Program Self Study Report
Materials Engineering
Materials Science and Engineering Department
Iowa State University
4/04/06

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Program Self-Study Report
for Materials Engineering

A. Background Information

1. Degree Titles

The Materials Science and Engineering department offers a degree in Materials Engineering. Although this degree does not have official options, a student is required to select two specializations by taking four courses in each specialization. The areas of specialization are:

Ceramic Materials
Electronic Materials
Metallic Materials
Polymeric Materials

Specialization courses are distributed in the third and fourth year, one each semester per specialization. Additional specialization courses, including courses primarily for graduates are offered as technical electives for students who desire additional depth (by taking courses in the designated area of specialization) or breadth (in the other areas of specialization).

The Materials Engineering degree was established in 1999 after careful study of the changing needs of our constituents, including students, industrial partners, alumni, and the faculty. After incorporating all the inputs and deliberating in various forums, the faculty determined that it was best to combine the two individual degree programs in Ceramic Engineering and Metallurgical Engineering into a single program (Materials Engineering). This program provides an integrated background in materials and requires the student to select two areas of specialization from four: ceramic, electronic, metallic and polymeric materials. The program is unique in the sense that it provides the breadth of materials engineering while allowing students to achieve depth in two (or more) of the four specializations within the materials field. Thus, we believe the curriculum provides the necessary breadth yet sufficient depth in two specialization area of student's choice. It is clear from increasing enrollments over the past seven years that the new program has indeed attracted highly qualified students and has resulted in better employment opportunities for our graduates.

2. Program Modes

Materials Engineering is a day program. For the most part, all courses and laboratories are offered during working hours. Occasionally, some courses are offered over the Iowa Cable Network in late afternoon, but this occurrence is the exception rather than the rule.

The MSE department at Iowa State University encourages its students to engage in experiential education (co-ops, internships, summer professional experiences, and research experiences.) The fraction of students participating in co-op programs and internship programs in the last five years is about 75%. The students who participate in co-op or internship programs meet the same graduation requirements as those who do not. Those who earn a co-op degree must work three non-consecutive terms for the same company in accordance with the cooperative education guidelines.

3. Actions to Correct Previous Deficiencies

No deficiencies were found in the previous accreditation visit. One concern was cited and three observations were made.

Concern:
The concern cited was in regard to Criterion 3, parts f and j (professional and ethical responsibility and contemporary issues). The suggestion was that students felt they were adequately prepared, but had difficulty identifying the specific experiences that provided that background. Criterion 3f and 3j are each listed as an outcome for all design experiences and appear in a number of the specialization course sequences, which assures that all students have multiple opportunities to develop in this area. However, since students were unable to identify *where* they gained experience, it is clear that a stronger emphasis should be placed on identifying the goals and desired outcomes of these courses. The curriculum committee and design team have implemented additional activities in ethics and contemporary issues into the professional practice course sequence. Additionally, the general education requirement was restructured to provide more experience in contemporary issues.

Observations:
The three observations dealt with the refinement of the assessment tools and methods for measuring outcomes, the monitoring of the vertically integrated design course (now called professional practice), and the improving national visibility of the department.

The original assessment survey was reworked after consultation with the statistical survey research group at ISU. Currently, a second adjustment in course-level assessments is being developed to align the assessment tool and data collected with Engineering Career Services (ECS). ECS, in conjunction with DDI (Development Dimensions International – a large performance assessment company), has developed a tool for measuring competencies gained in co-op and internship experiences. In the past 5 years, this tool has been well validated in the engineering workplace and has also been used in the engineering classroom (for freshmen) and for alumni surveys. As the 15 ISU competencies have been mapped to Criterion 3 a-k, this tool provides a direct measure of performance. Course-level evaluations are being modified to use this tool.

The Vertically Integrated Design (renamed Professional Practice) sequence has been monitored, modified, discussed, restructured and revaluated a number of times in the last 5 years. While student satisfaction with the courses has improved significantly, questions remain about the effectiveness and efficiency of the course. Additionally, some students report highly positive experiences (some culminating in job offers with the company for which the project was done), while others report very negative experiences (largely due to a company that is not as responsive or involved as necessary for progress on the project.) Currently, an ad-hoc study group has been appointed to study the issue and redefine course content and method of delivery.

Finally, improving visibility of the program is of great importance to us. We have implemented a multi-pronged approach to improving our department's national reputation that involves increased visibility of faculty in leadership positions in national organizations and visits of faculty to other universities, as well as bringing prominent members of our field to ISU. Since the last ABET visit, we have made several improvements to the departmental newsletter, ELEMENTS, which is distributed nationally to alumni, chairs of MSE departments, and other materials programs. The newsletter "Centennial" issue commemorating the establishment of the department 100 years ago represents the pinnacle of newsletters among our contemporaries and has received numerous compliments from our peers around the nation. Last year, we invited a number of MSE department chairs to campus to showcase our department and program. Based on feedback from these visitors, it appears that these visits made a positive impression on the chairs. Also in this period, we have made concerted effort to broadly announce the internationally prominent faculty who have recently joined the department (examples of which are available in the supplementary documents binder). As part of the centennial celebrations, we have conducted two special symposia honoring world-renowned faculty members and established a "Distinguished Lecture Series." Finally, we will be inaugurating an "Alumni Hall of Fame" which will showcase our many prominent alumni. We will continue to seek other opportunities to improve external visibility.

In summary, we are proud of the evolution of our program and welcome the opportunity to discuss its effectiveness and possible strategies for improvement.

4. Contact Information

The primary contact person is Prof. Larry Genalo, Asst. Chair for Undergraduate Programs, 2220A Hoover Hall, Ames, IA 50010, (515) 294-4722, genalo@iastate.edu. A secondary contact is Prof. Kristen Constant, ABET self-study coordinator, 2220J Hoover Hall, Ames, IA 50010

5. General Approach to the Self-Study

We have elected a future-oriented approach to writing this self-study to allow us to maximize the benefits of our reporting and analysis efforts. While in many cases we relate the evolutionary changes that have occurred over the past six years, the data are presented in the context of our current assessment methods. We focus on the interpretation of results for the purpose of informing change.

B. Accreditation Summary

1. Students

Students are evaluated, monitored and advised to provide the instruction and guidance required to successfully complete the Materials Engineering program. The system for evaluating, monitoring, and advising students coordinates with and complements the college and university systems. In this section, the MSE department system for evaluating, monitoring, and advising students will be presented, followed by a reference to information on applicable college and university supporting systems.

Materials Science and Engineering Department Infrastructure

The MSE department uses faculty as advisors for undergraduate students. At present the department has three advisors, one of whom is designated as the Lead Advisor. The Lead Advisor represents the department at the College and University levels. In addition to these three faculty advisors, there is currently another faculty member who is heavily involved in advising undergraduates. This faculty member coordinates the experiential education and placement programs and reviews and approves students' honors program plans. These activities also involve representation on College-level committees. Additionally, the department supports one undergraduate secretary who handles some administrative tasks for undergraduate students.

Evaluating Students in the MSE department

Students are evaluated in every course through a variety of methods reflecting the variety of faculty and courses taught. These vary given the subject matter, the preference of the professor, and the competency being assessed. Methods include homework, quizzes, written, oral, and electronic (web pages) reports, self and peer evaluation, and journals or portfolios. In some cases, external sources are also used including performance evaluations of work experiences and externally supported and evaluated design projects. Detailed discussion of these processes appears in B3: Program Outcomes and Assessment.

Advising Students in the MSE department

In the Materials Science and Engineering department, each student is assigned a faculty advisor as his/her academic advisor. This advisor is responsible for advising students on academic matters and educational alternatives. The academic advisor is an important resource person and therefore has to be knowledgeable about university, college, and departmental policies, course offerings, programs, and procedures.

For students who enter ISU as declared Materials Engineering majors, advising begins during summer orientation where they meet a departmental summer orientation advisor to plan their first semester classes. At this time the student is personally advised of the options and opportunities within the department (co-op, honors, international study, hourly work opportunities, available scholarships, and the concurrent BS/MS program). Also in this meeting, the student is supplied with a copy of the MSE undergraduate student handbook, and the curriculum four-year plan is reviewed (see the 4-year plan in the departmental documents notebook). Additionally, the program outcomes and objectives are briefly discussed, and a copy is given to the student.

Each fall all new freshman students are enrolled in an engineering orientation class (ENGR 101 for MSE students). As part of this class, the Lead Advisor meets with the students and reviews many of the university, college, and departmental rules and policies that are important for each student to understand. This class also reviews OPAL (the college-based competency assessment tool). Other non-advising topics are also addressed in 101.

Each semester students have individual meetings with their advisors prior to their pre-registration date. During this meeting, advisors review course planning for the following semester and evaluate the students' progress toward graduation with the help of the degree audit. Also, throughout the semester, advisors help students with such things as:

- making schedule changes (adds, drops, section transfers),
- assessing transfer credits,
- monitoring academic progress issues,
- exploring and planning for study abroad opportunities,
- exploring and planning for work experience opportunities,
- managing academic and personal concerns,
- referring students to other university support services when appropriate, and
- explaining and managing policies and procedures to ensure the student meets all graduation requirements at the department, college, and university levels.

Advisors in our department are especially attentive to a student's interest and potential for graduate school and advise students as early as possible to begin preparing themselves. Since 40% of our students do enroll in graduate programs, it is important for advisors to identify and counsel these students appropriately.

Quality control is achieved through feedback collected periodically through surveys and yearly in senior exit interviews. Advisors meet regularly to discuss common concerns and emerging trends related to advising. There is also advisor representation on the department curriculum committee to ensure good communication between the groups.

Student Monitoring in the MSE department

The academic advisor is responsible for monitoring a student's academic progress. This is mainly accomplished through the use of the university degree audit system (as mentioned above). A degree audit is generated each semester, and the advisor reviews this with the student. Through this review, the advisor and the students make sure the courses the student has taken are counting as they should toward the degree, and they also can see which requirements are left to fulfill. The advisor may need to request adjustments to be made to the degree audit (such as moving a course that has been listed in the wrong area).

In addition, a number of other university and college system are in place to monitor student progress. Each semester midterm grades are generated for any student earning below a C in any course. This list is sent to the advisor and allows the advisor to contact the student and assess what action, if any, should be taken (drop the course, get tutoring, etc.). Students can access their midterm standings through two electronic means. For most courses, faculty use WebCT – a web-base course support and organization tool – to post grades. Also, official midterm grades can be accessed though the students' personal electronic record (Access Plus), which also allows them to view their unofficial transcripts including their grade points, drops remaining, etc.

Another university monitoring system involves the Academic Probation policies for the university and the college (the engineering college has a more stringent policies than the university). If a student is placed on Academic Probation, she/he is referred to the advisor for academic counseling. The advisor will help the student evaluate the issues that have contributed to this situation. They will then form a plan, which will almost certainly involve referrals to the appropriate support services.

Policies for transfer students and transfer credits

Transfer students are accepted both from within the college and university and from outside the university. Students interested in transferring from outside the university must meet university and college admission requirements. The college holds a number of special orientation days for transfer students each spring. As part of their campus visit, these prospective transfer students will meet individually with an academic advisor in the MSE department. The advisor will review each student's transfer credits (which will have to be evaluated at the university level) and help the student determine an appropriate program of study.

Transfer cases also include students seeking to transfer into the MSE department from another department at ISU (often from another engineering department). The advisors in the department (or the assistant department chair) visit with many of these prospective students to help them determine if Materials Engineering is right for them and to help them plan their course of study.

Transfer student evaluations for Materials Engineering courses are done by the assistant department chair. The assistant chair will do the evaluation for the introductory materials course, but will refer most other courses to faculty who have recently taught the course in question. Course materials, textbooks, and student interviews are used to evaluate the level and content of the course. Evaluation of courses outside the department is done by transfer credit coordinators in the appropriate department. Transfer credit evaluation is discussed in more detail in B3 Program Outcomes and Assessment.

College of Engineering

The College of Engineering supports departmental efforts in student evaluation, monitoring and advising through a number of procedures, policies, and programs appearing in detail in Appendix II, including:

Admission to the College of Engineering
Admission of Students by Transfer from Other Institutions
Transfer Credit Practices
Students Transferring from Regionally Accredited Colleges and Universities
Students From Colleges and Universities which have Candidate Status
Students from Colleges and Universities Not Regionally Accredited
Students from Foreign Colleges and Universities
Students with Credit Obtained During Military Service
Students with Credit Obtained Through Non-Collegiate Sponsored Instruction

Students with Credit Obtained Through Correspondence Courses
College Level Examination Program (CLEP)
Students with Test-Out Credit
Articulation/Transfer Agreements
1. Iowa Regents' Universities Articulation Agreement.
2. Associate in Arts Articulation Agreement with Iowa Community Colleges.
3. Vocational-technical credits from Iowa community colleges.
4. CLEP credits from Iowa community colleges.
Advanced Placement Program
College-Level Examination Program
International Baccalaureate Program
Basic Program Requirements
Quality of incoming students
K-12 interactions to insure quality students
Admission to Freshman Honors Program
Requirements for Graduation
Curriculum development/tracking for compliance
Indication of Grade Point Average Required for Graduation
New Student Orientation
Four Year Plan

Iowa State University
Iowa State University supports departmental and college efforts in student evaluation, monitoring, and advising through a number of procedures, policies, and programs which appear in detail in Appendix II.

Student Evaluation, Monitoring and Advising at the University Level
Degree Audit
General University Criteria for Admission
General High School Requirements and Deficiency Policy
Temporary Enrollment Status and Academic Dismissal
Reinstatement, Reentry
Learning Communities
Academic Success Center
Disability Resources
Tutoring – Individual Consultation
Academic Learning Lab
Supplemental Instruction
Student Counseling Service
Career Exploration Program
Individual Counseling, Computer Guidance Systems, Career Exploration Library
Student Health Center

2. Program Educational Objectives

The program educational objectives for the Materials Engineering program have been developed through ongoing conversations with various constituencies. These are periodically reviewed and adapted to the changing environment in which our students are expected to practice as engineers and scientists. The objectives are published in our undergraduate student handbook, on the web and in other promotional documentation for the department. The objectives are also discussed with students during summer orientation and during the Engr. 101 Freshmen Engineering Orientation.

In this section, excerpts from the departmental mission statement are given and linked to the program objectives. These objectives are closely tied with those of the university and the college. For that reason, excerpts from the strategic plans and mission statements of the University and the College are frequently referred to (the entire documents: the Strategic Plans and Mission Statements will be available at the time of the visit).

EDUCATION MISSION OF THE DEPARTMENT:

The Materials Science and Engineering Department embraces the commitment of the ISU College of Engineering to education focused on learning-based, practice-oriented, active involvement of students. With its small student body, extensive laboratory experiences, and ample opportunities to participate in research projects and co-op/internship programs, the Department is ideally situated to realize this vision.

The materials engineering curriculum builds on strong basic science fundamentals. The program offers four areas of specialization: ceramic, electronic, metallic and polymeric materials. Each student has the option to choose any two (or more) areas of specialization providing the flexibility for each student to design his/her area of expertise. Additionally, the department is defining and will soon implement a "proposal-based specialization" that allows a student even more flexibility to define a program consistent with individual career goals.

<u>Published Educational Objectives</u>

Within the scope of the MSE mission, the objectives of the Materials Engineering Program are to produce graduates who

- practice materials engineering in a broad range of industries including materials production, semiconductors, medical/environmental, consumer products, and transportation products.
- respond to environmental, social, political, ethical, and economic constraints to improve the quality of life in Iowa and the world
- work independently and in teams and are proficient in written, oral, and graphical communication
- engage in lifelong learning in response to the rapidly expanding knowledge base and changing environment of our world
- engage in advanced study in materials and related or complementary fields

The wording of the second and third objectives have been changed since 2000 from "are capable of responding" to a more definitive statement to better convey that we expect students to not only have the capacity to respond but also to demonstrate the initiative to do so.

<u>Relationship of Departmental Objectives to College and University Missions</u>
These objectives are consistent with and complementary to those of the engineering college and the university. Here, each departmental objective is given with the appropriate university and college excerpts.

A. practice materials engineering in a broad range of industries including materials production, semiconductors, medical/environmental, consumer products, and transportation products.

Excerpted from the College Priorities statements:
The College of Engineering will provide an excellent education coupled with experiential learning that recognizes the global leveling of the engineering profession and the rapid pace of innovation. This will be accomplished by providing choice, breadth, and accelerated pace in undergraduate and graduate curricula.

Excerpted from the University Mission statement:
- Share knowledge through outstanding undergraduate, graduate, professional, and outreach programs.

Excerpted from the University Priorities statement:
- Leverage strengths in science and technology to enhance research and scholarly excellence with emphasis on interdisciplinary initiatives involving biological, **materials**, and information sciences.

B. respond to environmental, social, political, ethical and economic constraints to improve the quality of life in Iowa and the world

Excerpted from the College Objectives statement:
- Empowering our students and faculty will create an environment that will enhance the intellectual, ethnic, and gender diversity of student body and faculty.
- To prepare our graduates to become leaders in a profession dominated by globalization, our students will have increasing opportunities for international experiences
- Our faculty, staff, students, and graduates will serve honestly and ethically, constantly seeking ways to use their knowledge and experience to improve the human condition.

Excerpted from the University Priorities statement:
- Enhance students' understanding of global, cultural, ethical, and diversity issues.

C. work independently and in teams and are proficient in written, oral and graphical communication

Excerpted from the University Priorities statement:
- Strengthen students' critical thinking, creative abilities, and communication skills

D. engage in lifelong learning in response to the rapidly expanding knowledge base and changing environment of our world

Excerpted from the College Priorities statement:

- The College of Engineering will provide an excellent education coupled with experiential learning that recognizes the global leveling of the engineering profession and the rapid pace of innovation. This will be accomplished by providing choice, breadth, and accelerated pace in undergraduate and graduate curricula.

- We will empower our students to customize their educations to achieve their career goals. We will recognize that future opportunities will involve expertise in systems in all engineering disciplines. We will enable an engineering education to be an ideal entry point to all careers.

E. engage in advanced study in materials and related or complementary fields

Excerpted from the College Priorities statement:

- The College of Engineering will provide an excellent education coupled with experiential learning that recognizes the global leveling of the engineering profession and the rapid pace of innovation. This will be accomplished by providing choice, breadth, and accelerated pace in undergraduate and graduate curricula.

