized in the program. The emphasis is intended to be on global issues such as environment, resources, sustainable growth, etc.
2. An objective was that graduates should "engage in life-long learning". It was concluded that prescribing an activity for life was beyond the capability of any undergraduate program, and furthermore was not measurable. Revised wording reflecting intent and ability was substituted.

The faculty considered these comments and agreed that the Student Advisory Board had accurately identified areas of concern.

Specific wording changes were made as follows (omitted text struck out, replacement text in italics)

> Understand the economic, ethical, societal, environmental and ~~international~~ *global* contexts of their professional activities.

And

~~Engage in lifelong learning~~ *Have a recognition of the need to remain current in their chosen field and are able to engage in lifelong, independent learning and professional development*

The program objectives as revised May 2003 are those listed in section 2.1

The revised program objectives were approved by vote of the department faculty in May 2003, were presented to and endorsed by the External Advisory Board at its meeting in October 2003.

The objectives are next due for review during the 2006-2007 academic year.

2.7 Specific results

2.7.1 Engineering Intern Exam

Year	MMAE Pass rate	National Average
2001	91%	83%
2002	89%	84%
2003	100%	88%

2.7.2 Tracking Survey, AE, ME and MSE programs, 6 months after graduation

Graduation	Employed in field	Graduate school	Seeking job	Other
2001-2002	46%	43%	6%	6%
2002-2003	41%	48%	8%	4%
2003-2004*	67%	22%	0	11%

*

Data for 2004 Spring graduates not available. Data rounded to nearest %.

2.7.3 Responses to specific questions in 2002 Alumni Survey

Question: *Please rate your BS program's overall effectiveness in preparing you for your job or graduate study:*

Excellent 12.5%,

Good 62.5%

Fair 18.8%

Poor 6.3%

Question: *Please rate your preparation relative to that of your peers from other* *institutions:*

Superior to	18.8%
Somewhat better than	75%
About the same as	0%
Worse than	6.3%

3. Program Outcomes and Assessment

The 2002 EAC of ABET visit identified the following weakness:

"*The program outcomes have been closely correlated to the objectives and are well documented. However, there is only a preliminary plan for assessing the data and establishing feedback from the constituencies. There is no evidence that the complete process has been used to improve the program.*"

Program Outcomes

The general program objectives listed in section 2 are framed in terms of outcomes and are repeated here for convenience, together with their relationship to the outcomes specified in EAC Criteria 3 and 4.

Graduates of the ME program:

- possess a strong foundation in mathematics, science and engineering and are proficient in the engineering sciences on which the major discipline is based **[3a, 4]**
- are able to link science and engineering principles to identify, formulate and solve engineering problems in professional practice and research and development contexts **[3b, 3c, 3e, 4]**
- are able to design and conduct experiments, as well as analyze and interpret data **[3b]**
- have experience working in multidisciplinary and interprofessional teams **[3d]**
- utilize effective oral, written, graphical and computational communication skills **[3g, 3k]**
- understand the economic, ethical, societal, environmental and global contexts of their professional activities **[3f, 3h, 3j, 4]**
- have a recognition of the need to remain current in their chosen field and are able to engage in lifelong, independent learning and professional development **[3i]**, and
- translate knowledge of their respective disciplines to a broad spectrum of professions **[3k]**

In addition, the program specific outcomes are:

- Ability to analyze and design engineering systems using principles of
  - solid mechanics
  - fluid mechanics
  - thermodynamics
  - manufacturing
  - control systems

3.1 Relation of curriculum to Outcomes

These outcomes are produced by a curriculum comprising:

- A required general education component emphasizing breadth of knowledge of society, human behavior and achievement.
- Required courses in mathematics, physics, chemistry and computer science laying a sound foundation for engineering studies.
- An introductory engineering course emphasizing the nature of engineering as a profession and the role of the engineer as a professional.
- Basic engineering science courses encompassing knowledge of mechanics, thermodynamics, materials and instrumentation.
- Advanced courses in the major discipline emphasizing structure, properties and performance of modern materials in engineering applications.
- Interprofessional projects in which students work in interdisciplinary teams to design solutions to real-world, open-ended problems, subject to realistic constraints.
- Laboratory courses in which students learn to design experiments, analyze data, and use modern tools of engineering practice
- Communication intensive courses both in the major and in other areas in which writing, oral, and graphical communication skills are developed.
- Technical elective courses enabling students to pursue studies outside of their major area.

The effectiveness of the curriculum in achieving these outcomes is reinforced by well qualified faculty, academic advising conducted by full-time faculty, a low student/faculty ratio, well equipped laboratory facilities, and support services.

Section 2.4 (Table 2.1) gives a detailed correspondence between the curriculum and the learning outcomes EAC of ABET 3(a) through 3(k). Each learning outcome is addressed in a *minimum* of three required courses, and all outcomes relating to technical competence are addressed in a *minimum* of 8 courses.

3.2 Assessment of Outcomes

The various program outcomes are assessed using the following tools:

- Faculty assessment of course and program outcomes, performed each semester
- Student course assessments and surveys of graduating seniors, performed each semester
- Surveys of alumni, performed triennially
- Interprofessional Project (IPRO) program assessments (university wide), performed annually
- Communications program assessments (university wide), performed biennially
- Student advisory board input
- Engineering Intern exam administered by the State of Illinois, biannual
- Direct feedback from students
- Analysis and recommendations by the IIT and departmental Undergraduate Studies Committees

Specific survey instruments in use are listed in Appendix 1C.

The table on the next page indicates how the specific outcomes are assessed, and the estimated utility of each assessment tool on a scale of 0 – 3. A score of zero indicates that no reliance is placed on this tool, and a score of 3 suggests that the tool is considered highly effective. These estimates are based on perceived accuracy and on response rate, and have been adjusted in the light of experience

Table 3.1 The tools used to assess program outcomes, and an estimate of their utility. Scale used: zero (no utility) through 3 (highly reliable).

Outcome/Assessment Tool	Faculty Assessment	Senior Survey	Alumni Survey At 3 and 5 years	IPRO and Communications Assessment	EI Exam
Foundation in Math/Science/ Engineering	3	2	1	0	3
Link principles with engineering problems	3	2	1	1	3
Design and conduct experiments…	3	2	1	2	0
Multidisciplinary team skills	1	2	1	3	0
Communication skills	1	2	1	3	0
Ethical, societal and professional responsibility	2	2	1	1	1
Lifelong learning	1	2	1	3	2
Translate knowledge of discipline to profession	2	2	1	2	2
Design to specifications	3	2	1	2	0

Metrics

Each engineering course has course-specific learning outcomes, and faculty have defined course-specific metrics for them. In addition, separate, comprehensive assessments are performed on a college-wide basis of the outcomes of the IPRO, communications, and basic mathematics programs.

