

**Interim Report**  
**For the Aerospace Engineering Program**

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## Preface

This interim report is to document progress made in correcting weaknesses identified in the Aerospace 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 Aerospace Engineering Program (AE) 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.

June 20, 2004

# **Interim Report**

## **For the Aerospace Engineering Program**

### **A. Background Information**

#### **1. Degree Titles**

Bachelor of Science in Aerospace 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**

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### **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)<sup>TM</sup> and Web for Faculty<sup>TM</sup> : 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 (1<sup>st</sup> and 2<sup>nd</sup> 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 in 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 of the program are concise and are closely aligned with the mission of the college and of the institution. However, a process-oriented approach to evaluating achievement of the objectives is lacking and there is limited involvement of constituencies.”*

### 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 AE program specific objectives are to develop graduates with an understanding of aircraft and spacecraft design and analysis using the principles of aerodynamics, structures and materials, thermodynamics and propulsion, and flight mechanics. **[program criteria, Aerospace 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 (attached).

It should be emphasized that the low student/faculty ratio in the AE 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:

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

ABET Criterion	Course						
	EG 105	CS105	100/111	MS 201	201	202	271
3a	1	0	2	2	2	2	3
3b(i)	0	0	1	0	0	0	3
3b(ii)	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	304	305	310	311	312	320	322
3a	3	3	3	3	3	3	3	3
3b(i)	3	0	0	3	1	1	0	3
3b(ii)	3	0	0	3	1	2	0	3
3c	3	2	2	1	0	3	0	1
3d	0	0	0	0	0	0	0	0
3e	0	2	2	2	3	3	3	2
3f	0	0	1	1	0	1	1	0
3g	0	1	1	2	0	1	1	3
3h	0	0	1	0	0	0	0	0
3i	0	0	1	1	0	2	0	0
3j	0	1	1	1	0	2	0	1
3k	3	2	2	0	0	3	3	2

Table 2.1 (continued)

ABET	Course						
Criterion	350	430	436,437	441	452	I PRO I	I PRO II
3a	3	3	3	3	3	2	2
3b(i)	1	3	0	0	1	2	2
3b(ii)	1	3	0	0	2	2	3
3c	0	3	3	1	3	3	3
3d	0	1	2	0	0	3	3
3e	3	3	3	2	3	3	3
3f	0	2	2	0	1	3	3
3g	2	3	2	0	1	3	3
3h	0	2	1	0	0	3	3
3i	1	2	1	0	1	3	3
3j	1	2	1	0	2	2	2
3k	2	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*, the wording of the objective relating to *lifelong learning*, and the coverage of *ground and sea transportation and wind related issues*. The survey results also indicated that coverage of *spacecraft and space missions* should be broadened.

## 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.
3. The original program specific objective (see below) referred to ground and undersea transportation systems, wind power, and wind effects on structures. It was found that these areas were not satisfactorily addressed in the existing program although they had previously been covered. The faculty determined that these areas were beyond the scope of the program.

The faculty considered all 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,

~~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.*

And

The Aerospace Engineering program specific objectives are to develop graduates with an understanding of aircraft and spacecraft design ~~and applications of those technologies to related areas such as ground and undersea transportation systems, wind power and wind effects on structures, and the use of advanced materials. This includes a knowledge of aerodynamics, structures and materials, propulsion systems, and flight mechanics and controls~~ *and analysis using the principles of aerodynamics, structures and materials, thermodynamics and propulsion, and flight mechanics.*

The program objectives as revised May 2003 have been listed in section 2.1

The issue of *spacecraft and space missions* is addressed in Section 3.

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 May 2004 graduating class not available. Data may not add up to 100% on account of rounding. Source, IIT Center for Career Development.