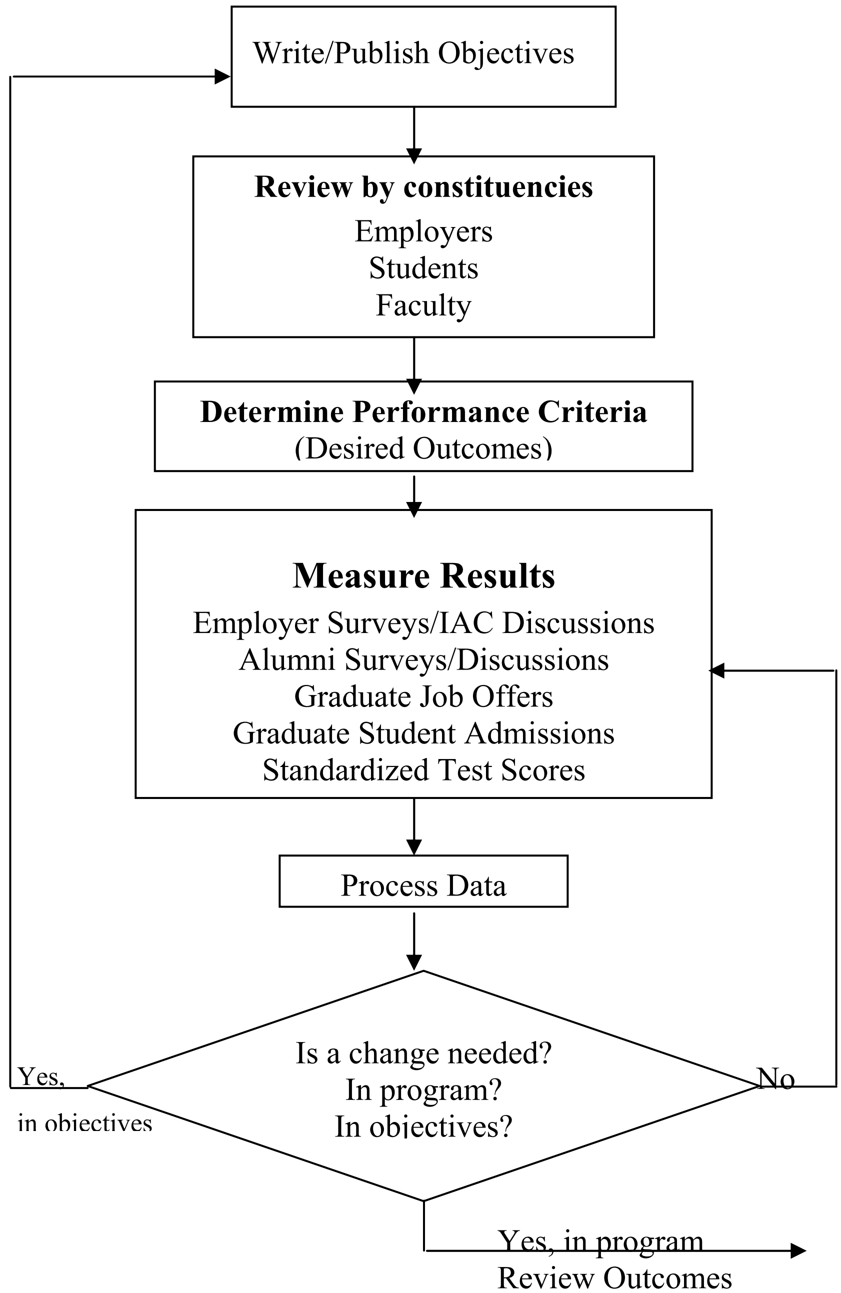
- We will empower our students to customize their educations to achieve their career goals. Engineering education seeks to develop a capacity for objective analysis, synthesis, and design to obtain a practical solution. Advanced work in engineering is offered in the post-graduate programs.

Excerpted from the University Priorities statement:

- Improve the rigor, challenge, and international reputation of academic programs.
- Create an environment that welcomes students to explore a variety of disciplines and career paths.

Process for Determining and Evaluating Objectives

Figure B2.1 shows how the program objectives are determined and evaluated for continuous program improvement. The objectives were written and published with input from all primary constituencies including faculty, students, industrial partners, and alumni. The performance criteria are set with respect to what is being measured. Data are collected from various sources including alumni surveys, statistics on graduate job offers, and graduate school placement as well as performance on standard exams (e.g. F.E., G.R.E., etc.). The collected data are processed and analyzed at the end of the academic year by the curriculum committee, at the spring industrial advisory council meeting, and at the annual faculty retreat, and changes are proposed, discussed, and considered for implementation. In the case where objectives are not being met, there are at least three considerations: the adequacy and appropriateness of the program to meet its objectives, the appropriateness of the program objectives statement, and the measurement instrument itself. Each is considered, and appropriate action taken as indicated in the flowchart. If it is determined that the program is at fault, the program outcomes are carefully examined for deficiencies, and corrective action is taken.



<u>Constituencies:</u>

The primary constituencies of this program are students, employers, and faculty. Other important constituencies include alumni, community colleges from which we admit transfer students, the parents of students, the Board of Regents, and universities to which we send graduates for further study. The effect on all of these constituencies is considered with each programmatic change and improvement. Students, faculty, employers, and alumni are directly involved in decision making by participation in faculty retreats and industrial advisory council meetings. Community college communication and coordination occurs through the Engineering College articulation efforts. Parents are informed of departmental activities through the mailing of a newsletter each year. The general public is informed of our expertise and program through a variety of outreach activities and news releases. The Board of Regents, State of Iowa, reviews our program every 5-7 years.

The MSE Industrial Advisory Council (MSEIAC) plays a key role in guiding the department. The MSEIAC was established in the fall of 1996, at which time it was charged with the following:

A. Advise the department of industry's expectations for engineering graduates in the 21st century.
B. Assist the department in curriculum planning decisions to achieve item #1.
C. Communicate MSE department needs and priorities to the College of Engineering Administration.
D. Assist the department in strengthening and expanding long-term industrial partnerships such as: internships, co-op programs for undergraduate students, employment opportunities for graduating engineers, industrial experience for MSE faculty, academic experience for the practicing engineer in industry, and research projects of mutual interest
E. Guide the department in fund raising activities.

The council membership exhibits a great deal of diversity in seniority (junior engineers to company presidents), demographics (Iowa to California), industry (traditional refractories to electronic packaging), background (discipline, educational level, schools), as well as diversity in gender. The unifying thread in the council membership is that all IAC members are genuinely interested in our programs and in the future of the department. The council membership is on a staggered rotating basis with three-year appointments with a maximum of two consecutive terms.

During ECIAC meetings, it is common to have breakout groups by specialization. These ECIAC members have provided valuable guidance to the MSE department.

Initial Determination of Objectives

The program objectives were first developed in 1999 through a concerted effort of all the constituents including, students, alumni, faculty, employers, the Board of Regents, and colleagues at other universities. The new program objectives reflected the evolution of the program from separate metallurgy and ceramics degrees to a single materials degree with specializations. The next review of objectives is scheduled for the 2006 spring Industrial Advisory Council Meeting.

Curriculum and Process to Ensure Achievement of Objectives:

The Materials Engineering Program has a number of elements that contribute to the achievement of our program objectives including the curriculum, supporting programs, and supporting activities as shown in the table below. All of these elements contribute to one or more of the program objectives. These elements are related to the program outcomes and the outcomes related to the objectives in the following section, B3 "Program Outcomes and Assessment".

Materials Engineering Program Elements		
Curriculum (C)	**Supporting Programs (P)**	**Supporting Activities (A)**
CB Basic Program and core engineering courses **CC** Materials Core **CS** Materials Specialization **CT** Technical Electives **CD** Design **CG** General Education	**PE-**Experiential Education (Co-op/Intern/Summer) **PI** International Program **PH** Honors **PR** Research **PA** Advising	**AS** Student Chapters of Professional Societies **AH** Honorary Societies **AO** Student Organizations

The Materials Engineering program has been designed specifically to achieve the program educational objectives. A primary goal in the structuring of the curricular component of the program was to maintain our historical strengths while providing the breadth and flexibility required of today's Materials Engineers. In this section, each program objective and the relevant curricular components are discussed.

A. Students are prepared for engineering practice through a number fundamental courses in math and science as well as foundational courses in engineering topics. Students can elect to prepare themselves for specific industries (e.g. the semiconductor industry) by choosing specializations in appropriate areas. Further preparation for engineering practice is achieved through experiential education. Preparation for functioning within an organization and leadership skills are available through participation in student organizations, honorary societies, and student chapters of professional societies.

B. Students are prepared to respond to environmental, social, political, ethical, and economic constraints through selected social science and humanities courses, but in a more holistic way through our professional practice and capstone design experiences. Experiential education and international experiences are also useful in meeting this objective.

C. Students in Materials Engineering gain the competence and confidence to work both independently and in teams through a variety of classroom (and for some students out-of-classroom) experiences. Both teamwork and individual accountability is stressed throughout the curriculum. Oral, written, electronic, and graphical communication proficiency is achieved through a variety of experiences spread throughout the curriculum. These include classes from the English department, as well as materials classes that include written, oral, and web or poster presentations.

D. Students are prepared for lifelong learning through professional practice and design courses that require a high level of independence in problem definition and resource identification. A number of core courses also include an independent research paper of some kind. Most students are also active in student chapters of professional organizations and many attend annual conferences and workshops. Students also gain appreciation for lifelong learning in experiential education as well as through employment in research, where class work usually provides only the foundation for the knowledge needed for the job, the remainder being incumbent on the student to acquire.

E. Student in Materials Engineering are prepared to engage in advanced study through rigorous fundamentals courses as well as the opportunity to take upper level courses in other programs and graduate level technical electives. A "learn and earn" program is offered to freshmen students involving early exposure to research laboratories. Students with interest in graduate education are also strongly encouraged to work in a research lab either within the University or through a national laboratory. A number of students have also taken advantage of the Research Opportunities for Undergraduates Program both here at ISU and at other institutions. Finally, advisors encourage students to better prepare themselves for graduate study by taking additional math courses and more challenging technical electives. As currently over 40% of our graduates go to graduate school immediately upon completing their bachelor's degree, we pay special attention to preparing students to meet this objective.

Achievement of Objectives:
The program ensures that these objectives are achieved through a number of mechanisms. These are measured through a variety of mechanisms including job offers for graduates, placement in graduate schools, performance on standardized examinations (e.g. FE exams and GRE exams), and OPAL™ alumni surveys. Results of these evaluations are detailed in section B3.

Employer input has been collected through the industrial advisory council. In-process employer input is collected on all co-op and internship students. The instrument used for that purpose has been redesigned to better reflect the core competencies indicated in the program outcomes section. A copy of all the survey instruments will be available at the time of the visit.

Feedback and Continuous Improvement:
The assistant chair writes a summary report for all senior exit interviews and surveys at the end of each academic year. At this time he also indicates areas of concern to be reviewed by the curriculum committee. He also reviews the previous year's report and the changes suggested at that time to determine whether and how well they have been implemented. The results of those changes are reviewed with respect to the present years' results. (An example of such a report will be available at the time of the visit.)

Alumni and employer input are reviewed at the industrial advisory council meetings on a yearly basis. The results are reviewed by the curriculum committee to determine what improvements can be made.

3. Program Outcomes and Assessment

In this section, program outcomes and assessment processes and results are discussed including:

- Program Outcomes and their Relationship to Criterion 3
- Relating Program Outcomes to Program Objectives
- Process to Assure Graduates Achieve Outcomes
- Qualitative and Quantitative Data & Documentation of Changes
- Continuous Improvement Process
- Process and Procedures for Acceptance of Transfers and Validating courses from Outside ISU
- List of Materials Available at the Time of Review

Program Outcomes and their Relationship to Criterion 3.

Program outcomes for materials engineers are divided into three categories. Outcomes a-k are applicable to any type of engineer. Outcomes l-o apply to any materials engineer and outcomes p-r are those which are specific to materials engineers graduating with a Materials Engineering Degree from Iowa State University. Many of these outcomes are multidimensional, and it is sometimes possible to achieve part, without achieving all of a particular outcome. In the assigning of particular experience as appropriate to assessing achievement of an outcome, we have taken the broad interpretation of "contributing towards" achieving the outcome rather than "proves achievement of" an outcome.

Program Outcomes

Graduates in Materials Science and engineering will have demonstrated the following at the time of graduation:

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function on multi-disciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
l. an ability to apply advanced science (such as chemistry and physics) and engineering principles to materials systems

m. an integrated understanding of the scientific and engineering principles underlying the four major elements of the field (structure, properties, processing, & performance)
n. an ability to apply and integrate knowledge from each of the above four elements of the field to solve materials selection and design problems
o. an ability to utilize experimental, statistical, and computational methods consistent with the goals of the program.
p. mastery of creative, independent problem solving skills, under time and resource constraints, in a broad range of materials-related applications critical to the success of the final product.
q. experience in materials engineering practice through co-ops or internships in industry, national laboratories, or other funded research work.
r. hands-on skills with a broad range of modern materials processing and characterization equipment and methods, with special in-depth concentration in two student-selected areas from among ceramic, electronic, metallic, and polymeric materials

Relating Program Outcomes to Program Objectives

It is critical to demonstrate that achieving program outcomes prepares students to meet program objectives. Table B3.1 shows this relationship and should be read, for example "In order to practice materials engineering in a broad range of …a student must demonstrate an ability to apply math, science, and engineering….". A case could be argued for situations where many of the program outcomes contribute to *each* program objective, however, only those outcomes most critical to the achievement of a particular objective are listed. Program Objectives are repeated below for reference.

Program Objectives

Within the scope of the MSE mission, the objectives of the Materials Engineering Program are to produce graduates who:

A. practice materials engineering in a broad range of industries including materials production, semiconductors, medical/environmental, consumer products, and transportation products.
B. respond to environmental, social, political, ethical, and economic constraints to improve the quality of life in Iowa and the world.
C. work independently and in teams and are proficient in written, oral, and graphical communication.
D. engage in lifelong learning in response to the rapidly expanding knowledge base and changing environment of our world.
E. engage in advanced study in materials and related or complementary fields.

TABLE B3.1 Relationship between Program Objectives and Program Outcomes

Objective		**Program Outcome**
In order to…		***a student must demonstrate:***
A, E	a.	an ability to apply knowledge of mathematics, science, and engineering

A, E	b.	an ability to design and conduct experiments, as well as to analyze and interpret data
A,C, E	c.	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
A, C	d.	an ability to function on multi-disciplinary teams
A, E	e	an ability to identify, formulate, and solve engineering problems
A, B, D	f.	an understanding of professional and ethical responsibility
A, C, E	g.	an ability to communicate effectively
A, B, D	h.	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and social context
A, B, D, E	i.	a recognition of the need for and an ability to engage in life-long learning
A, B, D	j.	a knowledge of contemporary issues
A, C, E	k.	an ability to use modern engineering tools necessary for engineering practice
A, E	l.	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
A, E	m.	an integrated understanding (structure, properties, processing, & performance)
A, E	n.	an ability to apply and integrate knowledge from each of the above four elements of the field to solve materials selection and design problems
A, E	o.	an ability to utilize experimental, statistical, and computational methods consistent with the goals of the program
A, B, E	p.	mastery of creative, independent problem solving skills, under time and resource constraints in a broad range of materials-related applications critical to the success of the final product
A, B, C	q.	experience in materials engineering practice through co-ops or internships in industry, national laboratories, or other funded research work
A, C, E	r.	hands-on skills with a broad range of modern materials processing and characterization equipment and methods, with special in-depth concentration in two student-selected areas from among ceramic, electronic, metallic, and polymeric materials

It is important to recognize that students achieve these outcomes through participation in a variety of program elements (repeated here for convenience). These elements include the curriculum, supporting programs, and activities. Each will be discussed separately, and then formative and summative measures will be discussed. Program elements and their contribution to achieving program outcomes are shown in Tables B3.2 and B3.3

TABLE B3.2 Materials Engineering Program Elements

Materials Engineering Program Elements		
Curriculum (C)	**Supporting Programs (P)**	**Supporting Activities (A)**
CB Basic Program and core engineering courses **CC** Materials Core **CS** Materials Specialization **CT** Technical Electives **CD** Design **CG** General Education (SSH, Humanities)	**PE** Experiential Education (Co-op/Intern/ Summer) **PI** International Program **PH** Honors **PR** Research **PA** Advising	**AS** Student Chapters of Professional Societies **AH** Honoraries **AO** Student Organizations

TABLE B3.3 Program Elements Contributions to Outcomes

	Program Outcomes	**Contributed to by: (Primary)**
a.	math, science, and engineering	CB, CC, CS, CT, PE, PI, PH, PR,
b.	design and conduct experiments	CB, CC, CS, CT, CD, PE, PI, PH, PR
c.	design a system, component, or process	CB, CC, CS, CT, CD, PE, PI, PH, PR,
d.	multi-disciplinary teams	CC, CS, CD, PE, PI, AS, AO
e	solve engineering problems	CB, CC, CS, PE, PR,
f.	professional and ethical responsibility	CC, CS, CD, PE, PA, AS, AO
g.	communicate effectively	CB, CC, CS, CT, CD, CG, PE, PI, PR, AO
h.	the broad education ….	CG, PE, PI, PH, AS, AO
i.	life-long learning	CC, CS, CT, CD, PE, AS
j.	contemporary issues	CS, CD, CG, PE, AS
k.	modern engineering tools	CC, CS, CT, CD, PE, PR
l.	apply advanced science to materials systems	CC, CS, CD, PE, PR
m.	integrated understanding (structure, properties, processing, & performance)	CC, CS, CD, PE, PR
n.	materials selection and design problems	CC, CS, CD, PE, PR
o.	experimental, statistical, and computational methods	CC, CS, CD, CT, PE, PR
p.	creative, independent problem solving skills, under time and resource constraints	CS, CD, CT, PE, PR
q.	to have gained experience	PE, PR
r.	to demonstrate hands-on	CS, CD, CT, PE, PR

<u>Process to Assure Graduates have Achieved Outcomes</u>

The process used to assure graduates have achieved program outcomes was designed after carefully examining Table B3.3. Clearly, almost all outcomes rely heavily on curricular content (as designated by a 'C'). Therefore a significant fraction of assessment efforts are an evaluation of the efficacy of the curriculum.

Assessment Methods

Various assessment methods are used to ensure that program outcomes are met prior to graduation including:

Curricular

- Performance in individual courses
- Course evaluations
- Student Transcripts (grades)
- Professional practice (Design) experiences (final reports and presentations, evaluations from industry sponsors)

Supporting Programs & Activities

- Co-op/Internship Evaluations
- International Experience evaluations
- Honors programs of study
- Participation in Professional Societies and Student organizations
- Participation in Academic/National Laboratory Research

Summative Measures

- Student Feedback Session
- Senior Surveys and Exit Interviews
- Placement Data (for industry and graduate school)
- Alumni Surveys

Not all methods are used (or are appropriate) for every desired outcome, but in most cases at least three are used to document achievement of each outcome. Selected assessment methods are discussed below.

Curricular Contribution to the Achievement of Program Outcomes

Table B3.4 shows how the desired outcomes are mapped against the courses required for a materials engineering degree to delineate which courses contribute to each of the outcomes. Five faculty committees did this mapping: one for the core curriculum and each of the four specialization areas. For each course within the department, the syllabus outlines the course objectives and outcomes as well as how they relate to the departmental objectives and outcomes. Course evaluations at the end of the semester are administered using the standard University form, but the department has a course evaluation addendum which addresses specifically the extent to which the student believes each of these outcomes has been met (both forms will be available at the time of the visit).