Satisfactory achievement of program outcomes is defined as follows:

- possess a strong foundation in mathematics, science and engineering and are proficient in the engineering sciences on which the major discipline is based.

  Metric/target: Better than 3.5/5.0 response on returned surveys of faculty, graduating seniors. National average or better EI score.

- are able to link science and engineering principles to identify, formulate and solve engineering problems in professional practice and research and development contexts.

  Metric/target: Better than 3.5/5.0 response on returned surveys of faculty, alumni, graduating seniors. National average or better EI score.

- are able to design and conduct experiments, as well as analyze and interpret data

  Metric/target: Better than 3.5/5.0 positive response on returned surveys of faculty, alumni, graduating seniors.

- have experience working in multidisciplinary and interprofessional teams

  Metric/target: Better than 3.5/5.0 response on returned surveys of faculty, alumni, graduating seniors. College-wide IPRO assessment report considered by program faculty.

- utilize effective oral, written, graphical and computational communication skills

  Metric/target: Better than 3.5/5.0 response on returned surveys of faculty, alumni, graduating seniors. Results of college-wide IPRO program outcomes assessment report considered by program faculty.

- understand the economic, ethical, societal, environmental and international contexts of their professional activities

  Metric/target: Better than 3.5/5.0 positive response on surveys of faculty, alumni, graduating seniors. The IPRO evaluation report is considered by program faculty.

- Understand need for lifelong learning

  Metric/target: Better than 75% positive response on surveys of faculty, graduating seniors for participation in professional development or continuing education activities.

- translate knowledge of their respective disciplines to a broad spectrum of professions

  Metric/target: More than 90% of graduating seniors employed in appropriate positions or in graduate school within 6 months of graduation

Data and Process

Data are collected from the following sources:

Surveys of graduating seniors, faculty, and alumni, see Appendix 1 – (C)

Engineering Intern Examination

Very few graduates of the ME program enter careers where PE certification is required; the faculty therefore believes it inappropriate to *require* students to take the EI exam. However, seniors are offered the opportunity to take an EI/PE review course free of charge on the IIT campus, and IIT provides an exam registration service The State of Illinois sends exam statistics to the dean. These are made available to the departments. No information is provided on when the candidate graduated the program. Further, the size of the ME program (average of 30 graduates/year) is such that too few graduates take the EI exam to be statistically meaningful if considered separately. However, the ME program shares all the mathematics, basic science, engineering science and general education components, with the AE and MSE programs, and most ME students take MSE or AE professional courses as technical electives. Consequently we believe it valid to aggregate ME results with AE and MSE results to obtain better data. The EI examination is offered biannually.

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Departmental External Advisory Board

This board meets annually. A standing agenda item is discussion of students ethical responsibility, communication, knowledge of societal context, team skills, recognition of lifelong learning, and knowledge of contemporary issues.

Departmental Student Advisory Board

This is a formal and highly effective vehicle for rapid consultation and feedback.

Graduate Employment data

The IIT Career Development Center (CDC) tracks graduate employment statistics. Report issued biannually.

Interprofessional Project (IPRO) and Communications Assessment

All students are required to take a minimum of 6 credit hours of Interprofessional Projects (See **Appendix II**), and 42 credit hours of courses classified as “communications intensive”. These are part of the General Education Requirements of the university and supervised by the IIT Undergraduate Studies Committee. The learning objectives of these programs include: development of an ability to work in interdisciplinary teams, developing an awareness of professional and ethical responsibility, developing an awareness of environmental and global issues, developing an awareness of the need for lifelong learning, and developing written and oral communication skills.

Protocols have been developed for assessing the objectives of the IPRO program and the Communications Across the Curriculum program. These assessments are coordinated by the Director of Interprofessional Projects and the Director of the Writing Program, respectively.

Written reports are conveyed to departments. The assessment for 2002-2003 and the preliminary assessment for 2003-2004 is attached.

The Department Faculty

The faculty has the primary responsibility for assessing program outcomes, and is considered to have the greatest insight. Faculty input is obtained at both the course and program level.

At the course level faculty are asked to evaluate their students' preparation in mathematics, science and engineering prerequisites, and to determine the level of achievement of the course objectives. Designing assignments and examinations to embed outcomes assessment is strongly recommended. A survey has been developed for students in the course to provide feedback to the instructor (attached), also a self-assessment that the instructor is asked to complete and return to the department chair (attached). Standard rubrics are available for assessing communications and design components of courses.

At the program level, faculty who teach senior level classes are asked to submit written comments on their perceptions of the achievement of the seniors with respect to the entire set of program objectives (attached).

Informal communication between faculty and students

The ME program graduates, on average, 30 – 40 students each year. Consequently the channels of communication between faculty and students are excellent and strongly encouraged. We find that identification and resolution of course level problems generally far more rapid by these channels of communication than by waiting for statistical analysis of data at the end of the semester or academic year.