### 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 has carefully correlated its program educational objectives with the program outcomes. Although some anecdotal assessment has been described in the self study, evidence presented by the program shows only preliminary plans for the development of a systematic process for assessment of program outcomes. There was no indication that assessment results have been used to improve the quality of the aerospace engineering 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
  - aerodynamics
  - 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 1 competence in engineering topics 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).**

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

## 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 AE 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 AE 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 AE program shares all the mathematics, basic science, engineering science and general education components, with the AE and MSE programs, and most AE students take some MSE or AE professional courses as technical electives. Consequently we believe it valid to aggregate AE results with AE and MSE results to obtain better data. The EI examination is offered biannually.

### **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 AE program graduates, on average, 10 – 15 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**

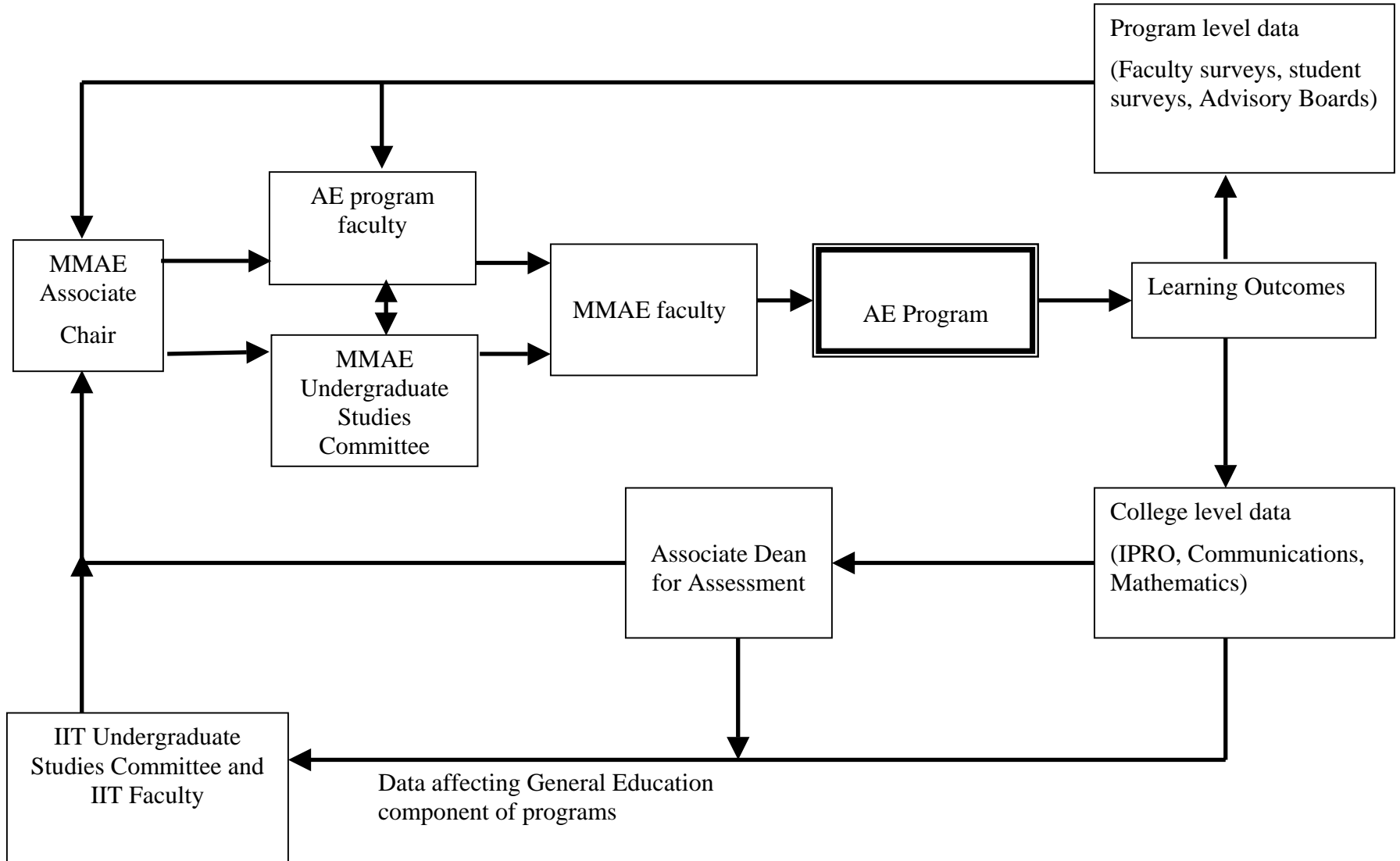
The IIT Faculty, the IIT Undergraduate Studies Committee (a subcommittee of the Faculty Council), the dean of Armour College of Engineering and Sciences, the department chair, the department Undergraduate Studies Committee, and program faculty are responsible for evaluating and analyzing data and implementing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