TABLE B3.4 Curricular Contribution to the Achievement of Program Outcomes

				ABET Program Outcomes																
	<--------General Engineering------->												**Materials**					**MSE/ISU**		
Course (credits)	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**		**l**	**m**	**n**	**o**		**p**	**q**	**r**
Basic Program (26.5)																				
ENGR 160 (3)	√			√	√		√													
ENG 104 (3)							√													
ENG 105 (3)							√													
PHYSICS 221 (5)	√	√			√															
CHEM 177 (4)	√				√															

MATH 165 (4)	√				√															
MATH 166 (4)	√				√															
LIB 160 (0.5)							√		√											
ENGR 101 (R)						√	√													
Supporting (22)																				
ENGR 170 (3)				√		√	√													
PHYSICS 222 (5)	√	√			√															
CHEM 177L (1)	√	√			√															
CHEM 178 (3)	√				√															
CHEM 178L (1)	√	√			√															
EM 274 (3)	√				√						√		√							
EM 324 (3)	√				√		√		√				√							
MATH 266 (3)	√				√															
Gen Ed Electives (15)						√	√	√	√	√										
Tech Electives (6)																				
Free Elective (3)						√	√	√	√	√										

Mat E Core (26)	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**I**	**j**	**k**		**l**	**m**	**n**	**o**		**p**	**q**	**r**
211 Intro to Material Science(5)	√	√		√	√		√				√		√	√	√	√				√
212 Thermodynamics	√				√						√		√	√						
214 Characterization	√	√					√				√		√	√		√				√
315 Kinetics	√				√		√				√		√	√		√				
316 Computations	√	√		√	√		√				√					√				
318 Mech Prop	√	√	√	√	√		√	√			√		√	√	√	√				√
313 Prof. Practice (2)	√	√	√	√	√	√	√	√	√	√	√		√	√	√	√		√		√
413 Prof. Practice (2)	√	√	√	√	√	√	√	√	√	√	√		√	√	√	√		√		√
414 Prof. Practice (2)	√	√	√	√	√	√	√	√	√	√	√		√	√	√	√		√		√
MSE Specializations (choose two - 12 each; except 14 in electronic - take 2 fewer tech elec)																				
Ceramic Materials																				
321 Int. Cer. Sci.	√				√		√		√		√		√	√				√		
322 Cer. Proc.	√	√	√		√	√					√		√	√	√	√				√
423 Glass	√	√	√		√	√	√		√	√	√		√	√	√	√				√
424 Adv Cer	√		√			√		√	√	√	√		√	√	√					
Electronic Materials																				
331Int ElecMaterials	√	√		√	√		√				√		√	√		√				√
332Semicon Mat.	√		√		√				√	√			√	√	√					
433Adv Elec Mat.	√		√		√			√	√	√			√	√	√					
432 Microelec Fab	√	√		√			√	√		√	√		√	√		√				√
Metallic Materials																				
341 Proc & Fab	√	√	√	√	√						√		√	√						√
342 Struc Prop	√	√	√		√		√				√		√	√	√	√				√

443 Ferr Met	√	√	√		√		√		√	√			√	√	√			√		
444 Corr. & Failure	√	√		√	√		√				√		√	√	√	√				√
Polymeric Materials																				
351 Int Poly Mat.	√							√		√	√		√	√	√	√				
442 Poly Engr	√	√		√	√						√		√	√	√	√				√
453 Phys Mech	√				√								√	√	√					
454 Pol Comp Proc	√	√		√	√		√			√	√		√	√	√	√				√
Co-op and/or Intern Experience																			√	

English Proficiency Requirement:
The Department of Materials Science and Engineering requires a grade of C or better in Engl 104 and 105 and certification from the departmental curriculum committee.

Certification by the curriculum committee is achieved through earning a "pass" on the communication grade in 4 of 8 selected communications-intensive materials engineering courses (Mat E 211, 214, 321, 331, 341, 351, 316, 414). The communication grade component of these courses is kept separately from the overall grade. (i.e. it is possible to PASS the course and FAIL the communications component).

If a student is not certified by the end of the junior year, he/she has the option of

- taking an advanced English course from the following list: 314, 302, 306 and earning a C or better, or
- getting certified by earning a passing grade in the communications portion of 414 if he/she already has 3 communication credits in previous courses. (Note graduation will be delayed if this credit is not earned.)

In practice using these eight Mat E courses has not proven to be a good assessment technique for communications abilities. Individual instructors teaching the listed courses are reluctant to "fail" a student based solely on communication skills and, therefore, it has not provided the checkpoint we had hoped for. In the next catalog we plan to have students be required to take another communications course from a specified list of courses (Engl 302, 309, 314 or JLMC 347) for three of the 15 "general education" credits they must take. We will then eliminate the "4 of 8" course rule listed above.

Supporting Programs and Activities Contribution to the Achievement of Program Outcomes

Co-op/Internship Evaluations: The accurate evaluation of students in the professional workplace can be an extremely valuable tool to assess the effectiveness of our program. Engineering Career Services oversees the process using OPAL ™ (**O**n-Line **P**erformance and **A**ssessment of **L**earning). Evaluations are administered to both the supervisor and the student. These evaluations reflect the competencies in which we are interested, and those competencies have been correlated to the ABET outcomes a – k. Since about 75 % of our Mat E students do a co-op or internship during their programs, these direct measures of performance are good indicators that our students are developing the abilities required by the expected outcomes. The data from this experience are rich and are analyzed in a following section of this report.

Participation in Professional Societies and Student organizations: Most students participate in the field-specific professional societies, many in other student organizations and some in a leadership capacity. Although participation doesn't validate achievement of a particular outcome, it does suggest that the student has the opportunity to develop many "soft skills" which are more difficult to address in the classroom. More than half of the Mat E students are members of the professional society student chapter and many take part and assume leadership roles in college and university organizations.

Participation in Research: A significant fraction of students (~40%) work in a research lab (either academic or national lab) during their undergraduate career. This experience affords opportunities to apply analytical skills, gain an appreciation for lifelong learning, and hone their laboratory skills and facility with modern engineering equipment. In most cases these students are required to communicate their results and achievements in written/and or oral form.

Other opportunities that contribute to the meeting of these outcomes are described in Appendix II including university opportunities (intramural athletics, extracurricular activities, campus organizations, etc.), college opportunities (learning communities, college student organizations, etc.) and national conventions, student conferences, and honor societies

Qualitative and Quantitative Data & Documentation of Changes

OPAL™ (Online Performance and Assessment of Learning), a professional assessment tool from DDI (Development Dimensions International), allows for a direct measurement of student achievement. An extensive notebook of descriptive materials and data will be available at the visit. So far we have applied this tool to assess student achievement during co-ops and internships and have also used it to collect baseline data for our freshmen. Recently, we began testing it with alumni "on the job." This tool measures "competencies" that we have aligned with the a-k outcomes. This alignment has been validated by Engineering Career Services through focus groups with over 200 employers, faculty, parents, and students. ECS has administered this instrument to over 1600 engineering students and 1400 supervisors through spring semester, 2005. In that time 200,000 data points have been collected.

Students and supervisors rate the student's competencies at the end of the internship period. The supervisor's direct measure is usually higher than the student's self-perception. The two measures, taken together, offer interesting glimpses into the abilities of our students. Through faculty, employer, student, and parent input the list of competencies was selected, aligned with the a-k outcomes, and validated. The outcomes a-k are multidimensional in nature and, therefore, difficult to measure directly. The competencies in OPAL™ are more easily measured directly. The validated alignment with the outcomes allows us to measure outcome achievement. The weighting factors determined for aligning a single outcome with the several competencies that comprise it are shown in TABLE B3.5. Since outcomes c and h have recently changed, we are in the process of validating the alignment to those outcomes anew.

One drawback of OPAL™ is the anonymity of the data. All co-op and internship students in a particular semester are grouped together. Therefore, sophomores are grouped with juniors and seniors. Since the desired program outcomes are to be achieved by the time of graduation, some data points in this measure are two or more years away from the final achievement date. Since the data are only for students who go on co-ops or internships, is it a true measure of outcomes achievement for Mat E students? Since about 75% of all Mat E students (about the same as the overall college percentage) have a co-op or internship experience during their undergraduate degree program, a large portion of the student population is represented. The data are quite encouraging. TABLE B3.5 shows the alignment of the OPAL™ competencies to the a-k outcomes (we are working within our department to align the "extra" departmentally-specified outcomes l-r to the competencies). It also shows the weighting factors used to determine numerical scores on outcomes since one competency may contribute more toward an outcome than another.

The actual results for Mat E students in the period 2001-05 are shown in FIGURES B3.1 and B3.2 and TABLE B3.6. FIGURE B3.1 shows the achievement of competencies. A rating of 3 corresponds to the student "sometimes" demonstrates the competency. Each competency has between 3 and 6 "key actions" that are specific and measurable. A rating spans the range between behavior is witnessed "never or almost never" (a rating of 1) up to "always or almost always." (a rating of 5). It is interesting to note that in every instance the supervisors rate the student higher than the student rates him/herself. This seems to add validity to survey measures of student perceptions of their achievement of program outcomes.

TABLE B3.5 Outcomes (a-k) vs. Competencies Matrix with Weighting Factors

ABET OUTCOMES VERSUS ISU COMPETENCY MATRIX

	Engineering Criteria 2000 Criterion 3 Program Outcomes and Assessment	ISU Competency													
		Engineering Knowledge	General Knowledge	Continuous Learning	Quality Orientation	Initiative	Innovation	Cultural Adaptability	Analysis and Judgment	Planning	Communication	Teamwork	Integrity	Professional Impact	Customer Focus
(a)	an ability to apply knowledge of mathematics, science, and engineering	4.8 ✗		3.8 ✗		3.5 ✗			4.3 ✗						
(b)	an ability to design and conduct experiments, as well as to analyze and interpret data	4.4 ✗		3.6 ✗	4.3 ✗	3.7 ✗	4.0 ✗		4.5 ✗	4.1 ✗		3.4 ✗			3.4 ✗
(c)	an ability to design a system, component, or process to meet desired needs	4.4 ✗		3.8 ✗	4.1 ✗	3.9 ✗	4.3 ✗	3.0 ✗	4.5 ✗	4.2 ✗	4.0 ✗	3.8 ✗			4.2 ✗
(d)	an ability to function on multidisciplinary teams					4.0 ✗		4.3 ✗	3.6 ✗	3.8 ✗	4.7 ✗	4.9 ✗	4.3 ✗	3.9 ✗	3.7 ✗
(e)	an ability to identify, formulate, and solve engineering problems	4.7 ✗		3.8 ✗	3.9 ✗	4.1 ✗	4.2 ✗		4.4 ✗		3.7 ✗	3.6 ✗			3.6 ✗
(f)	an understanding of professional and ethical responsibility		3.8 ✗	3.6 ✗	3.3 ✗			3.7 ✗	3.5 ✗				4.7 ✗		
(g)	an ability to communicate effectively		3.8 ✗			3.7 ✗					4.9 ✗			4.2 ✗	4.0 ✗
(h)	the broad education necessary to understand the impact of engineering solutions in a global and societal context	3.4 ✗	3.9 ✗	3.9 ✗				4.1 ✗	3.5 ✗						
(i)	a recognition of the need for, and ability to engage in, life-long learning			4.6 ✗		4.1 ✗									
(j)	a knowledge of contemporary issues		3.7 ✗	3.8 ✗				3.8 ✗	3.1 ✗						
(k)	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	4.3 ✗		4.2 ✗	3.6 ✗	3.7 ✗		2.6 ✗	4.0 ✗						

TABLE B3.6 also shows almost perfect agreement among students and supervisors about which of the competencies they are "best" at and which are the worst. Here the term worst is comparative since the students rate highly in all competencies. FIGURE B3.2 shows the most important pieces of information in regards to this report, that the Mat E students are achieving the program outcomes a-k. The lowest rating shows an 84% achievement rate for students who are one, two or even three years from graduation.

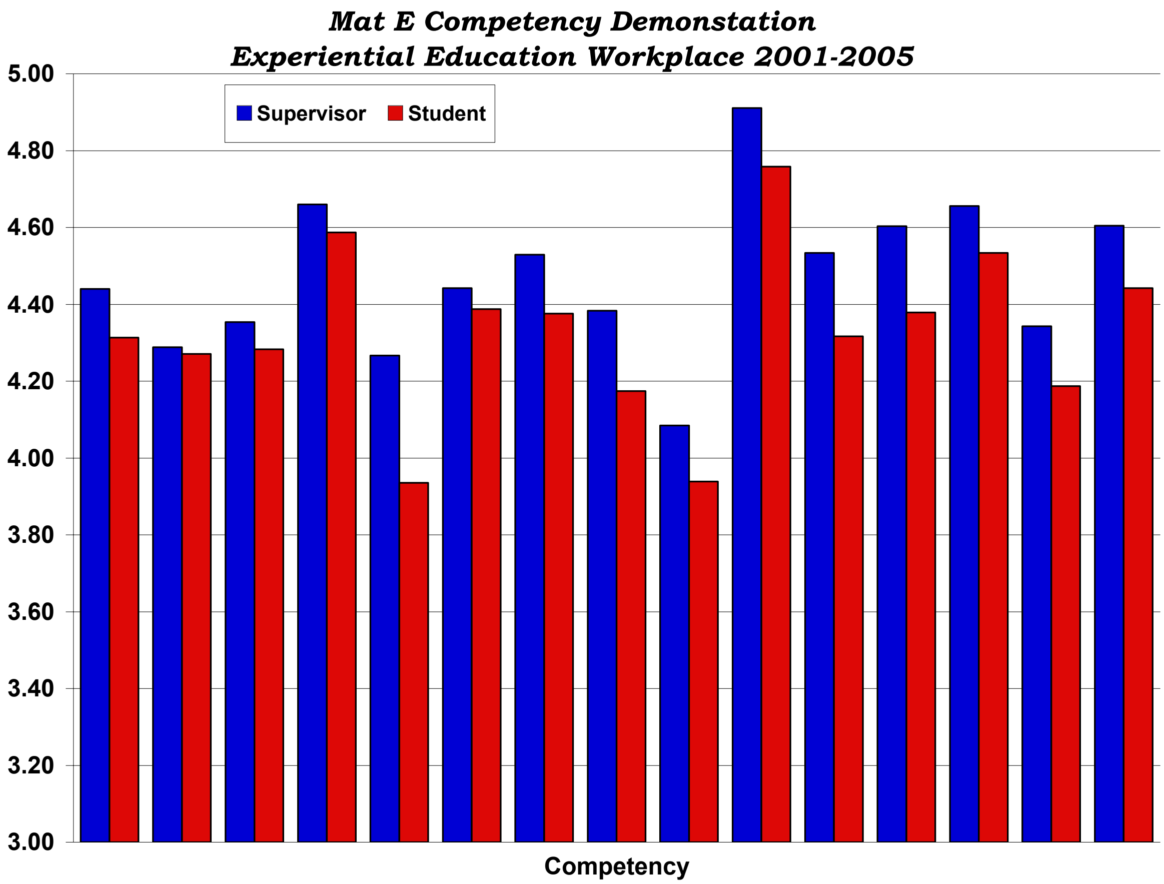


FIGURE B3.1 OPAL™ Competencies are Being Achieved by Mat E Students

TABLE B3.6 Top and Bottom 5 OPAL™ Competencies

Mat E Top 5/Bottom 5 Competencies

Experiential Education Workplace 2001-2005

Student Assessment	*Top 5*	Supervisor Assessment
Integrity		Integrity
Cultural Adaptability		Cultural Adaptability
Quality Orientation		Quality Orientation
Teamwork		Teamwork
Engineering Knowledge		Professional Impact

Student Assessment	Bottom 5	Supervisor Assessment
Continuous Learning		Initiative
Communication		Continuous Learning
Initiative		Communication
Innovation		Customer Focus
Customer Focus		Innovation

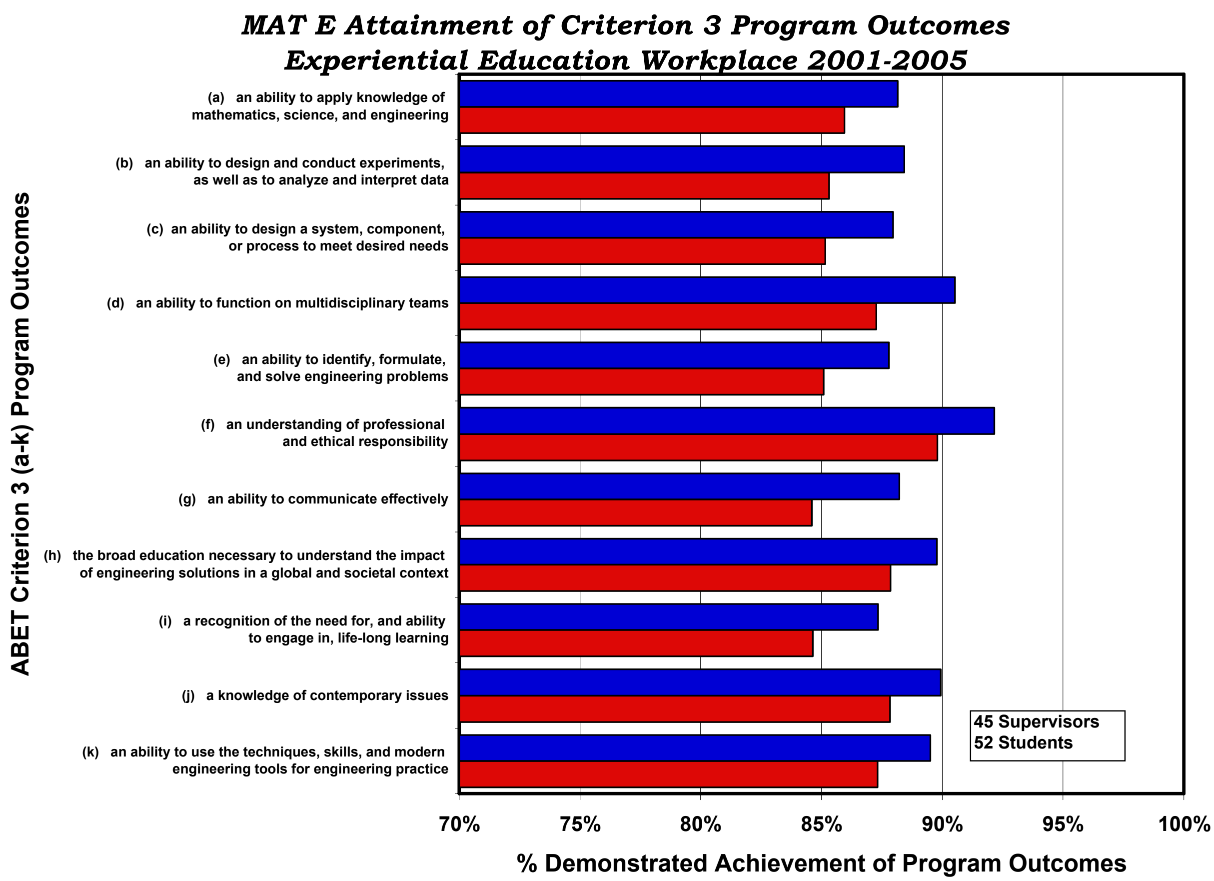


FIGURE B3.2 Program Outcomes a-k are Being Achieved as Measured by OPAL™

Moreover, the students who experience co-ops and internships in industry are excelling in them. Below is a message copied from an industry supervisor about three of our Mat E students from one semester who were working at Rockwell-Collins. Although anecdotal, it demonstrates how three students in one semester at one company excelled in their engineering experiential learning environment.

From: ddhillma@rockwellcollins.com [mailto:ddhillma@rockwellcollins.com]

Sent: Thursday, February 16, 2006 10:09 AM
To: kbriley@iastate.edu; makinc@iastate.edu
Cc: dopauls@rockwellcollins.com; tjcopple@rockwellcollins.com; jrharris@rockwellcollins.com; nlcavana@rockwellcollins.com

Subject: Student Awards

Hi Krista/Muffit! I have some really good news! As part of their co-op tasks/efforts spent here are Rockwell, Peter VanZante, Courtney Slach, and Nate Devore have received industry awards! Details:

IPC Distinguished Committee Service Award: Peter VanZante In appreciation and recognition of your contribution to the development of both IPC/EIA/JEDEC JTD-002C Solderability Testing for Components and IPC/EIA/JEDEC JSTD-003B Solderability Testing For PWBs Peter completed a tremendous amount of work on this industry specification development project that resulted in both Rockwell Collins and Global Electronics Industry impact. Without Peter's efforts, the project would not have been completed.

IPC APEX 2006 Conference Honorable Mention Conference Best Paper:
Courtney Slach and Nate Devore

IPC-Association Connecting Electronics Industries' recognized the winners of this year's Best U.S. and International Papers at IPC co-located shows, held February 8-10, 2006, in Anaheim, Calif. The technical program committee selected the winners in a secret ballot.