Evaluation and Process for Corrective Action

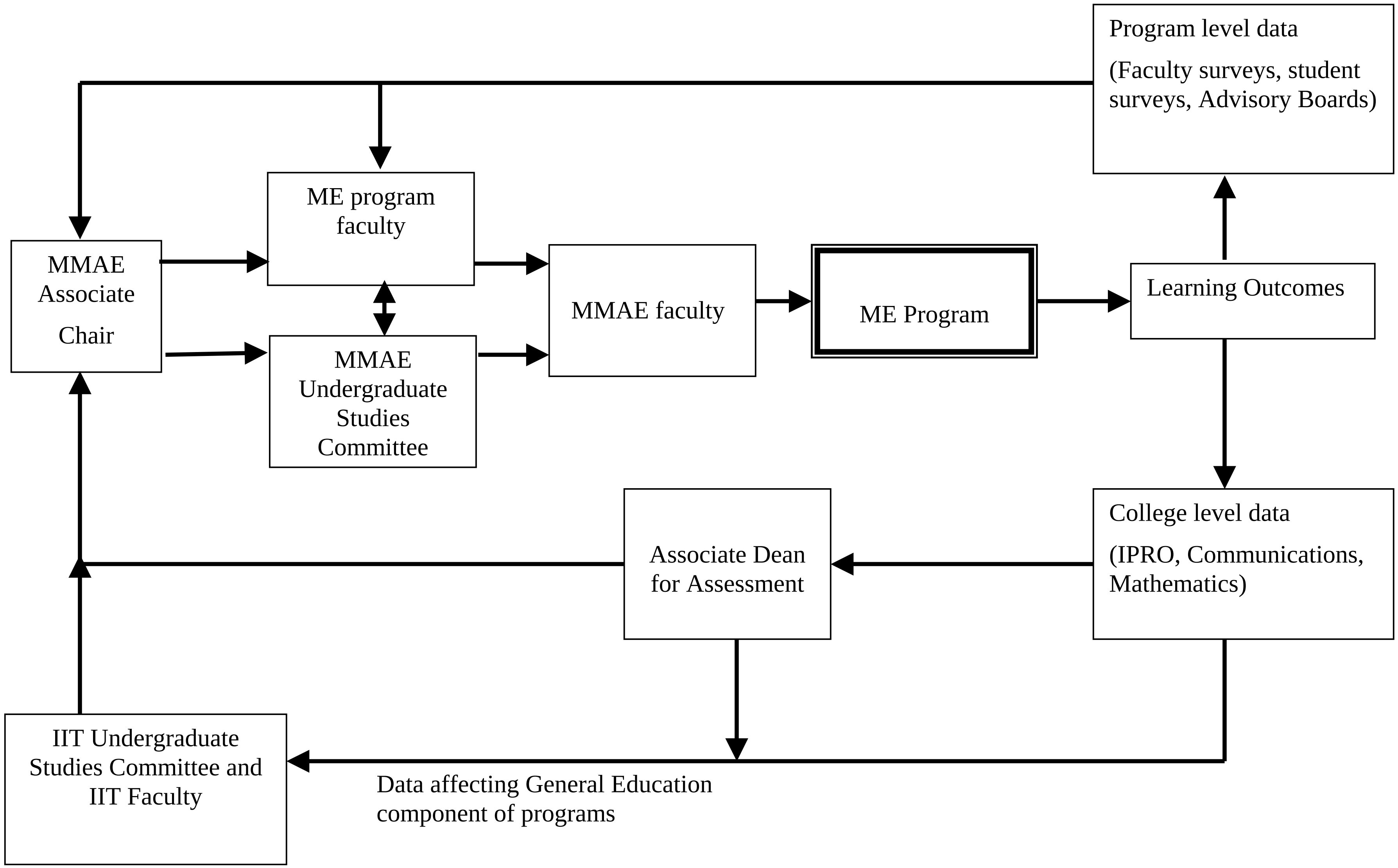
The IIT Faculty, the IIT Undergraduate Studies Committee (a subcommittee of the Faculty Council), the dean of Armour College of Engineering and Sciences, the department chair, the department Undergraduate Studies Committee, and program faculty are responsible for evaluating and analyzing data and implementing program changes.

Changes to the General Education Program must be approved by the Faculty. Detailed analysis and recommendations for proposed changes is delegated to the IIT Undergraduate Studies Committee. The IIT Undergraduate Studies Committee meets monthly throughout the academic year.

Program changes that do not affect the General Education Program must be approved by the MMAE department faculty and by the dean. Analysis of data and recommendations for program change are the responsibility of the MME program faculty, the MMAE department associate chair, and the MMAE department Undergraduate Studies Committee. The MMAE Undergraduate Studies Committee meets bimonthly throughout the academic year.

The schematic on the following page illustrates the assessment process.

Schematic Illustrating the ME Assessment Process



3.3 Survey and Engineering Intern Examination results:

Table 3.2 Average on scale from 1 (poor) to 5 (excellent) on questions pertaining to ABET criteria 3(a) through 3(k)

ABET Criterion	Faculty 2002-03	Faculty 2003-04	Graduating Seniors 2002-03	Graduating Seniors 2003-04
3a	3.8	3.8	3.8	3.9
3b	3.6	3.8	4.1	3.9
3c	3.4	3.4	3.5	3.6
3d	4.1	4.0	3.8	4.1
3e	3.8	3.8	3.7	3.9
3f	4.1	4.0	*	*
3g	3.6	4.0	3.3	3.3
3h	3.3	3.3	*	*
3i	3.7	3.7	*	*
3j	3.5	3.5	*	*
3k	3.7	3.8	3.5	3.6

*** These topics required yes/no response from students.**

Table 3.3 Percent "Yes" answers from graduating senior survey questions:

Question	% "Yes" 2002-03	% "Yes" 2003-04
Understand ethical and professional responsibility 16) Do you belong to a professional society in your field?	25	29
17) Were ethical considerations covered in any of your engineering courses?	67	54
18) Was the coverage of ethics adequate in your opinion?	53	33

Understanding of global and societal context of the engineering discipline 19) Did the IPROs make you consider the role of engineering in society?	**54**	**50**
20) Did the humanities and social sciences courses influence your thinking about the role of engineering in society?	**37**	**33**
Recognition of the need for life-long learning and knowledge of contemporary issues 21) Did the program encourage you to consider graduate school?	**82**	**79**
22) In the last year have you attended at least one lecture in the field of engineering that was not part of the curriculum?	**52**	**58**
23) Have you browsed the internet or in the library for engineering or scientific information that was not related to your classes?	**70**	**71**
24) In your engineering courses did you ever go beyond the requirements of an assignment just because it interested you?	**84**	**88**
25) Have you read a technical article just for fun..	**74**	**71**
26) Do you subscribe to any technical journals	**25**	**29**
27) Do you regularly read a newspaper or news magazine	**88**	**83**
28) Do you think that your engineering program was up-to-date	**80**	**67**

Table 3.4 Percent "Yes" responses to questions concerning prerequisites on course surveys:

Question	2002-3	2003-4
Was the preparation adequate in prerequisite math and science courses	100	100
Was the preparation adequate in pre-requisite engineering courses	95 **	100

Comments on Table 3.4: The course generating a "No" response was MMAE350 – Computational Mechanics. A professor teaching that course for the first time expected the students to have been trained in the use of "Matlab" in a previous course. See section 3.5 for more information.

Table 3.5 – Summary of scores from Engineering Intern Examinations

Subject	2002 MMAE Average	2002 National Average	2002 Difference	2003 MMAE Average	2003 National Average	2003 Difference
Chemistry	51	48	3	87	76	11
Computers	76	64	12	82	65	17
Dynamics	64	53	11	72	75	-3
Electrical Circuits	54	54	0	46	56	-10
Engineering Econ	100	63	37	70	55	15
Ethics	70	68	2	90	80	10
Fluid Mechanics	50	57	-7	75	62	13
Mat Sci/Str Matter	59	63	-4	88	63	25
Mathematics	84	65	19	82	69	13
Mech of Materials	63	53	10	69	61	8
Statics	63	63	0	73	57	16
Thermodynamics	74	64	10	75	59	16

3.4 Analysis

The data presented in Tables 3.2 – 3.5 clearly indicate that the students in the program are achieving the target outcomes in those criteria relating to proficiency in mathematics, basic and engineering sciences (scores >3.5/5.0 on faculty and student surveys, technical scores exceeding the national average on the EI exam by 8 and 11 points respectively in 2002 and 2003). These are outcomes corresponding to **Criteria 3(a), 3(b), 3(e), and 3(k)**.