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

**\* These questions required yes/no response from students.**

**Table 3.3 Percent “Yes” answers from graduating senior survey questions:**

<b>Question</b>	<b>% “Yes” 2002-03</b>	<b>% “Yes” 2003-04</b>
<i>Understand ethical and professional responsibility</i>		
16) Do you belong to a professional society in your field?	<b>25</b>	<b>29</b>
17) Were ethical considerations covered in any of your engineering courses?	<b>67</b>	<b>54</b>
18) Was the coverage of ethics adequate in your opinion?	<b>53</b>	<b>33</b>
<i>Understanding of global and societal context of the engineering discipline</i>		
19 ) Did the IPROs make you consider the role of engineering in society?	<b>54</b>	<b>50</b>
20) Did the humanities and social sciences courses influence your thinking about the role of engineering in society?	<b>37</b>	<b>33</b>
<i>Recognition of the need for life-long learning and knowledge of contemporary issues</i>		
21) Did the program encourage you to consider graduate school?	<b>82</b>	<b>79</b>
22) In the last year have you attended at least one lecture in the field of engineering that was not part of the curriculum?	<b>52</b>	<b>58</b>
23 ) Have you browsed the internet or in the library for engineering or scientific information that was not related to your classes?	<b>70</b>	<b>71</b>
24) In your engineering courses did you ever go beyond the requirements of an assignment just because it interested you?	<b>84</b>	<b>88</b>
25 ) Have you read a technical article just for fun..	<b>74</b>	<b>71</b>
26) Do you subscribe to any technical journals	<b>25</b>	<b>29</b>
27) Do you regularly read a newspaper or news magazine	<b>88</b>	<b>83</b>
28) Do you think that your engineering program was up-to-date	<b>80</b>	<b>67</b>

**Table 3.4** Percent “Yes” responses to questions concerning prerequisites on course surveys:

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

**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

**Table 3.5 – Summary of scores from Engineering Intern Examinations**

<b>Subject</b>	<b>2002 MMAE Average</b>	<b>2002 National Average</b>	<b>2002 Difference</b>	<b>2003 MMAE Average</b>	<b>2003 National Average</b>	<b>2003 Difference</b>
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 AE 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 Fall 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 eliminated. 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 credit hours released allowed an additional senior design experience (see (5) below). 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. This change was made effective Fall 2003
3. MMAE271 (Engineering Materials and Design) has been moved from the second year to 5<sup>th</sup> 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 and this placement is considered more appropriate. The change promotes student use of modern engineering tools (Criterion 3(k)).
5. At the time of the 2002 ABET visit the program required MMAE 436 (Design of Aerospace Vehicles) as the major design experience. In order to strengthen the design skills of the graduates, an additional *required* design course MMAE 437 (Design of Aerospace Vehicles II) has been added to the program effective Spring 2003. This new course emphasizes spacecraft and space mission design, and addresses the issue identified in section 2.5
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)

#### **3.5.2 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.

MMAE 436 and MMAE 437 (Design of Aerospace Vehicles). 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. However, the instructors have agreed to make this change voluntarily pending the faculty decision.

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

### **3.5.3 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.

Student surveys indicated variable quality of the advising process. In response new Undergraduate Advising Guidelines were developed. This 15 page booklet, now 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](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.