The Committee selected two Honorable Mention papers. The U.S. Honorable Mention went to Douglas Pauls, Rockwell Collins, and Courtney Slach and Nathan Devore of Iowa State University for "Process Qualification Using theIPC-B-52 Standard Test Assembly..

About IPC
IPC is a global trade association based in Bannockburn, Ill., dedicated to the competitive excellence and financial success of its 2,300 member companies, which represent all facets of the electronic interconnection industry, including design, printed circuit board manufacturing and electronics assembly. As a member-driven organization and leading source for industry standards, training, market research and public policy advocacy, IPC supports programs to meet the needs of a $40 billion U.S .industry employing more than 350,000 people. IPC maintains additional offices in Taos, N.M.; Arlington, Va.; Garden Grove, Calif.; Stockholm, Sweden; and Shanghai, China. For more information, visit www.ipc.org.

Course Evaluations

The standard university course evaluation form is used with a supplement added by the MSE department. The survey is divided into two areas, “the course” and “the instructor.” Departmental averages for “the instructor” are traditionally the highest in the college – at 4.3/5.0 in the most recent semester. When asked if the stated goals of the course were attained, 86% of the students said “yes.” This information allows us to conclude that the students perceive that both the quality of the instruction and course content is high. Both the university forms and the departmental supplement will be available at the time of the visit.

Outcomes Ratings (Supplemental Course Evaluation Forms)

TABLE B3.7 shows the program outcomes correlated to individual Mat E courses within our program. A check mark indicates that the individual course contributes towards the development of a student in the process towards achieving the stated outcome. Red check marks represent outcomes that were rated (on the average of the last four offerings) by students as below 3 on a scale of 1 (course does not contribute to this outcome) to 5 (course contributes significantly to this outcome). Yellow check marks indicate a single semester low rating in the most recent offering of the course

TABLE B3.7 Student Outcomes Ratings by Course

	ABET Program Outcomes																			
	<--------General Engineering------->												**ABET/Mat**					**MSE/ISU**		
Course	**a**	**b**	**c**	**d**	**E**	**f**	**g**	**h**	**i**	**j**	**k**		**l**	**m**	**n**	**o**		**p**	**q**	**r**
Mat E Core (26)																				
211 Intro(5)	√	√		√	√		√				√		√	√	√	√				√
212 Thermo	√				√						√		√	√						
214 Char	√	√					√				√		√	√		√				√
315 Kinetics	√				√		√				√		√	√		√				
316 Computations	√	√		√	√		√				√					√				
318 Mech Prop	√	√	√	√	√		√	√			√		√	√	√	√				√
313 Prof Practice (2)	√	√	√	√	√	√	√	√	√	√	√		√	√	√	√		√		√
413 Prof Practice (2)	√	√	√	√	√	√	√	√	√	√	√		√	√	√	√		√		√
414 Prof Practice (2)	√	√	√	√	√	√	√	√	√	√	√		√	√	√	√		√		√
MSE Specializations																				
Ceramic Materials	**a**	**b**	**c**	**d**	**E**	**f**	**g**	**h**	**i**	**j**	**k**		**l**	**m**	**n**	**o**		**p**	**q**	**r**
321 Int Cer Sci	√				√		√		√		√		√	√				√		
322 Cer Proc	√	√	√		√	√					√		√	√	√	√				√
423 Glass	√	√	√		√	√	√		√	√	√		√	√	√	√				√
424 Adv Cer	√		√			√		√	√	√	√		√	√	√					
Electronic Materials																				
331 Int Elec Mat.	√	√		√	√		√				√		√	√		√				√
332 Semicon Mat,	√		√		√				√	√			√	√	√					
433 Adv Elec Mat.	√		√		√			√	√	√			√	√	√					
432 Microelec Fab	√	√		√			√	√		√	√		√	√		√				√
Metallic Materials																				
341 Proc & Fab	√	√	√	√	√						√		√	√						√
342 Struc Prop	√	√	√		√		√				√		√	√	√	√				√
443 Ferr Met	√	√	√		√		√		√	√			√	√	√			√		
444 Corr. & Failure	√	√		√	√		√				√		√	√	√	√				√
Polymeric Materials																				
351 Int Poly Materials	√							√		√	√		√	√	√	√				
442 Pol Engr	√	√		√	√						√		√	√	√	√				√
453 Phys Mech	√				√								√	√	√					
454 Pol Comp Proc	√	√		√	√		√			√	√		√	√	√	√				√

Each specialization committee examines the data for courses in that area and develops an action plan to correct the deficiency or restate contribution to outcomes. The courses in the materials core are similarly evaluated by the department's curriculum committee. While four-year averages are shown here, these committees examine the low-rated outcomes each semester for possible action. The committees looked at the original outcomes specified and the results being gathered each semester when the degree program and these outcomes assessments by course were first put into place (fall, 1999) to determine if the appropriate outcomes were being specified. In many cases outcomes were inappropriate for the course and were removed from the assessment process for that course. For example, it was concluded that outcomes b, c, d, and r do not belong in the Mat E 315 Kinetics class. The tables shown in this document represent the current outcomes being assessed and analyzed.

Summative assessment

Senior Surveys

Senior surveys and interviews have been implemented since 1994, although the form of the survey changed in 1998 to better reflect stated objectives and outcomes. Since the program changed in the 1999 catalog, it is only the more recent surveys provide data for students whose entire program was taken in the new curriculum. A total of 110 senior exit surveys and interviews have been administered from F1999 through F2005 (representing the entire graduating populations). Students were asked to rate their achievement of each of the program outcomes a-r. Students were asked to rate themselves between 1 (outcome not achieved) to 10 (achieved at a bachelor's level). The averages and standard deviations of the responses are shown below.

TABLE B3.8 Student Surveys at Graduation (1999-2005)

a	b	c	d	e	f	g	h	i	J	k	l	m	n	o	p	q	r
9.1	9.1	8.4	8.9	9.0	8.7	9.2	8.3	9.0	8.0	8.9	9.0	8.9	8.8	8.7	9.0	9.1	8.7
0.8	1.1	1.2	1.7	1.3	1.6	1.0	1.7	1.6	1.6	1.2	1.3	1.0	1.1	1.3	1.1	1.8	1.3

Overall, the students rated themselves 8.8/10, a high average. The lowest ratings are at or above 8/10 and they are in outcomes j (8.0), h (8.3), and c (8.4). In reaction to lower scores on j and h, the program shifted to "general education" course electives beginning with the 2005 catalog. Since no students who started in 2005 have graduated yet, a report on those exit survey outcomes will be made in the future. In reaction to the lower score on c, we have revamped the design sequence (several times) over the past few years. A complete report on that is shown below.

Although about 75% of our Mat E students experience a co-op or internship, and a much greater percentage is realized when we add in those who have part-time Ames Lab jobs while attending school, a good portion of our students were unsure of their abilities as related to outcome (q) experience in materials engineering practice through co-ops or internships in industry, national laboratories, or other funded research work. This is determined by noting that although the overall achievement rating is 9.1, the standard deviation is fairly large (1.8) in this outcome. A significant effort is being made to involve more students in research-related part-time jobs and to encourage students to avail themselves of the numerous co-op and internship experiences. The thrust toward experiential learning is college-wide, and we augment that with a "Learn and Earn" program for our freshmen to encourage them to work in research projects. We have also begun an online resume service for students seeking such positions.

Senior Exit Interviews
In general, the students perceive the outcomes are being met as shown in the data of the previous section. In the personal interviews the students generally expressed that they had a positive experience, were pleased with their choice of majors, and had been satisfied with both teaching and advising in the department. They had no reservations about duplication in courses as previous years had mentioned. The revised curriculum has apparently taken care of that concern. The students were more enthusiastic about the career placement help they are able to receive through the college's Career Services Office than in previous years. The graduating students were almost unanimously supportive of the revision of the curriculum to a single degree with four specializations.

The placement rates for Mat E students in the last six years have been close to 100%.

The most common negative comments in exit interviews have been in two general areas; the ceramics specialization and the design (now professional practice) sequence. The ceramics specialization has been dealt with as described in a following section of this report. The design sequence has undergone intense scrutiny and change as described in a following section. Briefly, starting with the 2005 catalog, the sophomore course was eliminated, and the junior year course will be eliminated in the 2007 catalog. With these changes we will return to the traditional "senior design" program familiar in most schools across the country.

Student Feedback Sessions
A program feedback session is held toward the end of the spring semester. This session is facilitated by senior students, and at the students' request, a faculty member is sometimes present to act as a resource person. The facilitator has a list of questions/topics related to all program elements (the curriculum, advising, co-op/internships, etc.) to address during this session. A recorder (also a senior leader) records comments and delivers them to faculty. This information is brought to the curriculum committee to discuss and suggest changes for continuous improvement.

In addition, student feedback sessions are run informally when issues arise. For example, when an issue about design courses arose, a course period was devoted to a student discussion of this issue. A student representative attends our weekly faculty meetings in order to provide student input on whatever issues arise and to present information to the other students. Our professional society student group, The Material Advantage, is quite large (over 100 members) and very active (they have been named outstanding student chapter in the nation the past two years). This group holds discussions and presents their suggestions to the group's faculty advisor or to the department's assistant chair who is responsible for the undergraduate program. Finally, the students have formulated their own online feedback system to allow any student in the department to provide input.

Feedback from these sources in the past few years has dealt with several issues:

1. Design (now professional practice) courses. This is discussed later in this section of the report in the course-by-course listings of continuous improvements made.
2. Scheduling difficulties for people returning from co-ops or internships. We looked at each of our courses and attempted to remove pre-requisites that weren't absolutely necessary. This allows for students to take the courses out of the usual sequence.
3. Pre-requisites. After removing some of the pre-requisites, students are now commenting that we should reinstate Mat E 212 (thermo) as a pre-requisite for Mat E 315 (kinetics). This is being prepared for the 2007 catalog.
4. Ceramics Sequence. Students said that the ceramics sequence needs to be overhauled since it doesn't provide both preparation for graduate school and industry. This has been done and is reported on below in the ceramics specialization.
5. Lab facilities and equipment upgrades. These comments were prior to our moving into our new state-of-the-art undergraduate facilities in our new building (October 2003). The students now comment about having great facilities.

Placement Data

The placement data are managed through a variety of sources. The college maintains a database, but we rely primarily on faculty, advisors, and staff who make personal contact with the students before and after graduation. TABLE B3.9 shows placement within six months of graduation.

TABLE B3.9 Placement Data for 2000-05

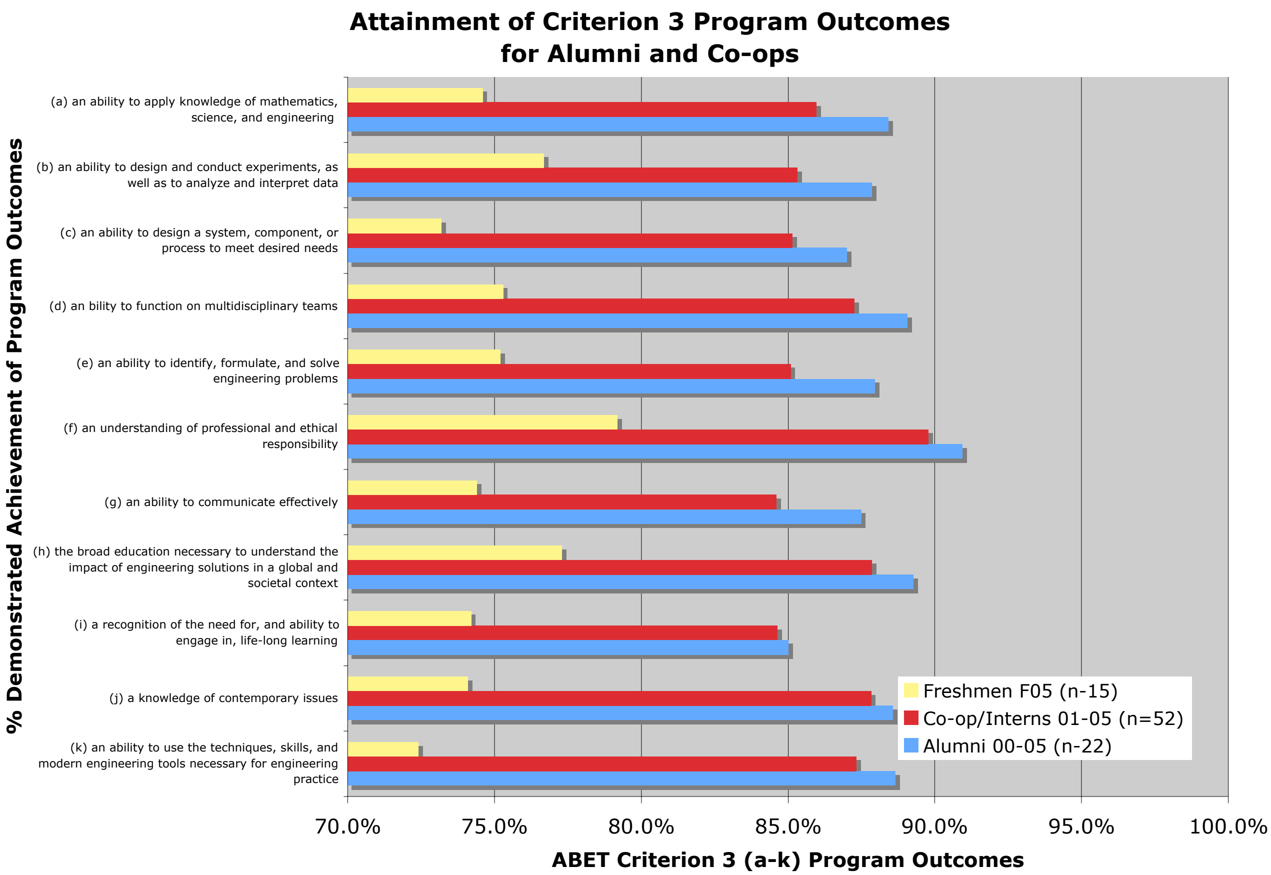
Semester	# of Grads	Took Jobs	Grad School	% Placed*	Not Placed
F 00	1	1	0	100%	0
S 01	7	4	3	100%	0
F 01	3	2	1	100%	0
S 02	4	3	1	100%	0
F 02	7	2	5	100%	0
S 03	26*	12	12	100%	2
F 03	3	1	2	100%	0
S 04	16	8	8	100%	0
F 04	3	2	1	100%	0
S 05	23	12	9	91%	2
F 05	5	2	3	100%	0
TOTAL	98*	49	45	98%	4

* S03 includes one person who was not looking and one who didn't report (percentage placed is based on 24 for S03, 94 out of 96 total)

Alumni Surveys

As TABLE B3.9 shows, a relatively small number of students have graduated from our Mat E curriculum since it was instituted for entering freshmen in the 1999 catalog. We saw only 22 graduates before the spring 2003 semester. Since we now have 98 graduates, we felt this number was sufficient to institute an OPAL™ instrument to certify that our objectives are being met. This is done by using the same OPAL™ instrument as is used by students on co-op. It measures competencies that are aligned with program outcomes (TABLE B3.5), thereby certifying the outcomes. Since our outcomes are aligned with our objectives (TABLE B3.1), we can use this instrument to certify that objectives are being met. TABLE B3.10 shows that the alumni ratings for achievement of outcomes as measured by the OPAL^{TM} instrument are higher in all a-k than the achievement by the students in co-ops and internships, which in turn are higher than 1st semester freshmen (our baseline data). Since all of the outcomes are being achieved according to this measure, so are all the objectives according to the alignment of objectives and outcomes as shown in TABLE B3.1.

TABLE B 3.10 Alumni Achievement vs. Undergraduates in Co-ops and Freshmen.



Continuous Improvement Process

For curricular evaluations, the results of the students' perceptions are compared to those of the faculty, and discrepancies are carefully examined. The flow sheet for the evaluation and continuous improvement process of this program element is shown in Figure B3.3. This process occurs on a yearly basis.

Continuous improvement is also facilitated by the maintenance of a course portfolio in which the

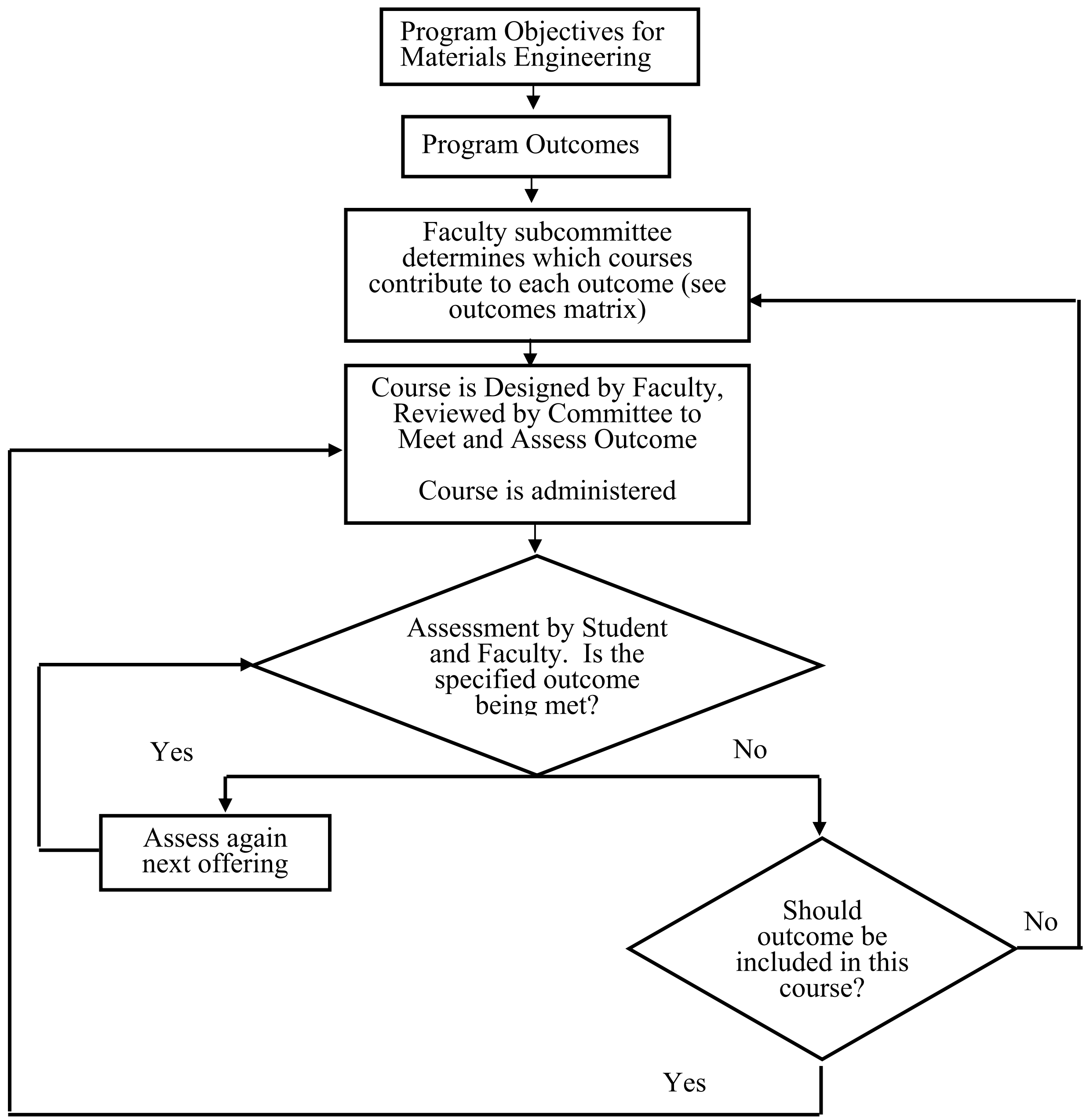


FIGURE B3.3 Process for evaluating student and faculty self-assessment of meeting outcomes for each Materials Engineering Course.

faculty write a self-reflective memo on the course and outline future plans in light of the feedback. This process occurs on a per course offering basis (usually yearly).