Results of the faculty surveys and the university wide IPRO and Communications across the Curriculum assessment (Appendix II) indicate that the students are able to communicate effectively, while the students themselves rated their abilities at 3.3/5.0, an above average score but below our target of 3.5. In this particular case, we believe that the lower student score may be a consequence of some residual insecurity particularly in terms of presenting oral reports. The IPRO presentations are evaluated by judges from outside the university, and their assessment is likely more reliable than the students' own perceptions. The faculty consider the students' communication skills to satisfy **Criterion 3(g)**.

Faculty, student and IPRO evaluations all indicate that the students' ability to work in multi-disciplinary teams is satisfactory (**Criterion 3(d)**).

The large fraction of the graduating seniors who enter graduate school (Table 2.7.2), combined with the number who report that they read articles or attend lectures going beyond the requirements of the program, and the faculty survey of instructors teaching senior level courses or supervising undergraduate research projects, all indicate that the graduates have a clear awareness of the need for lifelong learning (**Criterion 3(i)**).

Professional and ethical issues, including consideration of the ISPE code of ethics, are explicitly covered in MMAE100, MMAE271, and CS105. In addition all laboratory courses, IPRO and design projects implicitly involve consideration of professional and ethical issues. The faculty believes (4.1/5.0 and 4.0/5.0 in the last two years) that the graduates of the program have been made aware of and understand these issues. The EI examination results show our graduates scoring above the national average on ethics questions. However, the students' own perceptions (Table 3.3) indicate the contrary. Indeed, it seems that over 40% cannot recall ethics having been covered at all!

Our interpretation of this apparent paradox is that the explicit coverage of ethics took place in the freshman and sophomore years, and course details had been largely forgotten by the time the students graduated. The MMAE271 instructor wrote on his assessment *"I do talk about ethical decisions and examples where an ethical decision would be needed (from biological devices to structures to transportation). But students tend not to focus very strongly on this aspect of the course."* The embedding of professionalism and ethical issues in the later courses is implicit, and we suspect that students simply were unaware of the presence of these components. On balance, the data suggest that graduates of the program are aware of professional and ethical issues**, Criterion 3(f)**, but that some action is needed to increase their perception (see section 3.5).

Design skills (**Criterion 3(c)**) are given similar ratings by faculty and students (3.4 – 3.6/5.0). In the ME program the major design experience consisted until 2003 of a single project in the senior year and participation in a senior year Interprofessional Project (IPRO) which has its own separate assessment (see Appendix II) that includes judging by practicing professionals. In 2003 a second senior project was added to the curriculum. The IPRO assessment rates the quality of work produced by student teams to be high. We conclude that the design skills of the graduates meets expectations, but can be improved (Section 3.5).

Section 4 describes the General Education requirement in Humanities and Social Sciences, which combined with 12 hours of technical electives, 3 hours of free elective, and the availability of minors, ensures that students receive a broad education necessary to understand the impact of engineering solutions in a global and societal context (**Criterion 3(h)**).

Faculty surveys rate students' knowledge of contemporary issues at 3.5/5.0. Over 80% of the students report that they regularly read a newspaper or journal, over 70% report reading engineering or scientific material not related to their classes and reading a technical article "just for fun". Over 25% subscribe to at least one technical journal and participate in professional society activities. Some 40% of the IPRO projects originate with companies, hospitals, not-for-profits, etc., while most of the rest are connected in some way with faculty research programs. We conclude that **Criterion 3(j)** is satisfied, although a greater participation in professional society activities should be encouraged. (Section 3.5)

3.5 Program Improvement

The data in section 3.3 are *lagging indicators* of the state of the program and the issues highlighted had, in most cases, already been identified by feedback from the Student Advisory Board or the faculty. We have found this to be such an effective mechanism that potential problems at the course level were identified and rectified before they become actual problems. Also, the surveys also ask open ended questions whose responses cannot be counted and tabulated but nevertheless provide useful information and recommendations. Thus most of the issues raised in Section 3.4 have already resulted in remedial action.

3.5.1 Program changes since the 2002 visit

1. Based on recommendations from the faculty and Student Advisory Board, the semester 2 course MMAE111 (Introduction to Design) has been replaced with a *free elective*. This course was a follow-on to MMAE100 Introduction to the Profession. The reason for the change was (a) second semester students did not have sufficient engineering background for realistic design problems at a level beyond the projects already undertaken in MMAE100, and (b) the free elective allows students to pursue interests beyond the purely technical, thus contributing to the achievement of Criterion 3(h) and 3(j). This change was made effective Spring 2003.
2. Materials Science (MS201) has been moved to semester 2. This is a basic science, and fits better in this position in the curriculum. It also serves to introduce materials majors to their discipline at the earliest opportunity. This change was made effective Fall 2003
3. MMAE271 (Engineering Materials and Design) has been moved from the second year to 5^{th} semester. It is now taken after MMAE202 (Mechanics of Solids II – Strength of Materials). This is the first design course and presenting it after MMAE202 removes the

need for much duplication of content. It also moves a course with explicit ethics content into the junior year, helping address the issue raised in Section 3.4. This change was made effective Fall 2003.

4. MMAE350 Computational Mechanics has been moved to semester 4. This course follows naturally from MMAE100 and CS105. This placement is considered more appropriate, and encourages use of modern engineering tools (Criterion 3(k))
5. Prior to 2002 the program required either MMAE432 (Mechanical Design Project) or MMAE433 (Thermal Design Project) as the major design experience. In order to strengthen the design skills of the graduates, both of these courses are now *required.*
6. Both alumni and senior surveys requested more coverage of manufacturing. The department has responded by offering two electives on manufacturing topics each year since Fall 2002 (These are: CAD/CAM and Numerical Control, Design for Manufacturing, and Design for Safety in Machines)

5.5.2 Course improvements.

At the end of each semester faculty are asked to complete a form documenting the extent to which course objectives were achieved, and recommending changes (if any) to the way the course is taught. The form also tracks from semester to semester whether these recommendations have been implemented. Among the improvements made since 2002 are:

MS202 Materials Science. Section on crystal systems and space lattices has been shortened to reflect only those found in common materials. More classes devoted to electronic materials. Change made Summer 2003.