### 3.5.4 Example of the Process to Resolve a Developing Problem

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 AE 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 to run a MATLAB workshop. Total time for resolution of the problem was less than one week.

In addition, the department undergraduate studies committee subsequently 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 21<sup>st</sup> 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 AE 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 AE 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 must 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 Aerospace 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<sup>1</sup>)

1 (3 credits) course: MMAE 100

#### Humanities and Social Science (21 credits<sup>2</sup>)

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

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<sup>1</sup> 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”

<sup>2</sup> contribute to the general education component, ABET EAC criterion 4c

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 (49 credits)

- 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 Mechanics of Aerostructures (MMAE 304)
- 1 (3 credits) course in Dynamics (MMAE 305)
- 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 Compressible Flow (MMAE 311)
- 1 (3 credits) course in Aerodynamics of Aerospace Vehicles (MMAE 312)
- 1 (4 credits) course in Heat and Mass Transfer which includes a laboratory (MMAE 322)
- 1 (3 credits) course in Computational Mechanics (MMAE 350)
- 1 (3 credits) laboratory course in Instrumentation (PHYS 300)
- 1 (3 credits) course in Aerospace Dynamics (MMAE 441)
- 1 (3 credits) course in Aerospace Propulsion (MMAE 452)

#### Interprofessional Projects (IPRO's) (6 credits)<sup>3</sup>

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)

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<sup>3</sup> 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.

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 (10 credits) (satisfies part of ABET EAC criterion 4b)

- 1 (4 credits) course in Measurement systems which includes the Design and Realization of an Experiment project (MMAE 430)
- 2 (6 credits) courses in Design of Aerospace Vehicles (MMAE 436, MMAE 437)

Opportunities for undergraduate research activity

serve as a source of motivation and stimulation as well as a means for developing creativity at all levels of student development from freshman to senior standing. In recognition of the value of this opportunity, provisions exist in the program to allow students to formally participate in ongoing departmental research programs. This provision is formalized by including MMAE 491, "Undergraduate Research" as a Technical Elective

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 Aerospace 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 a student chapter 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  
Aerospace Engineering**

Semester	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Sciences	Engineering Topics <i>Check if Contains Significant Design (✓)</i>	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 I-1. Basic-Level Curriculum (continued)**

## Aerospace Engineering

Semester	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Science	Engineering Topics  <i>Check if Contains Significant Design (✓)</i>	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 304: Mechanics of Aerostructures		3 ( )		
	MMAE 311: Compressible Flow		3 ( )		
	MMAE 312: Aerodynamics of Aerospace Vehicles		3 ( )		
	I PRO I: Interprofessional Project I		( )	3	
	MMAE 271: Engineering Materials and Design		3 (✓)		
7	MMAE 322: Heat and Mass Transfer		4 ( )		
	MMAE441: Aerospace Dynamics		3 ( )		
	MMAE452: Aerospace Propulsion		3 ( )		
	Technical Elective				3
	Humanities or social science elective		( )	3	
8	MMAE 436: Design of Aerospace Vehicles I		3 (✓)		
	MMAE 437: Design of Aerospace Vehicles II		3 (✓)		
	MMAE 430: Engineering Measurements		4 (✓)		
	Technical elective		( )		3
	I PRO II: Interprofessional Project II		( )	3	

**Table I-1 (continued)**

TOTALS-ABET BASIC-LEVEL REQUIREMENTS		35	60	27	8
OVERALL TOTAL FOR DEGREE	130				
PERCENT OF TOTAL		27%	46%	21%	5%
Totals must satisfy one set	Minimum semester credit hours	32 hrs	48 hrs		
	Minimum percentage	25%	37.5 %		

**Table I-2 Program demographics in the MMAE Department**

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



# 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.

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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?

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

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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).

To: Prof. \_\_\_\_\_

**Survey of Educational Outcomes for MMAE seniors.**

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

**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**