Faculty retreats focusing on curriculum are held periodically (approximately every two years). This gives the opportunity for the faculty to consider the curriculum as a whole.

Curricular changes to complete the assessment/revision loop
Curricular changes are made periodically, informed by assessment results and environmental scans. These changes are described for the materials core and the four specializations. Additionally, there have been changes in requirements in courses outside of Mat E courses.

Core materials program update and revision, 2000-2006

The materials core consists of Mat E 211, 212, 213 (eliminated with F05 catalog), 214, 313 (will be eliminated in F07 catalog), 315, 316, 318, 413 (will change from 2 to 3 credits in F07 catalog), and 414 (will also change from 2 to 3 credits in F07 catalog). These courses will be discussed in this section.

Mat E 211, Introduction to Materials Science & Engineering, our five-credit introductory course, is considered by our students and our faculty to be our most important undergraduate course. Consequently, we have assigned our best instructors to teach this course. The assessment data show that those program outcomes that we have determined to be related to Mat E 211 (see TABLE B3.7) have been achieved each semester ("achieved" is measured here as an average score of 3/5 or better).

Mat E 212, Thermodynamics in Materials Engineering had some low outcome scores (b, d, g) in the spring semester of 2002. Faculty and students reviewed the outcomes assessment and those outcomes that were correlated to individual courses as described in process flowchart Figure B3.3. It was determined that these three outcomes were inappropriate for the Mat E 212 course and, as TABLE B3.7 shows, were removed from the row in the matrix for Mat E 212.

Mat E 213, 313, 413, 414 will be considered here as a group because they represent our design (now called professional practice) sequence.

"X13- Vertically Integrated Design" began in 1999 as an NSF funded CRCD grant that would involve sophomores (213), juniors (313), and seniors (413) on common design teams working on industry-based projects (many of them related to non-destructive evaluation) under the guidance of industry engineers and faculty mentors. Capstone design would continue in the spring of the senior year with 414. At the time the project was proposed, the entire undergraduate population was under 100, and that of the three combined classes involved in the course was about 70. Evaluations from the initial offering were quite poor with the following concerns cited by students and faculty involved:

- Poor organization
  - late start of projects (4th week of class)
  - timing of final presentations unclear/unscheduled
  - When/where/how to turn in reports and in what format
- Rubrics were well developed but not implemented
- Differential expectations of different faculty mentors, the course coordinator, the industry representatives
- Grading – expectations not communicated – perceived inequities
- Sophomores feel that they aren't ready to do the work.
- Project "quality" and support varied widely
- Poor communication led to confusion for students, faculty, and companies.
- Too much work (to do it right) for a two credit course.

- Many students have had significant industry experience – isn't this repetitive?

Some of these concerns were partially addressed in the next two offerings, but other administrative concerns arose, many of them related to the number of students. The student population grew significantly requiring double the number of industry projects and contributing to logistical problems – managing a design class with over 100 students. Additionally, with such a large class, multiple faculty were involved in coordination and teaching, and communication became a more significant problem.

The course results and possible changes were discussed in both the industrial advisory council meetings and the faculty retreat in 2002 and 2003.

In 2003, when the official funding for the project CRCD expired, the course was assigned a new coordinator. Improved organization included:

- Identifying projects before the start of the semester
- Requiring industry representatives to fully specify the project, expectations, intellectual property concerns, etc.
- Utilizing Web CT to communicate with the students via a calendar, posted lectures, announcements, reading material, and evaluation forms
- Implementing peer evaluation. Grading was linked carefully to published rubrics.
- Implementing early term evaluation of project mentors and industry partners
- Developing focus groups for feedback
- Allowing students with at least 9 months of industry experience (evaluated through OPAL) to replace one of the three courses with a technical elective.

The 213 part of the course was "broken out" of the course and taught separately as "topics in design" in 2003 and 2004, and then it was dropped entirely in 2005 after a review of the content in Engr. 170 revealed considerable overlap. The name of the course was also changed to "Professional Practice" to better encompass the range of projects included in the course.

Student instructor evaluations improved from an average of 1.9/5.0 for Fall 02 to 4.3 for Fall 03 and continued to remain higher for the next two offerings. However, there remained questions about both the efficiency and effectiveness of the course. Securing high quality, appropriate projects became even more problematic and time consuming for the single course coordinator.

These courses have been discussed with the students at several feedback sessions and at numerous faculty meetings. Detailed results of these discussions are in the X13 notebook.

After a number of faculty discussions, it was decided to change the three two-credit courses (313, 413, and 414) to two three-credit courses (413 and 414) offered only in the senior year.

Currently, an ad-hoc committee is reviewing the course and is considering a variety of options, including

- Presenting more "fundamentals of design" background
- Using more case studies
- Using 'canned' or 'past' projects

We are also aware that our issues with design in materials are not unique, but rather shared with other universities, who also struggle with design education. We are working to collaborate with colleagues from peer institutions to learn from their experiences in “designing the design experience.” We are also reviewing the University Materials Council “White Paper” on design.

Mat E 214, Structural Characterization of materials has had good assessment results as measured by outcome achievements at the end of the course. No ratings have ever been below 3/5. However, following the Figure B3.3 process, the outcomes being ascribed to 214 were reviewed and d, e, and n were removed from this course as not being of primary consideration for our assessment.

Mat E 315, Kinetics and Phase Equilibria in Materials underwent the same reviews as described for the previous classes and outcomes b, c, d, and r were removed from alignment with this course. All other outcomes have received consistently high ratings, except for the most recent offering (F05) when outcome g was rated 2.8/5. This item will be reviewed by the curriculum committee for possible corrective action or referred for further review after the next offering.

Mat E 316, Computation Methods in Materials, has had good assessment results as measured by outcome achievements at the end of the course. No ratings have ever been below 3/5. However, following the Figure B3.3 process, the outcomes being ascribed to 316 were reviewed, and i and l were removed from this course as not being of primary consideration for our assessment.

Mat E 318, Mechanical Behavior of Materials, had outcome j removed from its assessment by the same process. It does, however, show some trouble spots. Outcomes c (2.74), d (2.65), and h (2.98) are below the 3/5 threshold when averaged over the last four offerings. Moreover, these ratings have steadily declined during that period. The curriculum committee has reviewed these results and come to the following conclusion; we will remove these outcomes from the assessment of Mat E 318. The course content and the goals for the outcome do not match well and, as the matrix in TABLE B3.7 shows, there are many other opportunities to assess student achievement of these outcomes.

Ceramics specialization program update and revision, 2000-2006

Summary:
In 2004, the ceramics curriculum was changed in response to the results of an analysis of job placement statistics from 1998-2004 and discussions among faculty in the ceramics specialization group. The changes involved three of the four specialization courses (the third course – Glass Science and Engineering remained the same).

An analysis of graduate outcomes revealed that about half of students (varying by year) went directly to industrial positions, and the other half went to graduate school.

Both companies and graduate school information was collected for all MSE graduates. About 75% had ceramics as one of their specializations, the remainder did not.

Examination of those placements of students with ceramics specialization showed that few students are being placed in traditional ceramic processing-based industries (e.g. Kohler) where they would make use of specific knowledge of traditional processing techniques. Many more are placed in “high tech” companies requiring a broader knowledge of materials – e.g.

semiconductor processing. Even those placed in "traditional" ceramics jobs, e.g. Kohler, report working on fairly complex development projects rather than in process maintenance. The conclusion was that the curriculum should respond by decreasing processing content and increasing ceramic science and advanced ceramic content.

The original curriculum was heavily weighted toward ceramic processing (much of it traditional). It is clear that the focus needs to evolve towards preparing students for life-long learning in the field rather than specific training in processing techniques. The following table (B 3.11) shows the changes in the Ceramic Specialization sequence implemented in 2004.

TABLE B3.11 Ceramics Sequence Changes

Previous	**Revised (04)**
Ceramic Processing – Forming	Ceramic Science
Ceramic Processing – Firing	Ceramic Processing Forming-Firing
Glass Science and Engineering	Glass Science and Engineering
Ceramic Industries	Advanced Ceramic Engineering

Follow up and further refinements:
These courses were taught for the first time fall 2004 (321) and spring 2005 (322 and 424). It was reported that it was too much to cover all processing content in 322, so the topics of powder packing, sintering, and ternary phase diagrams were brought into 321 in the fall of 2005. Several outcomes for 322 received lower ratings in the last offering, and they will be reviewed after assessing them again on the second offering. One outcome, f, has received a low average rating and the curriculum committee and specialization committees are reviewing that outcome and its assessment in this course. The Mat E 424 instructor also reported that he had to back up to cover some fundamentals that the students had not mastered. This should be remedied by the stronger science background from the restructured 321. The faculty involved in these courses have had detailed discussions of complementary content. Course evaluations from both the restructured 321 (4.5/5) and 424 (4.3/5) were significantly improved from the previous year.

Electronics specialization program update and revision, 2000-2006

This sequence of courses (Mat E 331, 332, 432, 433) includes two courses that are taught by another department. The ECpE Department teaches 332 and 432. Student assessment of these two courses has indicated a high level of satisfaction in learning outcomes except for one year. It was determined that the usual instructors for these courses were changed that one year. After consultation with the offering departments, the usual teachers were re-assigned to the courses, and student feedback is again positive.

Faculty evaluation of the preparedness of students for 332 showed that the Mat E 331 class needed to include more quantum mechanics and band theory, but it didn't need to include as much optical properties coverage. The optical properties coverage was moved to the fourth course (433) in the sequence, and Mat E 331 was increased from a 3-credit course to a 4-credit course in fall, 2003. This allowed for the increased coverage of the two topics mentioned. Assessment in both courses (331 and 332) showed faculty and students were pleased with the results.

Since this sequence now includes two 4-credit classes (331 and 432) it includes two more credits than our other specialties. In order to compensate for this, students who select the electronics specialization are required to take two fewer credits of technical electives (four instead of six).

Metals specialization program update and revision, 2000-2006

Since first instituted, the Metals Specialization has consisted of a series of four classes. The classes were designed to be "stand alone" modules, rather than a sequential series of classes in which each course builds upon the preceding course. This provides more flexibility for students engaged in coops, internships, or study abroad opportunities. In this sense the class structure appears to work well.

The content of each class has changed slightly as different instructors have been asked to teach each course, and this is only natural. Feedback provided by students has led to a few more substantial changes, and these are detailed below. Items presently being discussed concerning each class as possible areas for change in the future are also briefly discussed.

Mat E 341: Metals Processing and Fabrication
Students really enjoy the hands-on aspects of this class and the move to larger facilities has enabled the course to keep pace with growing numbers. Delays in getting equipment in this laboratory up and running caused a slight problem fall 2005 but in general this class has run smoothly since the last accreditation visit. Additionally, the instructor of 341 was changed so there were some necessary adjustments in content. The student course assessments for Mat E 341 reflect these temporary difficulties.

Mat E 342: Structure Property Relationships in Metals
While this course deals with all aspects of structure/property relationships in metals, early assessments showed overlap between some of the material and Mat E 443, which deals entirely with ferrous metallurgy. Therefore, the focus of the class was changed slightly to emphasize more the structure/property relationships in the non-ferrous metals. As such, Mat E 342 and Mat E 443 better serve as companion courses covering structure/property relationships in nonferrous and ferrous metallurgy.

Mat E 443: Ferrous Metallurgy
This class provides in-depth analysis of ferrous metals, which are industrially important and is a historic strength of the department. As such, ISU is a major recruitment site for companies such as Caterpillar and John Deere. Class assessments have shown that students feel some of the material covered in the laboratory component is a repeat of information provided in other classes. While assessment indicates they still enjoy the laboratory component, faculty in the metals emphasis area have begun discussions to see whether the students might be better served by moving some of the experiments to an earlier class, such as Mat E 341. This would allow for an enhancement of course content. While no change is planned as of yet, student input will be sought and further discussions concerning this possible change are planned for the future.

Mat E 444: Corrosion and Failure Analysis

This class provides instruction in the mechanisms and causes for failures as well as methods to prevent failures. The balance of instruction between corrosion related vs. mechanical / metallurgical failures has fluctuated depending upon the particular strength of the instructor. Student assessments indicate satisfaction with both areas and a desire to maintain some balance between the two. The hands-on laboratory component involving a corrosion project and examination of actual failures is well-liked by the students, although room for improvement exists in obtaining more, better-documented cases to examine.

Polymer program update and revision, 2000-2006

The original sequence of courses in the polymer program included a sequence of courses which included an introduction to polymers followed by a general properties course with polymer characterization lab. During the second year, an introduction to polymer composites was offered which was followed by a processing-oriented course with a polymer processing lab (see TABLE B3.12).

Table B 3.12 Initial (1999) sequence of polymer courses

Mat E 351. Introduction in Polymeric Materials
Mat E 352. Physical & Mechanical Properties of Polymers with Laboratory
Mat E 453. Introduction to Polymer and Composite Processing
Mat E 454. Industrial Polymers and Processing (with Laboratory)

However, in the process of designing and teaching the new polymers courses, we encountered several problems that suggested a modification of the original polymer sequence was necessary. Thus, we redesigned and introduced a new polymers sequence (TABLE B3.13). First, we tried to resolve an issue of unbalanced student backgrounds. Most of the materials students do not have an organic chemistry background (as Ch E students do) and thus needed additional training. An introduction to polymer/organic chemistry was added to the content of Mat E 351, and other content related to the polymer properties and industrial applications was moved to Mat E 442, a newly designed course. Second, limited resources (only 1-2 faculty members were available to teach in-depth polymers topics) called for more efficient teaching practice. We have arranged team-teaching with the Ch E Department (alternating years) for a new general polymer course Mat E/Ch E 442 focused on properties and applications. In addition, we have combined processing and characterization experimental labs in one extended lab. Third, polymer composite and processing content was combined in the Mat E 454 course that was moved to become the third course in the sequence.

TABLE B 3.13 Current sequence of polymer courses

Mat E 351. Introduction in Polymeric Materials
Mat E /Ch E 442. Polymers and Polymer Engineering
Mat E 454. Polymer Composites and Processing
Mat E 453. Physical &Mechanical Properties of Polymers (with Extended Laboratory)

Finally, the Mat E 453 course was redesigned to combine the content of the former Mat E 352 course and to become a last course in the sequence and a capstone course in the polymer program. This course was extended to include extensive lab experiments which combined all major experiments from former labs. Five new experiments were designed (synthesis, chromatography, injection molding, extrusion, and crystallization). This course includes intensive lab reports writing, final report writing, presentations, team-work, comprehensive discussions, and hands-on experience in running experiments for all students (each student runs a single polymer sample, and a team of 3-5 students collected comprehensive data for all classes of polymers (e.g., amorphous, partially crystalline, filled, elastomers).

Refinements in Other Curricular components

The curriculum committee periodically examines all aspects of the curriculum, and is currently evaluating the following:

  - Design content restructuring (course structure has already been changed)
  - Math requirements (faculty approved adding multivariable calculus 3/8/06)
  - Math content enhancement in existing Mat E courses
  - Lab flexibility – scheduling for optimal use
  - Proposal-based specialization (allowing students to define one of the two specializations according to their career goals.

<u>Materials Available at the Time of Review</u>

- OPAL™ notebook
  - Mat E results (cumulative and annual)
  - All engineering results (cumulative and annual)
  - Metrics used
  - Validation methods
  - Printed copy of the on-line survey
- Course portfolios
  - Course information
  - Relationship to program objectives, relationship to industry practices (if appropriate), assignments, learning activities list, grading standards.
  - Pedagogy
  - Description of teaching practices, philosophy and goals
  - Evidence of Student Learning
  - Assessment practices and tools, results, samples of student work
  - Self-reflective memo, changes to be made, professional growth related to course (papers, presentations)
- Student Transcripts
- Senior design project reports
- Copy of all survey instruments
- Compilations of all assessment data

4. Professional Component

The Materials Engineering Curriculum at Iowa State University has been carefully designed to strike a balance between Basic Science, Engineering Science, Engineering Design and General Education.

Table B4.1 shows the courses in the ISU Materials Engineering curriculum sorted into three categories derived from the areas specified above. According to Criterion 4, the professional component must include one year of a. math and basic sciences, and one and one-half years of b. engineering topics. If we assume an average of 16 credit hours per semester, this establishes the targets for categories (a) and (b) at 32 and 48 credit hours respectively. In table B4.1 it can be seen that the curriculum exceeds the criterion specifications.

Table B4.1 Credits in Materials Engineering by Area

a. Math, Basic Science		**b. Engineering Topics**		**c. General Educ.[4]**	
		Engr. Prob. w/VBA progr.	3		
Calculus I	4	Engr. Graph.&Design	3	English 104	3
Calculus II	4	Engineering Statics	3	English 105	3
Diff. Equations	3	Mechanics of Materials	3	Library 160	0.5
Gen. Chem and Lab I[1]	5	Intro to Mat. Engr.	5	Gen Ed Elective 1	3
Gen. Chem and Lab II[1]	4	Structural Char. Of Mat	3	Gen Ed Emphasis 1	3
Classical Phys. I & Lab[1]	5	Kinetics and Phase Eq.	3	Gen Ed Emphasis 2	3
Classical Phys II &lab[1]	5	Comp. Methods in Mat.	3	Gen Ed U.S. Div.	3
Thermo of Mat	3	Mech Behav. of Mat.	3	Gen Ed Int. Persp.	3
		Professional Practice[2]	6	Free Elective[5]	3
		Specialization Courses	**24-26**		
		Tech Electives[3]	4-6		
TOTALS	33	TOTALS	65	TOTALS	24.5[4]

Note: Courses offered by the MSE department are listed in GREEN type, other departmental/college offerings are listed in BLACK type.

[1]Chemistry and Physics both have laboratories associated with the class
[2]See below for a detailed description of ***Professional Practice***
[3]Technical Electives are often MSE courses, but not necessarily. Technical elective guidelines can be found in Appendix I.
[4]The department requires one sequence in social science or humanities as indicated in the policy statement in Appendix I - Table IA. The University level requirements for Diversity and International Perspectives are outlined in Appendix II. These courses contribute to the outcomes related to broader cultural and international awareness.
[5]The free elective policy is described in Appendix I Table IA. The student may choose to study a science or engineering topic for this elective, in which case the General Education total would be 21.5 credits.

Preparation for Engineering Practice - Professional Practice and Capstone Design

The Materials Science and Engineering Department is committed to providing the student with realistic design experiences commensurate with her/his current knowledge and skills. These professional practice and design experiences are distributed through a number of courses as indicated in the course syllabi, but are concentrated in three courses. The first two experiences, 313 and 413 (called Professional Practice I and II), are taken each of the fall semesters (shown in ***bold italics*** in Table B4.2) with juniors and seniors in the same classroom. In this approach to learning and practicing design, teams of students including both juniors and seniors are given design problems to solve. Each member of the teams takes on a role commensurate with his/her background, experience, and skills. Most often the junior is the "junior" engineer, while the senior is the "senior" engineer and/or the "project leader / manager". In these courses the process of design is discussed as well as practiced. The senior student also participates in a capstone senior design course in the spring semester. In this course, our industry partners present design problems for teams of 2-4 students to work on most often in conjunction with a practicing engineer from the company and a faculty member from the department. The design team meets with industry representatives, and when possible the team visits the company and meets with engineers there to better define the problem and strategize. The course requires periodic reports (often oral) and a final oral and written (and sometimes electronic -- web pages) document presented to the faculty and industry representatives.