MMAE100 Introduction to the Profession. First homework assignment is to locate the ISPE Code of Ethics. Third and fourth classes in the course are ethics case studies. Partially addresses ethics issue identified in Section 3.4. Change made Fall 2002. **MATLAB** software package to be introduced. This accommodates the needs of MMAE350 (Computational Mechanics). Change effective Fall 2004.

MMAE201 and MMAE202 (Mechanics of Solids I and II) – content distribution between these two courses adjusted. Change effective Spring 2003.

MMAE432 and MMAE433 (Design projects). The department Undergraduate Studies Committee recommends that professional ethics be *explicitly* covered in these courses. This recommendation has not yet been voted on by the faculty.

IPRO. Faculty member added with specific responsibility for core content and educational outcomes, Fall 2003. See Appendix III.

5.5.3 Other changes

IIT Student Chapter of ASM International started Spring 2004. .

First Student Poster Competition held 4/9/2004. Chicago Chapter of ASM International sponsored cash prizes.

MMAE department has allocated a budget of $1,500 to promote student chapter activities (ASM International, ASME, AIAA, SAE) for 2004-5 academic year.

Annual $5,000 Ralph L. Barnett Excellence in Teaching Award. Students nominate faculty for the award. This award promotes teaching excellence.

Student Advisory Board solicits input from students and advises the department on the selection of elective courses for the following year.

New Undergraduate Advising Guidelines developed. This 15 page booklet, revised annually, provides guidance on course selection, a tool for assisting students meet pre-requisite requirements, information on how to complete a minor or double major, and more. It is given to all faculty advisors and all students at the beginning of the academic year, and is available on the internet at http://mmae.iit.edu/downloads/undergrad_guidelines.pdf

These actions are designed to promote increased awareness of professional responsibilities and knowledge of contemporary issues in engineering, and generally improve the teaching program of the department.

5.5.4 Example of the Use of Student Advisory Board to Help Resolve Developing Problems

Five weeks into Fall semester 2002 the Student Advisory Board brought to the attention of the Undergraduate Studies Committee a developing problem in MMAE350 (Computational Mechanics) – a required course in the ME program. The instructor, who was experienced but had previously taught only graduate level courses, was teaching the course at too high a level and incorrectly assumed pre-requisite experience with MATLAB. The Chair met with the instructor to discuss the level at which the course was taught. To assist students who had fallen behind an additional teaching assistant was assigned to MMAE350 for the purpose of tutoring the students in MATLAB. In addition, the faculty decided that MATLAB should be introduced in MMAE100 effective the following fall.

4. Professional Component

In recognition of the professional environment in which IIT's graduates will work, and in line with a revision of the mission and goals of the university by the Board of Trustees, the program was modified in 1999 with the objective of placing more emphasis on

- Teaching students to understand the economic, ethical, societal, environmental and international context of their professional activities.
- Improving oral and written communication skills
- Training students to work in multidisciplinary teams
- Preparing students for the interprofessional work force of the 21st century

The curriculum includes an introductory course in the freshman year (MMAE 100). This course includes the following:

- Introduction to engineering and design through case studies;; hands-on sessions; simple design projects; etc.
- Familiarization with IIT facilities such as the Galvin library, Career Development Center, Academic Resource Center
- Horizontal connection with the first year mathematics and science courses
- Emphasis on written and oral communication skills
- Exposure to the interdisciplinary and interprofessional nature of engineering
- Introduction to engineering ethics
- Hands-on experience with computers and software packages

IIT's General Education requirement specifies two three credit-hour ***Interprofessional Project*** (IPRO) courses. The two IPRO courses are taken in the Junior and Senior years. These projects involve teams of (nominally) 10 students drawn from two or more different disciplines who work under faculty guidance on open ended projects created by the faculty or submitted by external organizations (companies, National Laboratories, hospitals, not-for-profit organizations, etc.). Projects must include a technical component and real-world constraints (economic, ethical, environmental) before being approved. The IPRO program is coordinated by a full-time professional staff member, Thomas Jacobius. Details of the services performed by his office may be found in Appendix II. In the ME program there is no constraint on project choice for either IPRO experience, but the majority of students enroll in projects rooted in mechanical or aerospace engineering. In addition to the General Education Requirements and ME program requirements, there are Special Academic Requirements concerning Writing and Communications. These requirements are the following:

"Students must satisfy the Basic Writing Proficiency Requirements as set forth in the General Education Requirements. Students much complete a minimum of 42 credit hours of courses with a significant written and oral communication component, identified with a **(C)** in the catalog, with a minimum distribution as follows:

- 15 hours in major courses
- 15 hours in non-major courses"

To obtain the BS in Mechanical Engineering a student must satisfactorily complete 130 credit hours. The courses can be broken down into the categories: basic math and science, engineering topics, humanities and social or behavioral sciences, Interprofessional Projects, and technical electives. More details of these courses and of the program requirements can be found in Table I-1.

In the following descriptions, 32 credits is equivalent to 1 year of study.

Basic Math and Science (35 credits)

- 4 (18 credits) calculus courses including one course each in "multivariate and vector calculus" and "differential equations" (MATH 151, 152, 251 & 252)
- 1 (4 credits) Chemistry course which includes a laboratory (CHEM 124)
- 3 (11 credits) Physics courses, two of which include a laboratory (PHYS 123, 221 & 224)
- 1 (2 credits) course in Computer Science (CS 105)

These meet the ABET EAC criterion 4a.

Introduction to the Professions (6 credits[1])

1 (3 credits) course: MMAE 100

Humanities and Social Science (21 credits[2])

7 (21 credits) courses in the humanities and social sciences (with a minimum of nine credit hours in each) are required provided the student takes and satisfies the IIT English Proficiency exam. Courses satisfying the 21 credit hours are listed in the Bulletin with either an (**H**) or (**S**) for humanities and social sciences respectively. Two courses at the 300 level or above are required in both humanities and social science. In addition, two but not all of the courses a student takes in social science must be in the same field. Students who do not satisfy the IIT English proficiency exam must take an English composition course at IIT in addition to the 21 credit hours in humanities and social sciences.

This meets the requirement of ABET EAC Criterion 4c and contributes substantially to the outcomes 3(g) 3(h), 3(i), and 3(k)

Engineering topics (56 credits) (contributes to ABET EAC criterion 4b)

1 (2 credits) course in Engineering Graphics (EG 105)
1 (3 credits) course in Material science (MS 201)
1 (3 credits) course in Statics (MMAE 201)
1 (3 credits) course in Strength of Materials (MMAE 202)
1 (3 credits) course in Engineering Materials and Design with a laboratory (MMAE 271)

1 (3 credits) course in Dynamics (MMAE 305)
1 (3 credits) course in Analysis and Design of Machine Elements (MMAE 306)
1 (4 credits) course in Fluid Mechanics with a laboratory (MMAE 310)
1 (3 credits) course in Thermodynamics (MMAE 320)
1 (3 credits) course in Applied Thermodynamics (MMAE 321)

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[1] 4 of the 6 credit hours are classified as Engineering topics and contribute to ABET EAC criterion 4b, 2 credit hours are classified as "other"

[2] contribute to the general education component, ABET EAC criterion 4c

1 (4 credits) course in Heat and Mass Transfer with a laboratory (MMAE 322)
1 (3 credits) course in Computational Mechanics (MMAE 350)
1 (3 credits) laboratory course in Instrumentation (PHYS 300)
1 (4 credits) course in Measurement Systems with a laboratory (MMAE 430[3])
1 (3 credits) course in Mechanical Design Project (MMAE 432)
1 (3 credits) course in Design of Thermal Systems (Project) (MMAE 433)
1 (3 credits) course in Systems and Control (MMAE 443)
1 (3 credits) course in Manufacturing Processes (MMAE 485)

Interprofessional Projects (IPRO's) (6 credits)[4]

2 (6 credits) IPRO courses are required. Students work in small multidisciplinary groups. Students are encouraged to take as one of the two IPRO's a project offered by the Department but this is not required. Often the students take one of their IPRO's outside of the Department where the faculty member in charge is from outside of the Department. Projects submitted for consideration for IPROs typically include most of the following considerations: economic; environmental; sustainability; manufacturability; ethical; health and safety; social; and political. IPRO's also strongly emphasize the need for lifelong learning.

Technical Electives (6 credits)

2 (6 credits) Technical Elective courses. These courses are any 300 level or higher, math, physics, computer science, or engineering course approved by the advisor. In addition, ECON 423 and Electrical and Computer Engineering 218 are permitted. Technical electives meet the objective of a broad educational experience.

Design (7 credits) (satisfies part of ABET EAC criterion 4b)

1 (3 credits) course in Analysis and Design of Machine Elements (MMAE 306)[3]
1 (3 credits) course in Design of Mechanical Systems (MMAE 432)
1 (3credits) course in Design of Thermal Systems (MMAE 433)

By the time the student enters the senior year, he/she will be well prepared to take "Design of Mechanical Systems" and "Design of Thermal Systems" as their senior year capstone design courses. The courses listed under engineering topics above, serve as prerequisites for these capstone design courses. There are several engineering topic courses in solid mechanics, materials and thermal sciences. The members of the faculty teaching the design courses are surveyed to determine if the preparation level of the students is adequate for the capstone design course. The three professors who have taught these design courses within the last two years have been impressed with the preparation level of the students.

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[3] 1 of the 3 credit hours is devoted to design

[4] Contributes to the General Education component. For ROTC students, completion of the 8 semester ROTC program that includes leadership laboratories, command experience and summer camp in a branch of the US military service is considered equivalent in experience to one IPRO course for the purposes of team skills, ethics awareness, professional development and lifelong learning.

The laboratory experience for mechanical engineering students combines both the theoretical and practical aspects of the basic sciences and engineering. In the first semester, students take CHEM 124 “Principles of Chemistry I”. This course covers stoichiometry of chemical reactions, thermochemistry, properties of gases, states of matter, chemical solutions, chemical reactions and kinetics. The course is 4 credit hours, 3 of which are lecture material and one credit hour is devoted to a 3 hour laboratory experience per week.

Several laboratory experiences are incorporated into MMAE 100 during the Freshman year. These experiences are intended to introduce the student to engineering experimental and design methods, engineering report writing and engineering presentation techniques.

The two credit hour Engineering Graphics course includes a two hour lab per week and the Computer science course includes a one hour laboratory session per week.

Two of the Physics courses taken during the Freshman and Sophomore year have one credit hour each devoted to a laboratory experience. PHYS 124 “General Physics I: Mechanics” is a four credit hour course and covers vectors and motion in 1, 2 and 3 dimensions, Newton’s laws, particle dynamics, work and energy principles, conservation laws, kinematics, dynamics, angular momentum and equilibrium principles of rigid bodies, harmonic motion, gravitation and basic fluid mechanics. PHYS 221 “General Physics II: Electromagnetism and Optics” is also a four credit hour course and is taken during the first semester Sophomore year covers charge, electric field, Gauss’ law, potential, capacitance, resistance, simple a/c and d/c circuits, magnetic field, ampere’s law, Faraday’s law, induction, Maxwell’s equations, electromagnetic waves and light, reflection, refraction, lenses, interference and diffraction.

During the second semester Sophomore year students take MMAE 271 ″Engineering Materials and Design″ which is a three credit hour course. One credit hour is devoted to experiments covering, laboratory testing methods including tension, torsion, hardness, impact, toughness, fatigue and creep.

MMAE 310 “Fluid Mechanics” is typically taken first semester Junior year. One credit hour of the four credit hour course is dedicated to the following laboratory components: introduction to measurements of fluid properties, conservation of mass and momentum, flow through pipes and channels, flow-induced forces on bodies, orifice flow and boundary layer flow.

Also, during the first semester Junior year students take Physics 300 “Instrumentation laboratory”. This course covers basic electronic skills for scientific research and includes electrical measurements, basic circuit analysis, diode and transistor circuits, transistor and integrated amplifiers, filters and power circuits and basics of digital circuits.

During the second semester Junior year, a typical Mechanical engineering student will take MMAE 322 “Heat and Mass transfer”. One credit hour is devoted to experiments covering an introduction to thermal science measurements, combustion, thermodynamic cycles, conduction, convection and radiation heat transfer.

During the senior year students take MMAE 430 “Measurement systems”. Two of the four credit hours are assigned to advanced laboratory experiments and a team based project addressing the application of engineering measurements to a variety of engineering problems. The course covers measurement principles and instrumentation, data acquisition, processing and presentation. Topics covered include measurement techniques for temperature, motion, forces, fluid flow, heat flux, strain and displacement. Modern analog and digital signal acquisition and processing techniques are discussed in the lectures and incorporated in the laboratory exercises. Statistical tools used in the analysis of the experimental data are covered including mean, standard deviation and probability density functions. A team based project spanning one half of the semester is also required which emphasizes the design and implementation of experiments addressing a variety of engineering problems.

Minors

Minors are available to mechanical engineering majors who wish to broaden their knowledge. A minimum of five courses is required for a minor and there are several minors approved and listed in the undergraduate bulletin for mechanical engineering majors. Those students wishing to minor in a different area can do so with the approval of the MMAE department undergraduate studies committee and the Department through which the minor is offered. Two of the required minor courses will substitute for the two required technical electives and therefore additional courses beyond the 130 credit hours will be required. In the event a required course for the minor is also required for the major, an approved substitution must be made.