Table B4.2 shows a generic plan for the sequence of courses taken in the Materials Engineering curriculum. The largest course load in this typical sequence is 17 credits, and the lightest is 13. The minimum number of credits needed to graduate is 122.5 under the current (2005-2007) catalog.

Table B4.2 Typical sequence of courses in Materials Engineering curriculum as specified in 2005-2007 Catalog, (122.5 credits total)

Semester 1		Semester 2	
Freshman Year			
4	Calculus I	4	Calculus II
3	Eng. Problem Solving w/VBA	3	Engr. Graphics & Design
R	Engineering Orientation	3	First Year Composition II
3	First Year Composition I	3	General Chemistry
4	General Chemistry	1	General Chemistry Lab
1	General Chemistry Lab	0.5	Library 160
	15cr.		14.5
Sophomore Year			
Semester 3		Semester 4	
3	Differential Equations	3	Thermodynamics of Materials
5	Introduction to Materials Science	3	Structural Characterization of Mat.
5	Classical Physics I	5	Classical Physics II
		3	Engineering Statics
		3	Gen Ed Elective
	13cr		17 cr.
Junior Year			
Semester 5		Semester 6	
2	***Professional Practice I***	3	Computational Methods in Matls.
3	Kinetics and Phase Equilibria	3	Mechanical Behavior of Matls.
3	Specialization 1a*	3	Specialization 1b
3	Specialization 2a	3	Specialization 2b
3	Mechanics of Materials	3	Gen Ed Elective
3	Gen Ed Elective		
	17 cr.		15 cr.
Senior Year			
Semester 7		Semester 8	
2	***Professional Practice II***	2	***Professional Practice III***
3	Specialization 1c	3	Specialization 1d
3	Specialization 2c	3	Specialization 2d
3	Gen Ed Elective	3	Gen Ed Elective
3	Technical elective	3	Technical elective
3	Free elective		
	17 cr.		14 cr.

* Specialization courses are discussed immediately below

Materials Engineering Specializations

At approximately the second semester of their sophomore years, all Materials Engineering Students choose **two** specializations from among Metallic, Ceramic, Electronic, and Polymeric Materials. The student takes four courses in each of his or her two specializations. The specialization courses were referred to above with figurative identifiers, are listed literally below in table B4.3

Table B4.3 Specialization Courses organized by Topic

Specialization Area / Course Title	**Mat E Course #**	**Credits**
Ceramic Materials		
Introduction to Ceramic Science	321	3
Ceramic Processing Forming and Firing	322	3
Glass Science and Engineering	423	3
Ceramic Industries	424	3
		12 Total
Electronic Materials		
Intro. to Electronic Materials	331	4
Semiconductor Materials	332	3
Advanced Electronic Materials	433	3
Microelectronics Fabrication	432	4
		***14** Total*
Metallic Materials		
Metals Processing and Fabrication	341	3
Structure / Properties Rel. Met.	342	3
Ferrous Metallurgy	443	3
Corrosion and Failure Analysis	444	3
		12 Total
Polymeric Materials		
Introduction to Polymeric Materials	351	3
Polymers and Polymer Engineering	442	3
Physical and Mechanical Properties of Polymers.	453	3
Polymer Composites and Processing.	454	3
		12 Total

Relationship of Professional Component to Objectives and Outcomes
Table B4.4 shows a summary of the professional component distribution, objectives, and outcomes contributed by each course in the program. The syllabi for these courses appear in Appendix IB.

Table B4.4 Summary of Professional Component, Objectives and Outcomes for All courses in the Mat E Program. MatE specific core courses are listed in GREEN, and Specialization courses are listed in their assigned colors (see table B4.3).

Course	Prof Comp (Cred)	Obj.	Outcomes	**Course**	Credits -Prof	Obj.	Outcomes
(Department, Number, Title)				(Department, Number, Title)	Comp		
Engl. 104 First Year Comp. I	GE (3)	C	g, i, j	MatE 316 Comp. Meth. in Mat.	ET (3)	ADE	a, b, d, e, g, k, o
Engl 105 First Year Comp. II	GE (3)	C	g, i,j	MatE 318 Mech Behav. of Mat.	ET (3)	AE	a, b, e, g, k-o, r
Engr. 101 Engr. Orientation	GE (R)	AD	f, g	***MatE 414 Sr. Capstone Design***	ET (2)	ABCD	a, p, r
Library 160 Lib. Instruction	GE (3)	D	i, k	MatE 321 Intro. Ceramic Science	ET (3)	ACE	a, e, g, i, k-m, p
Engr. 160 Engr. Prob. W/Fortran	ET (3)	ABC	a, d, e, g,	MatE 322 Ceramic Processing	ET (3)	ACE	a-c, e, k-o, r
Engr 170 Eng. Graphics and Design	ET (3)	ABC	a, b, d, f, g, k,	MatE 423 Glass Science and Engr.	ET (3)	ACE	a-c, e, g, i-o, r
Math 165 Calculus	MS (4)	AE	a	MatE 424 Ceramic Industries	ET (3)	ABD	a, e-n
Math 166 Calculus II	MS (4)	AE	a	MatE 331 Intro. to Electronic Mat.	ET (4)	ACE	a, b, d, e, g, h, k-o, r
Math 266 Elem. Diff. Eq.	MS (4)	AE	a	MatE 332 Semiconductor Mat.	ET (3)	AE	a, c, e, i, j, l-n
Chem 177 General Chem&Lab	MS (5)	AC	a, b, e, k, l	MatE 433 Adv. Elect. Mat.	ET (3)	AE	a, c, e, h-j, l-n
Chem 178 General Chem&Lab	MS (4)	ACE	a, b, e, k, l	MatE 432 Microelect. Fab.	ET (4)	ACDE	a, b, d, g, h, j-m, o, r
Phys 221 Class. Phys. I	MS (5)	AE	a, b, e, k, l	MatE 341.Metals Proc. And Fab.	ET (3)	ACE	a-e, k-m, r
Phys 222 Class. Phys. II	MS (5)	AE	a, b, e, k, l	MatE 342 Stuct./Prop. Relat. Met.	ET (3)	ACE	a-c, e, g, k-o, r
EM 274 Statics of Engineering	ET (3)	AE	a, e ,k, l	MatE 443 Ferrous Metallurgy	ET (3)	ACE	a-c, e, g, I, j, l-n, p
EM 324 Mechanics of Mat.	ET (3)	AE	a, e ,g, i, l	MatE 444 Corr. and Failure Anal.	ET (3)	ACE	a, b, e-g, k-o, r
MatE 313/413 Prof. Practice	ET (4)	ABCD	a-p, r	MatE 351 Intro. to Polym. Mat.	ET (3)	AE	a, h, j-o
MatE 211 Intro. to MSE	ET (5)	ACE	a, b, d, e, g, k-o, r	MatE 442 Polym. & Polym. Engr.	ET (3)	ACE	a, b, d, e, g, k-o, r
MatE 212 Thermo in Mat.Sci.	ET (3)	AE	a, e, k-m,	MatE 453 Phys and Mech Prop Polymers	ET (3)	ACE	a, e, l-n
MatE 214 Structural Characterization of Materials	ET (3)	ACE	a, b, g, k-m, o, r	MatE 454 Polym Composites and Processing	ET (3)	AE	a, b, d, e, g, j-o
MatE 315 Kinetics and Phase Equilibria in Materials	ET (3)	AE	a, e, g, k-m, o	Gen Ed. Electives	GE (15)	BCD	h, i, j
Free Elective	(3)	*	*	Tech Electives	6-	‡	*

GE = General Education, MS = Math/Basic Science, ET = Engineering Topics *Assignment will vary according to student selection
‡ Could be Math/Basic Science or Engineering Topic as defined in Table B3.1

Additional information regarding the sequence and prerequisite structure is presented in the flow sheet in Figure B4.2. The flow sheet indicates prerequisites and pictorially represents courses within the major, within specializations, lab courses, required and elective courses, all arranged according the usual course sequence. The curriculum is shown in tabular form in Table B4.2

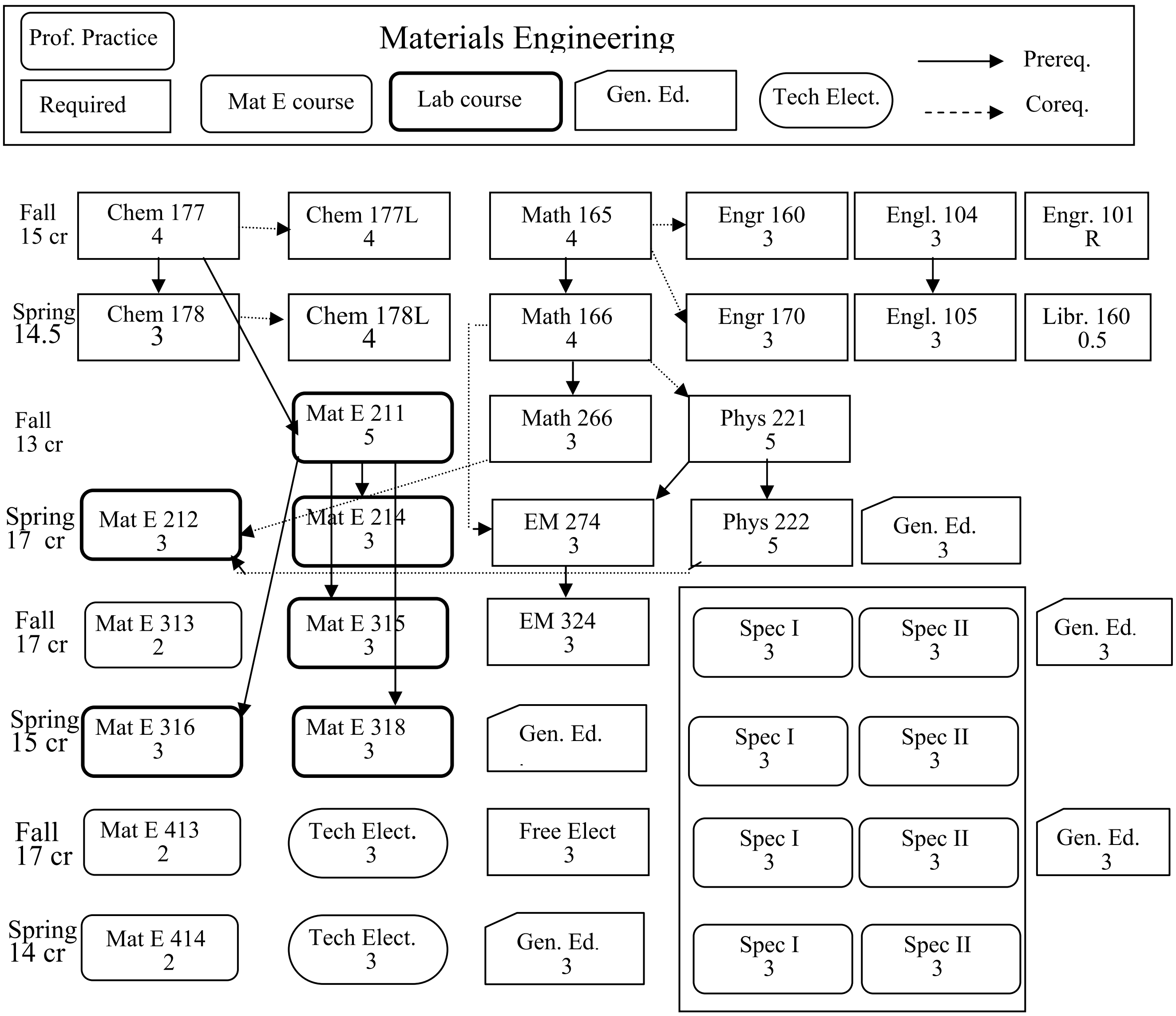


Table B4.2 shows the Math and Basic Science, Engineering and Design, and General Education areas by credit.

5. Faculty

The faculty of the Materials Science and Engineering Department represent a diversity of curricular and research expertise, educational and industrial backgrounds, and cultures. Appendix IC provides a current summary of curriculum vitae for all faculty.

In this section:

- Competency to Cover all Curricular Areas
- Faculty Interaction with Students
- Adequacy of Size of Faculty
- Faculty Evaluation

are addressed briefly.

Competency to Cover all Curricular Areas:

The faculty composition is summarized in Table B5.1 with respect to rank and primary and secondary area of expertise.

Teaching Preferences for all required courses in the program.

Because most faculty are flexible in the courses they can teach, it is possible to review adequacy of faculty by considering which faculty can teach each course in the curriculum. Table B5.2 shows the depth of "coverage" for each required course in the program. Each faculty selected either 1st preference (they are currently willing and prepared to teach the course) or 2nd preference (they are willing to teach with some preparation). A faculty member could also select "not appropriate to teach". Note that all courses are well covered with the exception of Mat E 431 Semiconductor Fabrication. This course is co-listed with Electrical Engineering which also has several faculty capable of teaching the course.

Responsibility Chart for the Materials Engineering Program

The faculty are ultimately responsible for the undergraduate program. Figure B5.1 shows how this responsibility is distributed among the faculty.

Table B5.1 Summary of areas of expertise of the faculty

	Name	**Title**	**Primary Area**	**Secondary Area**
MA	Akinc, Mufit	Professor	Ceramic processing	Polymers
IA	Anderson, Iver	Adj. Prof.	Powder Metallurgy	Physical Metallurgy
BB	Biner, Bulent	Adj. Assoc. Prof.	Mechanical Metallurgy	Computational Mat. Sci.
SC	Chumbley, Scott	Professor	Metallurgy	Structural Charact., EM
AC	Constant, Alan	Lecturer	Semiconductor Processing	Electronic Properties
KC	Constant, Kristen	Assoc. Prof.	Photonic Materials	Ceramic Processing
MC	Conzemius, Michael	Assoc. Prof.*	Veterinary Medicine	Biomaterials
LG	Genalo, Larry	Professor	Materials Education	Computational Methods
BG	Gleeson, Brian	Professor	Physical Metallurgy	Oxidation, Corrosion
KG	Gschneidner, Karl	Distinguished Prof	Physical Metallurgy	Electronic, magnetic prop.
DJ	Jiles, David	Collaborator	Magnetic Properties	Non-destructive evaluation
MK	Kessler, Michael	Asst. Prof.	Polymer Matrix Composites	Polymer Processing
MJK	Kramer, Matt	Adj. Assoc. Prof.	Materials Characterization	Mechanical Properties
MJKu	Kushner Mark	Professor*	Electronic Materials	Plasma Processing
ZL	Lin, Zhiqun	Asst. Prof.	Polymer Characterization	Polymer Physics
SM	Mallapragada, Surya	Assoc. Prof.*	Polymer Processing	Biopolymers

HM	Martin, Hogan	Lecturer	Materials Characterization	Materials Processing
SM	Martin, Steve	Professor	Glass Proc. & Characterization	Photonic Materials
WM	McCallum, William	Adj. Professor	Magnetic Materials	Materials Processing
TM	McGee, Tom	Professor	Bioceramics	Glass, Refractories
RN	Napolitano, Ralph	Assoc. Prof.	Physical Metallurgy	Thermodynamics
VP	Pecharsky, Vitalij	Professor	Materials Characterization	Magnetic/electronic prop.
KR	Rajan, Krishna	Professor	Materials Characterization	Computational Methods
AR	Russell, Alan	Professor	Physical Metallurgy	Processing of Alloys
MS	Selby, Martha	Adj. Asst. Prof.	Metallic Materials	Materials Education
JS	Snyder, John	Adj. Asst. Prof.	Electronic Materials	Thin Films
XT	Tan, Xiaoli	Asst. Prof.	Electronic Materials	Materials Characterization
PT	Thiel, Patricia	Distinguished Prof.*	Surface Chemistry	Materials Chemistry
BT	Thompson, Bruce	Distinguished Prof.	Non-destructive Evaluation	Materials Properties
RT	Trivedi, Rohit	Distinguished Prof.	Physical Metallurgy	Thermodynamics
VT	Tsukruk, Vladimir	Professor	Phys. & Chem. Polymers	Microelectromech. systems
EU	Ustundag, Ersan	Assoc. Prof.	Micromechanics of Matls.	Materials Characterization

*Courtesy Appointment

TABLE B5.2 Teaching Preferences of Materials Engineering Faculty

Teaching Preferences		
Course # and Title	**1st Preference**	**2nd Preference**
Engr. 101 Intro. to Engineering	SM, TM, MA, BG, RT, KC, AC, MS	VP, LG, SC, AR
Mat E 211 Introduction to Materials Science and Engineering	SM, BG, MA, TM, AR, RT, KC, AC, HM	VP, SC, MS
Mat E 212 Thermodynamics in Materials Engineering	VP, SM, BG, MA, RN, KR	TDM, RT, AC, KR
Mat E x13 Integrated Materials Design	SM, KC, MA, HM	SC, BT, BG, AR, AC, KR
Mat E 214 Structural Characterization of Materials	VP, SM, SC, TM, KR, HM, KR	MA, BG, AR, RT, KC
Mat E 315 Kinetics and Phase Equilibria in Materials	SM, MA, BG, TM, VP, RN, KR	RT, KC, AC
Mat E 316 Computational Methods in Materials	VP, LG, RT, SWM, KR	KC, AC, RN
Mat E 318 Mechanical Behavior of Materials	XT, EU, TM	SC, BG, AR
Mat E 414 Materials Engineering Design	SM, SC, KC, KR	VP, BG, AR, TM, AC
Mat E 321 Intro. to Ceramic Science	SM, KC, MA,	EU, HM
Mat E 322 Intro. to Ceramic Processing	KC, TM, MA,	SM
Mat E 423 Glass Science & Engineering	SM, TM	MA, KC
Mat E 424 Advanced Ceramic Engineering	SM, TM, AC	MA, KC
Mat E 331 Introduction to Electronic Materials	SM, KC, AC, XT	VP, BG, RT
Mat E 332 Semiconductor Materials and Devices	AC, XT, VD*	VP, BG, RT
Mat E 432 Microelectronic Fabrication Techniques	AC, VD*, GT*	
Mat E 433 Advanced Electronic Materials	SM, AC, XT	VP
Mat E 431 Introduction to Microelectronics Fabrication	AC, GT*	
Mat E 341 Metals Process. & Fabrication	AR, RN, RT,	VP, SC, BG
Mat E 342 Struc./Prop. Rel. in Metals	VP, BG, AR	SC, BT, KR
Mat E 443 Ferrous Metallurgy	BG, RN, AR	VP, SC, RT, KR
Mat E 444 Corrosion and Failure Analysis	BG, RN	SC
Mat E 351 Intro. Polymeric Materials	VT, MK, ZL	SM, MA, AC, HM
Chem E. 442 Polymers & Poly. Eng.	VT, ZL. BN*	MK
Mat E 453 Phys.&Mech. Prop. Polymers	MK, VT, ZL	MK, MA
Mat E 454 Polymer Composites & Proc.	VT, MK, ZL	

*VD: Vikram Dalal, GT: Gary Tuttle, ECpE, BN: Balaji Narasimhan, Chem Eng.

<u>Faculty interactions with students</u>

MSE faculty are actively engaged with students in a number of ways. Table B5.3 summarizes the involvement of faculty with students. Appendix IA summarizes the faculty workload including teaching and other responsibilities and activities.

Table B5.3 Involvement of selected faculty with students in advising, service and professional development and in interactions with industry.