Professional Societies

All faculty are active in professional societies and encourage student participation. We sponsor student chapters of ASME, SAE, AIAA and ASM International and we host an annual student poster competition. Chicago is the heart of one of the largest concentrations of manufacturing industry in the world: our faculty are actively engaged with local metals, materials and manufacturing companies and with Argonne National Laboratory and Fermilab, resulting in excellent opportunities for establishing student summer internships and co-ops.

Appendix I

Program and Department Specific Information

Table I-1. Basic-Level Curriculum
Mechanical Engineering

Semester	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Sciences	Engineering Topics *Check if Contains <u>Significant</u> Design (✓)*	General Education	Other
1	MMAE 100 Introduction to the Profession I		1 ( )		2
	EG 105: Engineering Graphics and Design		2 ( )		
	Chem 124: Principles of Chemistry	4	( )		
	Math 151: Calculus I	5	( )		
	Humanities or social science elective			3	
2	MS 201: Materials Science		3 ( )		
	CS 105: Introduction to Computing	2	( )		
	PHYS 123: Mechanics	4	( )		
	MATH 152: Calculus II	5	( )		
	Humanities or social science elective		( )	3	
3	MMAE 201: Mechanics of Solids I		3 ( )		
	PHYS 221: Electricity and Magnetism	4	( )		
	MATH 251: Multivariate and Vector Calculus	4	( )		
	Humanities and social science elective		( )	3	
	Humanities and social science elective		( )	3	
4	MMAE 202: Mechanics of Solids II		3 ( )		
	PHYS 224: Thermal and Modern Physics	3	( )		
	MATH 252: Introduction to Differential Equations	4	( )		
	MMAE 350: Computational Mechanics		3 ( )		
	Humanities and Social science elective		( )	3	

Table 1. Basic-Level Curriculum (continued)

Mechanical Engineering

Semester	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Science	Engineering Topics *Check if Contains Significant Design (✓)*	General Education	Other
5	PHYS 300: Instrumentation Laboratory		3 ( )		
	MMAE 305: Dynamics		3 ( )		
	MMAE 310: Fluid Mechanics		4 ( )		
	MMAE 320: Thermodynamics		3 ( )		
	Humanities or social science elective		( )	3	
6	MMAE 306: Analysis and Design of Machine Elements		3 ( )		
	MMAE 321: Applied Thermodynamics		3 ( )		
	MMAE 322: Heat and Mass Transfer		4 ( )		
	IPRO I: Interprofessional Project I		( )	3	
	MMAE 271: Engineering Materials and Design		3 ( )		
7	MMAE 430: Engineering Measurements		4 (✓)		
	MMAE 433: Design of Thermal Systems		3 (✓)		
	MMAE 485: Manufacturing Processes		3 ( )		
	Technical Elective				3
	Humanities or social science elective		( )	3	
8	MMAE 432: Design of Mechanical Systems		3 (✓)		
	MMAE 443: System Analysis and Control		3 ( )		
	Technical elective		( )		3
	Free elective		( )		3
	IPRO II: Interprofessional Project II		( )	3	

Table I (continued)

TOTALS-ABET BASIC-LEVEL REQUIREMENTS		35	57	27	11
OVERALL TOTAL FOR DEGREE	130				
PERCENT OF TOTAL		27%	44%	21%	8%
Totals must	Minimum semester credit hours	32 hrs	48 hrs		
satisfy one set	Minimum percentage	27%	37.5 %		

Table I-2 Program demographics in the MMAE Department

Program and Academic Year	1st year students	2nd year students	3rd year students	4th & 5th students	Number Graduated
Aerospace 2002 – 2003	31	26	20	22	12
Aerospace 2003 – 2004	47	23	20	24	16
Mechanical 2002 – 2003	30	14	23	62	37
Mechanical 2003 – 2004	30	27	17	42	33
Materials 2002 – 2003	2	2	4	6	3
Materials 2003 – 2004	2	3	5	7	3

Appendix I – (B) Course Syllabi

Please see following pages

Appendix 1 - (C) Survey Instruments

Survey Instruments are attached on the following pages, as follows:

Survey of alumni, conducted triennially

Student course assessment form, conducted biannually

Faculty course assessment form, conducted biannually

Faculty assessment of program outcomes, conducted annually

Survey of graduating seniors, conducted annually

Illinois Institute of Technology

Survey of Engineering and CS Alumni

As part of IIT's process for continuous improvement of programs, we are requesting your help as a recent graduate with a BS in engineering or computer science. Please take a few minutes to complete this survey. A reply-paid envelope is included for your convenience. If you also received an advanced degree from IIT***, please confine your answers to your BS program at IIT.*** Thank you.

John S. Kallend, Professor of Engineering, Associate Dean.

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1. Your name (optional): ____

2. Your BS degree program: ________________ 3. Year BS awarded __________

4. Current employer or graduate school: ____________________________________

5. Your job title or position: ____

6. Type of work: (Check all that apply)

____ Graduate School ____Design ____Research ____Teaching/Training

____Manufacturing/Production ____Management ____Technical Support

____Programming ____Maintenance ____Safety

____Owner/Operator ____Sales/Marketing ____Other

7. Have you engaged in professional development by:

Attending professional seminars/professional society meetings ? **Yes / No**

Pursuing a graduate degree or professional certification? **Yes / No**

Subscribing to a technical journal **Yes / No**

8. Please rate your BS program's overall effectiveness in preparing you for your job or graduate study (please circle one word)

Excellent Good Fair Poor

9. How do you rate your preparation relative to that of your peers from other institutions (circle one response):

Superior to Somewhat better than About the same as Worse than

10. Please circle the word that best describes your program of study in the following areas:

A. How do you rate your preparation in

- Mathematics: **Good Average Poor**
- Science: **Good Average Poor**

B. Rate your preparation to perform research and/or development tasks in your area:

Good Average Poor

C. Rate your preparation for designing and/or implementing components or systems:

Good Average Poor

D. Rate your preparation to work in a team with individuals from other disciplines:

Good Average Poor

E. Rate your preparation to solve technical problems in your area:

Good Average Poor

F. Rate your preparation for handling ethical issues:

Good Average Poor

G. Rate your preparation to deal with social issues and “people problems” at work

Good Average Poor

H. Rate your ability to communicate effectively by:

- Interaction with other employees and management **Good Average Poor**
- Making oral presentations **Good Average Poor**
- Writing reports and proposals **Good Average Poor**

I. Rate your ability to use computers, computer networks and other communication and information processing tools in your work: **Good Average Poor**

11. Did your IIT education encourage you to consider the impact of your professional decisions on society? **Yes / no / not applicable**

12. Did IIT prepare you to handle issues such as pollution, safety, etc? **Yes / no / not applicable**

13. Based on your post-graduation experience, what, if any, areas of study should receive more emphasis in your IIT BS degree program:

Thank you again for your assistance.

MMAE Course Assessment

Course MMAE/MS_____________ Semester _____________

The MMAE department is committed to continuous improvement of its programs and would like to have more information than is provided by the standard IIT course evaluation form. Please take a few minutes to complete this survey. Thank you.

1. Did you understand what was expected of you in the course? Yes / No
2. Do you think that you achieved the learning objectives for the course? Yes / No
3. If you answered "No" to question 2, which objective or objectives did you not achieve (please list). Your instructor should have supplied you with a list of learning objectives for the course.

4. Were you adequately prepared to take this course by your mathematics and science background? Yes / No
5. Were you adequately prepared to take this course by prerequisite MMAE courses (if any)? Yes / No / Not applicable
6. What did you like best about this course?

7. What, if anything, would you change about this course?

Please continue on the back if necessary.

FACULTY - COURSE SELF-ASSESSMENT

Course: MMAE _______ Semester __________ Number of students______

1. How many students earned each grade? A ____ B ____ C ____ D ____ E ____ W____

2. Indicate how many, and to what extent, students met each of the course objectives you defined for the students (please attach. Note, course files are available in 207A E1)

	NEEDED IMPROVEMENT	MET EXPECTATIONS
Objective 1		
Objective 2		
Objective 3		
Objective 4		
Objective 5		
Objective 6		
Objective 7		
Objective 8		

3. In your opinion, were the students adequately prepared in mathematics? (Yes/No). If "No", what deficiencies did you identify?
____
____

4. In your opinion, were the students adequately prepared in basic science (Yes/No). If "No", what deficiencies did you identify?
____
____

5. In your opinion, were the students adequately prepared by other pre-requisite courses, if any? (Yes/No). If "No", what deficiencies did you identify?
____
____

6. If you were to teach the course again, what changes would you make? (Use additional pages if needed)
____
____

7. Did you incorporate any changes recommended in a previous assessment (Yes/No). If "Yes", did the changes result in improved outcomes (Yes/No).

Please return to Renata Howard, 243 E1

To: Prof. __________________

This survey is being given to MMAE faculty who teach 400 level classes or supervise undergraduate research projects.

Survey of Educational Outcomes for MMAE seniors.

Please rate YOUR opinion of our seniors' abilities in the following areas, using a scale of 1 (poor) to 5 (excellent). If you are unable to judge in any area, leave it blank.

ability to apply knowledge of mathematics, science, and engineering	1 2 3 4 5
ability to design and conduct experiments, as well as to analyze and interpret data	1 2 3 4 5
ability to design a system, component, or process to meet desired needs	1 2 3 4 5
ability to function on multi-disciplinary teams	1 2 3 4 5
ability to identify, formulate, and solve engineering problems	1 2 3 4 5
understanding of professional and ethical responsibility	1 2 3 4 5
ability to communicate effectively	1 2 3 4 5
the broad education necessary to understand the impact of engineering solutions in a global and societal context	1 2 3 4 5
recognition of the need for, and an ability to engage in life-long learning	1 2 3 4 5
knowledge of contemporary issues	1 2 3 4 5
ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	1 2 3 4 5

Based on your experience teaching MMAE seniors, do you see any areas of weakness that need to be addressed in our programs? If "Yes", please elaborate.

Please return to John Kallend by ______________

MMAE Graduating Senior Exit Survey

Date:___________________ Major___________________

On a scale of 1 (poor) to 5 (excellent) please rate the following

Math/Science/Engineering Skills

1) How well were you prepared in math and science at IIT? 1 2 3 4 5

2) How well did your preparation in math/science prepare you to tackle engineering problems? 1 2 3 4 5

Design, conduct, and analyze experiments

3) Rate your ability to design experiments 1 2 3 4 5

4) Rate your ability to conduct experiments in the lab. 1 2 3 4 5

5) Rate your ability to analyze experimental data 1 2 3 4 5

Design a system or process

6) Rate your ability to engage in engineering design 1 2 3 4 5

7) To what extent did the IPRO experience prepare you for engineering design 1 2 3 4 5

Multidisciplinary teams

8) Rate your ability to work in multidisciplinary teams 1 2 3 4 5

9) Rate the IPRO experience in preparing you for working in teams 1 2 3 4 5

Ability to solve engineering problems

Rate your ability to formulate and solve engineering problems 1 2 3 4 5

Ability to communicate

11) Rate the extent to which the program helped develop your written communication skills 1 2 3 4 5

12) Rate the extent to which the program helped develop your Oral communication skills 1 2 3 4 5

Ability to use modern skills and techniques

13) Rate your ability to use computers as tools in solving engineering problems. 1 2 3 4 5

14) Rate the effectiveness of your coursework in preparing you to use computer and communications technology 1 2 3 4 5

15) Rate your preparation to use laboratory equipment and techniques relevant to your field? 1 2 3 4 5

Please answer Yes/No to the following questions:

Understand ethical and professional responsibility

16) Do you belong to a professional society in your field? Yes No

17) Were ethical considerations covered in any of your engineering courses? Yes No

18) Was the coverage of ethics adequate in your opinion? Yes No

Understanding of global and societal context of the engineering discipline

19) Did the IPROs make you consider the role of engineering in society? Yes No

20) Did the humanities and social sciences courses influence your thinking about the role of engineering in society? Yes No

Recognition of the need for life-long learning

21) Did the program encourage you to consider graduate school? Yes No

22) In the last year have you attended at least one lecture in the field of engineering that was not part of the curriculum? Yes No

23) Have you browsed the internet or in the library for engineering or scientific information that was not related to your classes? Yes No

24) In your engineering courses did you ever go beyond the requirements of an assignment just because it interested you? Yes No

25) Have you read a technical article just for fun.. Yes No

Knowledge of contemporary issues

26) Do you subscribe to any technical journals	Yes	No
27) Do you regularly read a newspaper or news magazine	Yes	No
28) Do you think that your engineering program was up-to-date	Yes	No

These are open ended questions. Feel free to write as much (or little) as you wish:

Was the academic advising in MMAE satisfactory

Which areas of the curriculum need more emphasis?

Which areas received too much emphasis?

How valuable were the IPROs?

How could the program be improved?

OPTIONAL: Your name________________________

Name of your employer or Graduate School (if any)____________________________

If not currently employed or in graduate school, are you seeking employment in your field

____

Please return to: Professor John Kallend, MMAE Department, IIT