Faculty	**Activity I**	**Activity II**
Akinc, Mufit	Department Chair	International Exchange Programs Faculty Advisor for Keramos
Chumbley, Scott	Student Affairs, International Exchange Programs	Career Assistance, Mentor, Materials Advantage faculty advisor
Constant, Alan	Advisor, Student Affairs	Student mentor
Constant, Kristen	Internship/Co-op Programs, Undergrad Studies, Honors Advisor	Placement, Mentor
Genalo, Larry	Asst. Chair, Undergrad Studies, Recruiter	Minority student Programs, Mentor
Martin, Hogan	Advisor,	Mentor
Martin, Steve	Mentor,	Gaffer's Guild Club advisor
Selby, Martha	Lead Advisor	Scholarships and awards
Ralph Napolitano	Student Affairs	Mentor, Materials Advantage faculty advisor

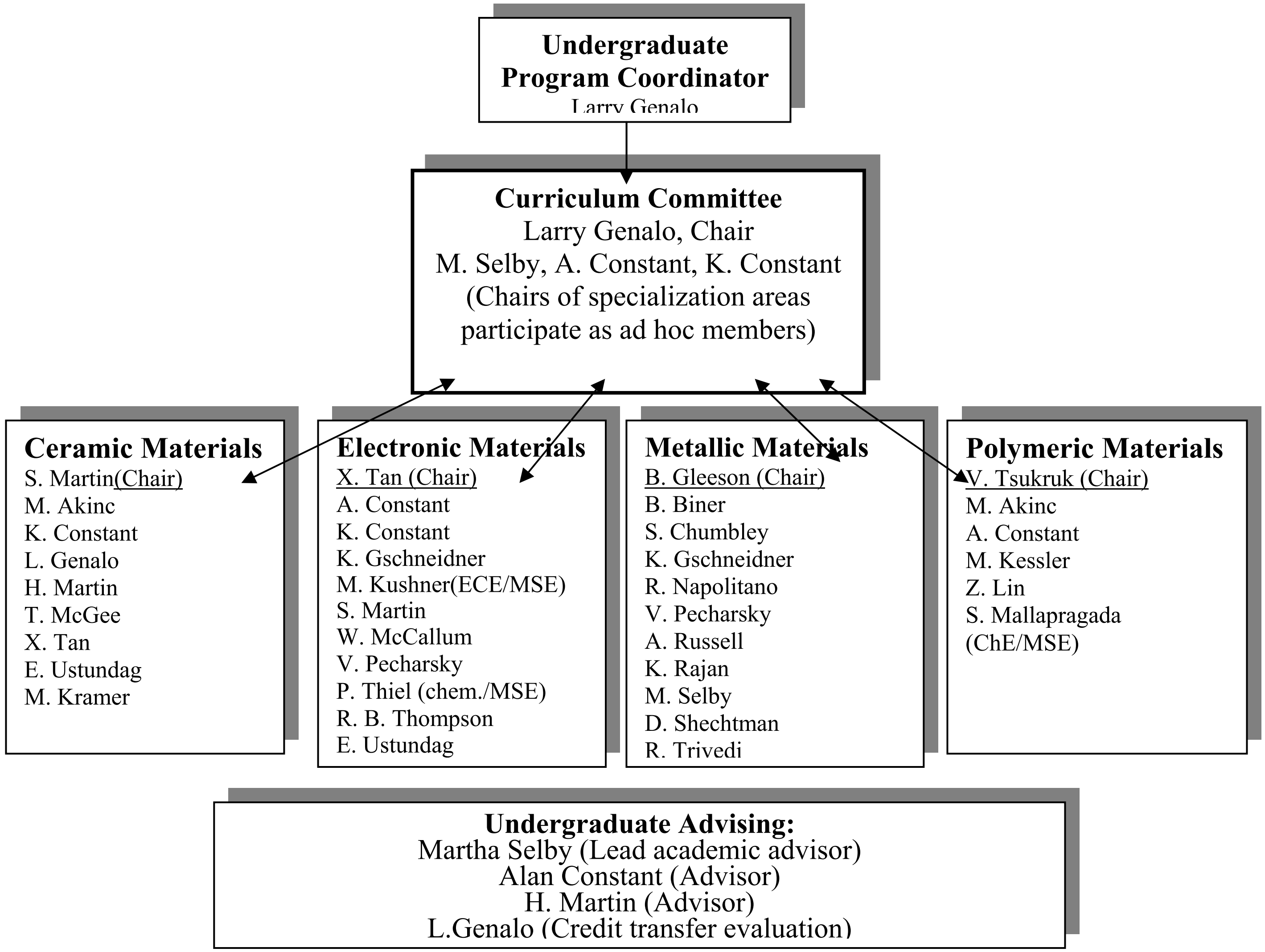


Figure B5.1 Responsibility Chart for the Undergraduate Program

Adequacy of Size of Faculty

With 22 budgeted and eight adjunct faculty, the MSE department is one of the larger Materials programs in the country. In addition, a number of researchers at Ames Laboratory, the Microelectronics Research Center, and the Center for Non-destructive Evaluation provide additional materials resources to our program both in research collaboration and teaching.

The MSE faculty is a dynamic group. Almost half of the faculty have been hired since the last ABET visit. This high turnover has allowed us to consider the needs of our constituencies and our revised programs as part of our selection criteria.

Adjunct Faculty

The MSE department is uniquely placed to make use of expertise of neighboring scientists at Ames Laboratory. A number of these scientists and engineers are adjunct faculty with the department. Adjunct faculty go through the same interviewing process as tenure-track faculty prior to appointment and are subject to the same evaluation criteria after appointment. Adjunct faculty occasionally teach classes, and frequently mentor graduate and undergraduate students in the research laboratory. Adjunct faculty usually attend faculty meetings and provide valuable input. They have the same voting rights as budgeted faculty except in personnel decisions and undergraduate curricular matters.

Faculty Evaluation

Faculty in MSE submit a yearly self-evaluation of their performance based on the performance objectives outlined in Section B2. Additionally, faculty discuss plans for improvement in each area in which they have responsibility (as outline by a Position Responsibility Statement). This document is used as a basis for discussion in a yearly performance coaching with the department chair. In this way the chair can monitor faculty growth and balance the needs of the department and the individual.

6. Facilities

Since the last review the MSE department has moved into 20,000 sq ft of new space in the Hoover Hall complex, the newest building on the engineering complex equipped with state-of-the-art lecture and instructional facilities. We have been fortunate to retain almost all of the space previously held in Gilman Hall, and much of this space has been renovated. Thus, the department currently has almost double the available space that existed at the time of the last review.

In this section:

- Classroom and Laboratory Space
- Computing and Information Infrastructures
- Laboratory Equipment
- Opportunities for Student Use of Modern Engineering Tools.

Classroom Space

The materials science and engineering department is assigned classroom space through the office of space and scheduling using standard university procedures. Most department undergraduate classes are held in new classrooms in Hoover Hall, equipped with built-in computer projectors, document cameras, and wireless Internet access, which allow faculty to quickly plug in their laptops for computer-based instruction. A few classes are held in Howe Hall, which is similarly equipped.

Laboratory Space

The bulk of the teaching laboratory space has been consolidated in Hoover Hall. Dedicated laboratories exist under the following designations:

- Mechanical Properties and Thermal Analysis
- Scanning Microscopy and X-ray Diffraction
- Materialography and Sample Preparation
- Polymer Processing and Properties
- Thermal Processing and Heat treatment
- Electronic Properties
- Materials Processing

Additionally, research equipment and laboratory space is often utilized for teaching undergraduates, particularly in the capstone design course. Most laboratory space serves multiple courses due to the emphasis on hands-on laboratory classes that the department maintains.

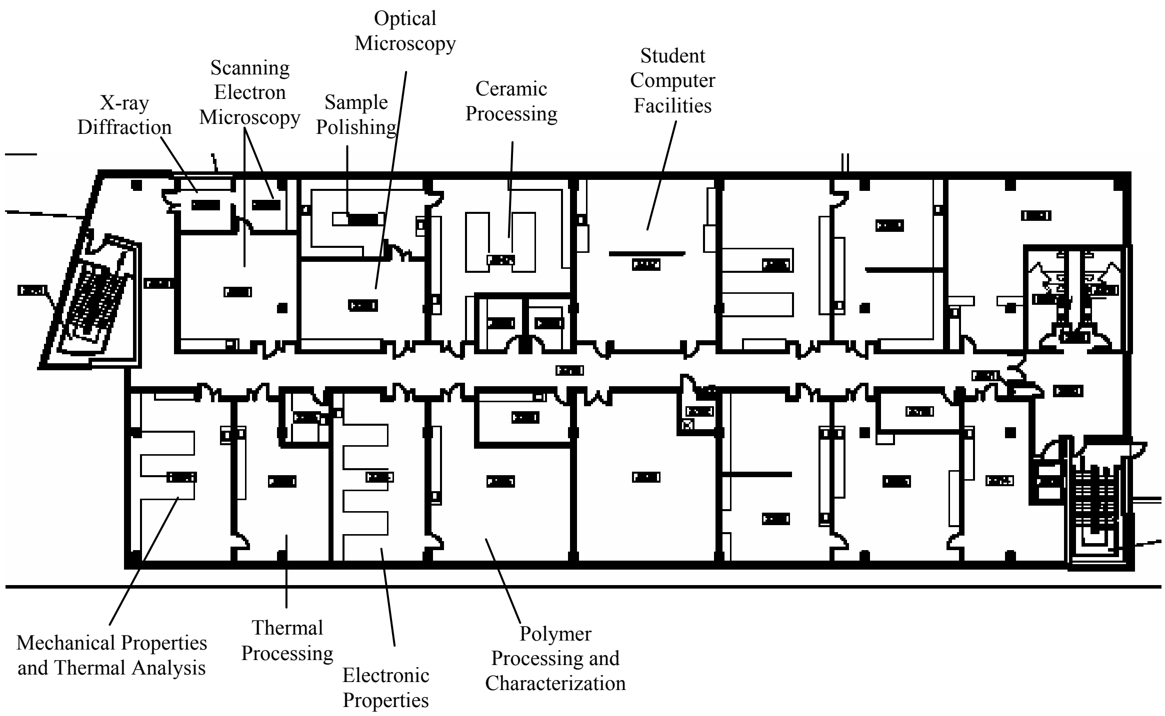
A single undergraduate laboratory remains in Gilman Hall, the metallurgy foundry used in conjunction with Mat E 341: Metals Processing and Fabrication. This laboratory recently moved into a larger room to accommodate the increase in enrollment, and the facilities have been upgraded including a larger casting area, more storage space, a new gas-fired furnace, and additional ancillary equipment.

Computing and Information Infrastructures

The MSE department provides computing resources to students on two levels. At the first level, much of the departmental teaching equipment is controlled by computer workstations. This includes devices such as the thermal analysis equipment, x-ray diffractometer, etc., which use proprietary software packages for data acquisition and analysis, and equipment (e.g. furnaces, the Instron) where the department has developed its own computer control interface. Special computing resources in this category include the computer-based SEM teaching laboratory. On a second level students are provided with personal computing resources by maintaining a common student workroom. This student room is fully equipped with computers, printers, and scanners for use by all students. Specific software packages used in various MSE classes are on these computers as well as general word processing, graphing, and drawing packages. Students have access to this room 24 hours per day through a key card access system. All of the computers are linked to the engineering domain so students can access their own personal profile from any computer at any time.

Since all of the new facilities in Hoover are fully equipped with projection systems, a large number of departmental classes have lectures and notes placed on web pages using WebCT, the university supported, web-based instructional support system. WebCT has a number of useful features including allowing posting of notes, class discussion of topics, grades, etc. This useful system enables the instructor to maintain communication with students outside of normal class meeting times. Web access is also possible and videos and animations are also frequently used classroom tools. The department also owns and maintains a number of stand-alone projector systems that are used heavily by students when traveling to companies involved in design projects.

A joint faculty/student computer committee oversees the student room as well as the remainder of the department computer resources. The student computer room is maintained using student computer fees paid as part of their tuition. The department provides half-time salary support for a staff member of the engineering computer support services who sees that the computers are kept in working condition. The committee decides on new purchases. Faculty and student requests are solicited each fall to ensure that the equipment and software will meet the needs of the curriculum. Laboratory computer equipment that is used for both research and teaching purposes (such as the thermal analysis equipment, XRD, SEM etc.) is maintained jointly using user fees charged to research contracts and from departmental resources.



Laboratory Equipment

The MSE department has an excellent inventory of equipment for use in teaching classes. This equipment is inventoried yearly, and the Facilities and Equipment Committee regularly reviews needs for upgrading, repairing, replacement and new equipment. Due to the recent move to Hoover, approximately $2.4 million worth of equipment was purchased by or donated to the department within the last three years. This has resulted in laboratory facilities that are rivaled by few, if any, materials programs in the nation. The inventory of new equipment includes:

- State-of-the-art SEM laboratory and upgraded x-ray diffraction facility
- Fully equipped materialography laboratory containing automatic polishing equipment, computer controlled microhardness testing facilities, and 12 fully equipped student optical microscopes
- Modern heat treatment facilities covering temperatures from room T to 1500˚ C
- Extensive thermal analysis, polymer characterization, and mechanical property testing equipment.
- Equipment for electronic property measurement and non-destructive testing

Along with purchase of the equipment, new guidelines for use of the equipment by research groups have been developed to ensure that the equipment is maintained on a regular basis. Hourly or per sample fees are assessed to anyone using the equipment for research purposes. Equipment used by design is also charged an hourly rate billed to the supporting company. This, in turn, provides a fund for equipment repair, maintenance and purchase of supplies.

Opportunities for Student Use of Modern Engineering Tools.

Students have ample opportunity to develop proficiency with a variety of modern engineering tools. The department has always stressed hands-on instruction as an important part of education, and students are required to take a large number of laboratory credits. While the actual number may vary depending upon which particular specialization path is chosen, all specializations require from one to four dedicated lab classes in addition to the 5 core labs required by the department. Additionally, students are exposed to laboratory work in Engr. 160, 170, both chemistry courses, and physics courses.

Computer-based tools:
Computer use is required throughout the curriculum, and students achieve a high level of proficiency with standard word processing, spreadsheet and graphics programs. Additionally, students are often required to use presentation programs, web-design tools and communication tools. Some courses require computer aided design and analysis. A variety of specialized software tools, (e.g. materials selectors, mold design for casting, etc.) are also used.

Equipment:
In addition to computer-based tools, students are required to operate a variety of materials processing and characterization equipment. The recent move of the department to new facilities in Hoover Hall was accompanied by a considerable upgrading of the equipment available for student use. Much of the equipment is employed in several classes so the students have ample opportunity to hone their skills before graduation. For example, in the case of the metals specialization, the SEM might be used in sophomore level Mat E 214, junior level Mat E 318, Mat E 341, and senior level Mat E 444 and Mat E 414 design. Occasionally, research equipment is used by undergraduates for special class projects, especially for engineering practice projects.

Many students gain additional experience with sophisticated research equipment and software working as undergraduate research assistants. A large number of students are employed either by the department or through the close ties the department maintains with the Ames Laboratory.

Use of Modern Engineering Tools in the Materials Engineering Program

Course No.	Title	Use of Modern Engineering Tools
Engr. 160	Engineering Problem Solving	Programming, Spreadsheets, Graphing Calculator for Statistics
Engr 170	Engineering Graphics	CAD, CAM
Chem 177, 178L	General Chemistry Lab	Chemical Analysis Equipment
Mat E. 211	Intro. Materials Sci. & Eng.	Heavy computer use: word processor and spreadsheets. furnaces and thermocouples, xrd,
Mat. E. x13	Integrated Materials Design	Cambridge Materials Selector Software, equipment varies with project
Mat. E. 214	Structural Charac. Materials	Fast Scanning Diffractometer, TGA, DTA, DSC, DMA, SEM, Quantitative Microscopy, EDS
Mat. E. 316	Computational Methods in Matls.	Design of Experiments, Mathematical Computations (finite differencing, finite elements, 3D visualization, matrices, tensors)
Mat. E. 318	Mechanical Behavior of Matls.	Computer controlled Instron, Impact Tester, Creep Testing
Mat. E. 322	Ceramic Processing- Forming-Firing	Tape Caster, Injection Molder, surface area analyzer, particle size analyzer, pycnometer LabView, optical and IR pyrometry, temperature measurement and furnace control.
Mat. E. 331	Intro. Electronic. Prop. Matls.	Current sources, electrometers, voltmeters, capacitance bridge, I-V curve tracer, oscilloscopes,
Mat. E. 341	Metals Processing & Fabrication	Casting and welding practices, theory and modeling of solidification and casting, analytical modeling of rolling, extrusion, forging
Mat. E. 342	Struc./Prop. Relations. In Metals	Microstructural characterization equipment, SEM, Cambridge Materials Selector, mechanical properties testing (microhardness and tensile testing)
Mat. E. 362L	Non-Destructive Testing Lab.	Dye penetrant testing, magnetic particle testing, x-ray testing, eddy current testing, Ultrasonic testing
Mat. E. 423	Glass Science & Engineering	Data base calculation, management, and use, Programmable furnace operation, Digital data logging, Optical microscopy, UV, IR, thermal expansion, differential thermal analysis, Impedance spectroscopy
Mat. E. 433	Advanced Electronic Mater.	Lab View, computer controlled dielectric property measurement
Mat. E. 443	Ferrous Metallurgy	Hardness testing, XRD, fusion welding, tensile testing, optical microscopy
Mat. E. 444	Corrosion & Failure Analysis	Optical and scanning electron microscopy, hardness testing
Mat. E. 453	Phys. & Mech. Prop. Polymers	Microstructural characterization equipment, SEM, X-ray, GPC, FTIR, DSC, TMA, Instron, optical microscopy, extruder
Mat. E. 454	Polymer Composites and Processing	Demonstration on injection molding, extrusions, compacting

7. Institutional Support and Financial Resources

The department of Materials Science and Engineering at Iowa State University enjoys strong support from the university and the college in fulfilling its mission and serving its students.

Since the last ABET visit in 2000, the university and college have seen major changes in its leadership positions. The current university President, Provost, and Dean were appointed after the last ABET accreditation visit. The current university administration not only provides the leadership but also pays special attention to significant involvement of all constituents in planning and decision-making processes in all aspects of the academic enterprise.
The previous college dean had practiced a de-centralized management system allowing each department to set their academic, administrative and fiscal priorities. The current dean of engineering took the helm in January 2005 with fundamental changes in leadership and management strategy. As clearly articulated in the college strategic plan, the new leadership emphasizes innovation, globalization, impact, and diversity in all aspects of the college affairs. As part of this philosophy, the dean is intimately engaged with each unit's performance and adoption of the new theme. Although the implementation of new policies is evolving, global optimization at the college level with input from various constituents seems to be the philosophy of the new college administration.

In this section, we will briefly describe:

- Process for Determining the Budget for the Program
- Adequacy of Institutional Support and Financial Resources
- Faculty Professional Development
- Resources for Facilities and Equipment
- Personnel and Institutional Services

<u>Process for Determining the Budget for the Program</u>
Annual budget for the department and hence the program is primarily decided by the Dean's office following the review of each department by the dean's team in May. The process, expectations, and format of the review are clearly articulated by the Dean and distributed to each department chair in advance.

<u>Adequacy of Institutional Support and Financial Resources</u>
Institutional support for the department has been excellent in the last five years. The departmental budget has seen a 28% increase since the last ABET visit from approximately $2.15M in FY'00 to $2.75MM in FY'06. Most of this increase was used to fund new faculty hires (including two lecturers). During the same period the total FTE in the department increased approximately 11% from 18.1 FTE in FY'00 to 20.1 in FY'06. On a head-count basis, the number of budgeted faculty increased from 22 to 25, about 14%. In addition, the physical facilities have seen a tremendous improvement. Hoover Hall, became the new home of the MSE department in late 2003. Concomitant with this move, all teaching laboratory equipment was renewed. Estimated total value of

the teaching equipment acquired is about $2.4M. We believe the teaching facilities of the MSE department are one of the best, if not the best, among its peers in the nation. More detail is provided in the Facilities section of this document.

Faculty Professional Development

Faculty professional development is highly encouraged both at the university level and the department level. A number of opportunities exist at the college and university level to attend conferences, workshops, and training sessions on various aspects of teaching activity including, information technology, teaching effectiveness, and distance education as well as specific programs like "Study in a Second Discipline," "Faculty Improvement Leave," and "Administrative Internships." Recently, the college of engineering has been encouraging and arranging opportunities for faculty to have an industrial experience. Performance coaching is key to faculty development as discussed in B5.

A significant portion of the faculty development funds at the departmental level is reserved for new faculty appointments. Within the start-up package, the faculty member has freedom to choose his/her development activity. The department also encourages faculty to participate in workshops on effective teaching, proposal writing, and others offered on the campus by the institution. The department has also provided funds to attend national and international educational, assessment, and leadership conferences and workshops for faculty.

Resources for Facilities and Equipment:

As is evident from Section B6, the laboratory facilities for undergraduate education in the MSE department are excellent. We have been able to provide our students with state-of-the art instruments. It is worth noting that state-of-the-art instruments such as SEM, XRD, thermal characterization (TGA, DSC, TMA, DMA) and Spectroscopy (FTIR, Raman) are regularly used by our undergraduate students starting in the sophomore year.

As mentioned above almost all the teaching equipment is fairly new, acquired in 2003. The sophisticated instruments are under service contract while others are maintained with the annual budget line for equipment repair and replacement. As part of the budget re-allocation process, the department replaced its technician position with a ½-time information technology (IT) specialist. This strategic move is believed to improve the effective use of the funds. Today's technology requires significant IT service while brand new and fully automated instruments reduced the need for technician time. Responsibility for the teaching facilities is assigned to one lecturer. His responsibility includes checking readiness of the instruments for student use each semester. He is the custodian of the departmental equipment and responsible for acquisition of supplies and spare parts, making arrangements for service and repair of the equipment. This system is recent and is currently being evaluated for efficiency and effectiveness. Early indications are positive.

Personnel and Institutional Services:

The personnel for achieving the program objectives can be considered at two levels: departmental and institutional. The department employs one administrative specialist, two secretaries, and one-half an IT specialist to support the academic personnel and students. The department also supports approximately 0.5 -time secretary within the Ames Laboratory system to provide support for the faculty who are housed in the Ames Lab physical facilities. In addition, one graduate student (business major) and several undergraduate students are employed as hourly workers to assist office operations as well as maintaining the computer network and departmental web site. The support provided for the computing environment for the department is derived from a special computer fee, and it provides excellent support for updating and maintaining computers for the department. At the institutional level, the college maintains a computing service unit that also helps the departments when needed. The college also has a number of support units for achieving program objectives. These include, but are not limited to Engineering Career Services, Engineering Undergraduate Programs, Engineering International Programs, and Engineering Publications and Communications Services. A recent addition of an Engineering Leadership Institute director will support the development of leadership skills of both students and faculty.

8. Program Criteria

Curriculum:

The curriculum in Materials Engineering was designed to meet the four program criteria specifically designated for materials. Table B8.1 shows which courses in the materials program contribute to each of the four outcomes, and it also highlights courses in which student evaluations indicate deficiencies in achieving the desired educational outcomes.

- *Outcome l: An ability to apply advanced science and engineering principles to materials systems.*

  To achieve this outcome, it is important to first assure that students have the necessary foundation in chemistry, physics, mathematics, and engineering mechanics (statics and mechanics of materials). We require students to take a year each of chemistry, physics, and engineering mechanics and 3 semesters of mathematics. Facility with application to materials systems is gained through many of the core and specialization courses, as indicated in Table B8.1.

  When assessing the curriculum as a whole, seniors graduating during the 2000-2004 academic years rated themselves as 9.1/10 in having achieved this outcome.

  When assessing the curriculum on a course-by-course basis, Table B8.1 indicates that students feel this outcome objective was achieved (rated 3 or higher on a scale of 1 [did not contribute significantly] to 5 [very significant contribution]) in the 2004-05 academic years for all but two courses:

  Mat E 321, in which the average student rating of this outcome was 2.76
  Mat E 341, in which the average student rating of this outcome was 2.97

  The Mat E 321 course was taught during 2004-05 by a new faculty member who had heavy travel commitments during the semester the course was taught and whose instructor and course ratings were low in several areas. During the 2001, 2002, and 2003 offerings of this course, this outcome was rated 3.76, 4.00, and 3.94. In the 2005-06 academic year, the content of this course was revised substantially, and the course was taught by a different, more senior faculty member. Ratings for Mat E 321 during fall, 2005 were 3.98

  The Mat E 341 course outcome *l* was slightly below 3 in fall 2004. Ratings for Mat E 341 for this outcome during the 2001, 2002, and 2003 academic years were 3.82, 3.65, and 3.25. Ratings for Mat E 341 during fall, 2005 were 3.30. The dip for that year is unexplained, and we will monitor the course carefully in the future.

- *Outcome m: An integrated understanding of the scientific and engineering principles underlying the four major elements of the field (structure, properties, processing, and performance).*

The scientific principles of structure, processing, properties and performance are learned in most core and all specialization courses.

When assessing the curriculum as a whole, seniors graduating during the 2000-2004 academic years rated themselves as 8.9/10 in having achieved this outcome.

When assessing the curriculum on a course-by-course basis, Table B8.1 indicates that students feel this outcome objective was achieved (rated 3 or higher on a scale of 1 [did not contribute significantly] to 5 [very significant contribution]) in the 2004-05 academic years for all but one course:

> Mat E 321, in which the average student rating of this outcome was 2.35

As previously discussed, the 2004 ratings for Mat E 321 were an anomaly. Ratings for Mat E 321 for this outcome during the 2001, 2002, and 2003 academic years were 4.18, 4.13, and 3.63 respectively. Ratings for Mat E 321 during Fall, 2005 were 3.33.

- <u>Outcome n</u>*: An ability to apply and integrate knowledge from each of the four elements of the field (structure, properties, processing, and performance) to solve materials selection and design problems.*

  Selection and Design problems appear in various places in the curriculum, but especially in the 313, 413, and 414 professional practice courses.

  When assessing the curriculum as a whole, seniors graduating during the 2000-2004 academic years rated themselves as 8.9/10 in having achieved this outcome.

  When assessing the curriculum on a course-by-course basis in the 2004-05 academic year, Table B8.1 indicates that students feel this outcome objective was achieved (rated 3 or higher on a scale of 1 [did not contribute significantly] to 5 [very significant contribution]) for all courses.

- <u>Outcome o</u>*: An ability to utilize experimental, statistical, and computational methods consistent with the goals of the program.*

  As shown in Table B6.1, a variety of experimental, statistical and computational methods are used in the Materials Engineering curriculum.

  When assessing the curriculum as a whole, seniors graduating during the 2000-2004 academic years rated themselves as 8.8/10 in having achieved this outcome.

  When assessing the curriculum on a course-by-course basis, Table B8.1 indicates that students feel this outcome objective was achieved (rated 3 or higher on a scale of 1 [did not contribute significantly] to 5 [very significant contribution]) in the 2004-05 academic years for all but one course:

Mat E 351, in which the average student rating of this outcome was 2.32

The Mat E 351 course also had a change in instructor. Ratings for Mat E 351 for this outcome during the 2001, 2002, and 2003 academic years were 4.00, 3.00, and 3.50. Ratings for Mat E 351 during Fall, 2005 were 3.17. We will continue to monitor progress.

B.8.1 Results of Student Assessments of Materials Engineering Program F, '04 & S, '05

	← General Engineering →											Materials				ISU MSE		
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r
PHYSICS 221 and 222(10)	●	●			●													
CHEM 177 and 177L (5)	●	●			●													
CHEM 178 and Lab (4)	●				●													
EM 274 (3)	●				●						●	●						
EM 324 (3)	●				●		●		●			●						
MATH 165,166,266 (11)	●				●							●						
MSE Core (27)	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**	**n**	**o**	**p**	**q**	**r**
Mat E 211 Intro(5)	●	●		●	●		●				●	●	●	●	●			●
Mat E 212 Thermo	●				●						●	●	●					
Mat E 214 Char	●	●					●				●	●	●		●			●
Mat E 315 Kinetics	●				●		●				●	●	●		●			
Mat E 316 Statistics	●	●		●	●		●				●				●			
Mat E 318 Mech Prop	●	●	●	●	●		●	●			●	●	●	●	●			●
Mat E 313 Design (1)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●
Mat E 414 Cap Des (2)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●
Ceramic Materials	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**	**n**	**o**	**p**	**q**	**r**
Mat E 321 Intro Cer Sci	●				●		●		●		●	● (green)	● (yellow)			●		
Mat E 322 Cer Proc	●	●	●		●	●					●	●	●	●	●			●
Mat E 423 Glass	●	●	●		●	●	●		●	●	●	●	●	●	●			●
Mat E 424 Adv Cer	●		●			●		●	●	●	●	●	●	●				
Electronic Materials	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**	**n**	**o**	**p**	**q**	**r**
Mat E 331 Int Elec Mat	●	●		●	●		●				●	●	●		●			●
Mat E 332 Semicon Mat	●		●		●				●	●		●	●	●				
Mat E 433 Adv Elec Mat	●		●		●			●	●	●		●	●	●				
Mat E 432 Microelec Fab	●	●		●			●	●		●	●	●	●		●			●
Metallic Materials	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**	**n**	**o**	**p**	**q**	**r**
Mat E 341 Proc & Fab	●	●	●	●	●						●	● (green)	●					●
Mat E 342 Struc Prop	●	●	●		●		●				●	●	●	●	●			●
Mat E 443 Ferr Met	●	●	●		●		●		●	●		●	●	●		●		
Mat E 444 Corro. &Fail	●	●		●	●		●				●	●	●	●	●			●
Polymeric Materials	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**	**n**	**o**	**p**	**q**	**r**
Mat E 351 Int Poly Mat	●							●		●	●	●	●	●	● (yellow)			
Mat E 352 Phy&Mec Prop	●			●	●		●				●	●	●	●				●
Mat E 442 Pol Engr	●	●		●	●						●	●	●	●	●			●
Mat E 453 Pol&Comp Proc	●				●							●	●	●				
Mat E 454 Ind Pol&Proc	●	●		●	●		●			●	●	●	●	●	●			●
Co-op and/or Intern Experience																	●	

Yellow	Student average < 2.5 (on a scale of 1 to 5)
Green	2.5 < Student average < 3 (on a scale of 1 to 5)

Raw survey data are presented at https://intranet.eng.iastate.edu/mse/default.aspx

Faculty:

The expertise of the MSE faculty is well distributed among the four major elements of materials engineering, as shown in Table B8.2. Note that all four areas are well covered, with faculty identifying their primary area of expertise as performance (4 faculty members), processing (5), properties (7), and structure (14). In addition, three faculty indicated that their expertise lies in educational methods. As faculty retire, careful consideration is given to candidates' affiliation in terms of both class of materials and area of expertise within the four elements of the field. Table B5.1 also gives information related to the depth and breadth of faculty expertise.

Table B8.2 Summary of areas of expertise of the faculty

	Name	Title	Primary Area	Secondary Area
MA	Akinc, Mufit	Professor	Processing	Properties
IA	Anderson, Iver	Adj. Prof.	Processing	Properties
BB	Biner, Bulent	Adj. Assoc. Prof.	Structure	Properties
SC	Chumbley, L. Scott	Prof.	Structure	Properties
AC	Constant, Alan	Lecturer	Processing	Properties
KC	Constant, Kristen	Assoc. Prof.	Structure	Processing
MC	Conzemius, Michael	Assoc. Prof.	Performance	Properties
LG	Genalo, Larry	Prof.	Educational Methods	
BG	Gleeson, Brian	Prof.	Performance	Properties
KG	Gschneidner, Karl	Distinguished Prof.	Properties	Processing
MKe	Kessler, Michael	Asst. Prof.	Properties	Processing
MKr	Kramer, Matt	Adj. Prof.	Structure	Processing
MKu	Kushner, Mark	J./K. Melsa Prof.	Properties	Structure
ZL	Lin, Zhiqun	Asst. Prof.	Structure	Properties
SMal	Mallapragada, Surya	Assoc. Prof.	Structure	Properties
MM	Martin, M. Hogan	Lecturer	Educational Methods	Structure
SMar	Martin, Steve	Prof.	Structure	Properties
WM	McCallum, R. William	Adj. Prof.	Properties	Processing
TM	McGee, Tom	Prof.	Processing	Performance
RN	Napolitano, Ralph	Assoc. Prof.	Structure	Processing
VP	Pecharsky, Vitalij	Prof.	Structure	Properties
KR	Rajan, Krishna	Prof.	Structure	Properties
AR	Russell, Alan	Prof.	Performance	Properties
MS	Selby, Martha	Adj. Asst. Prof.	Educational Methods	
DS	Shechtman, Dan	Prof.	Structure	Properties
JS	Snyder, John	Adj. Asst. Prof.	Processing	Properties
XT	Tan, Xiaoli	Asst. Prof.	Properties	Structure
PT	Thiel, Patricia	Distinguished Prof.	Structure	Properties
BT	Thompson, R. Bruce	Distinguished Prof.	Performance	Properties
RT	Trivedi, Rohit	Distinguished Prof.	Structure	Processing
VT	Tsukruk, Vladimir	Prof.	Structure	Properties
EU	Ustundag, Ersan	G. Murphy Prof.	Properties	Structure

Appendix I Additional Program Information

A. Tabular Data for Program

Table 1	Basic level Curriculum
Table 2	Course and Section Size Summary
Table 3	Faculty Workload Summary
Table 4	Faculty Analysis
Table 5	Support Expenditures

Table 1. Basic Level Curriculum
Materials Engineering

Semester	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Sciences	Engineering Topics Check Contains Design	General Education.	Other
1	Math 165 Calculus I	4	( )		
1	Engr. 160 Engr. Prob. W/Fortran		3( )		
1	Engr. 101 Engr. Orientation		( )		
1	Engl. 104 First Year Comp. I		( )	3	
1	Chem 177 General Chemistry	4	( )		
1	Chem 177L Lab In Gen. Chem	1	( )		
1	Library 160 Lib. Instruction		( )		0.5
2	Math 166 Calculus II	4	( )		
2	Engr 170 Eng. Graphics and Introductory Design		3(x)		
2	Engl 105 First Year Comp. II		( )	3	
2	Chem 178 General Chemistry	3	( )		
2	Chem 178L Lab in Gen. Chem	1	( )		
3	MatE 211 Intro. to MSE		5( )		
3	Phys 221 Class. Phys. I	5	( )		
3	Math 266 Elem. Diff. Eq.	3	( )		
4	MatE 212 Thermo in Mat.Sci.	3	( )		
4	MatE 214 Structural Characterization of Materials		3( )		
4	Phys 222 Class. Phys. II	5	( )		
4	EM 274 Statics of Engineering		3( )		
4	Gen Ed Elective[1]		( )	3	
5	MatE 313 Prof. Practice		2(x)		
5	MatE 315 Kinetics and Phase Equilibria in Materials		3( )		
5	MatE Specialization A1[1]		3( )		
5	MatE Specialization B1[1]		3( )		
5	EM 324 Mechanics of Mat.		3( )		
5	Gen Ed Elective[1]		( )	3	
			( )		

(continued on next page)

Table 1. Basic-Level Curriculum (continued)
Materials Engineering

Year; Semester	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Science	Engineering Topics Check if Contains Design	General Ed.	Other
6	MatE 316 Computational Methods in Materials		3(x)		
6	MatE 318 Mech Behav. of Mat.		3( )		
6	MatE Specialization A2 [1]		3( )		
6	MatE Specialization B2		3( )		
6	Gen Ed Elective[1]		( )	3	
7	MatE 413 Prof. Practice		2(x)		
7	MatE Specialization A3[1]		3( )		
7	MatE Specialization B3 [1]		3( )		
7	Gen Ed Elective[2]		( )	3	
7	Free Elective[3]		( )		3
7	Technical Elective I[4]		3( )		
8	MatE 414 Prof. Practice		2(x)		
8	MatE Specialization A4[1]		3( )		
8	MatE Specialization B4[1]		3( )		
8	Gen Ed Elective[3]		( )	3	
8	Technical Elective II[4]		3( )		
	TOTALS-ABET BASIC-LEVEL REQUIREMENTS	33	65	21	3.5
	OVERALL TOTAL FOR DEGREE	123.5	123.5	122.5	
	PERCENT OF TOTAL	26.9%	53.1%	17.1%	
Totals must satisfy one set	Min. sem. cr. hours	32 hrs	48 hrs		
	Minimum percentage	25%	37.5 %	17%	

[1]Specialization Courses

Ceramic Materials

Mat E 321 Introduction to Ceramic Science
Mat E 322 Introduction to Ceramic Processing
Mat E 423 Glass Science & Engineering
Mat E 424 Advanced Ceramic Engineering

Electronic Materials

Mat E 331 Introduction to Electronic Properties of Materials
Mat E 332 Semiconductor Materials and Devices
Mat E 433 Advanced Electronic Materials
Mat E 432 Microelectronics Fabrication Techniques

Metallic Materials

Mat E 341 Metals Processing and Fabrication
Mat E 342 Structure/Property Relationships in Metals
Mat E 443 Ferrous Metallurgy
Mat E 444 Corrosion and Failure Analysis

Polymeric Materials

Mat E 351	Introduction to Polymeric Materials
Mat E 442	Polymers and Polymer Engineering
Mat E 453	Physical & Mechanical Properties of Polymers
Mat E 454	Polymer Composites and Processing

[2]General Education (Gen Ed) Electives

Materials engineering students are encouraged to select Gen Ed courses that broaden their academic program. Courses in the social sciences (sociology, anthropology, journalism and mass communication, economics, political science, human development and family studies, psychology) or humanities (architecture, literature, foreign language, music, philosophy, religion, history) are especially encouraged.

All materials engineering majors must take 15 credits of Gen Ed courses. The university requirements for U.S. Diversity and International Perspectives must be met, and can be met through the courses selected in the Gen Ed requirement.

Any university course may be selected for Gen Ed requirements except;

1. The course may not be remedial.
2. The course may not be offered in engineering, the physical sciences, computer science, or mathematics.
3. The course may not be one that could have counted as a technical elective (e.g. a 300 level life science may not be used, but a 200 level can be used).
4. No more than 9 credits in 100-level courses
5. No more than 9 credits may be taken from any one department
6. A 6-credit area of emphasis is required (does not have to be in the same dept. e.g. Phil 235 Ethical Issues in a Diverse Society and Mgmt 472 Management of Diversity)
7. No “skills” courses (such as PE classes in golf, pool, etc. or music courses in playing an instrument or participating in band, choir, etc.)

[3]Free Electives

The free elective may be chosen from any University credit course, technical or non-technical that is not considered remedial. The "spirit" of the free elective is that it provides students with "space" in the curriculum to pursue a broadening experience, be it drama or advanced solid state physics that might not otherwise fit in their programs.

The policy of the Engineering College (and of the MSE department) is that courses required to remediate a high school deficiency (e.g. Math 142, Chem 150, etc.) cannot be applied as "free elective" credits.

[4]Technical Electives

Guidelines for Technical Electives in Materials Science and Engineering:

Materials Science is a diverse field and there are many options for appropriate technical electives. Most fall in the following categories, however, if the student finds a course that is appropriate for a free elective but is not on the list, he/she can take the course with consultation from his/her advisor and approval of the curriculum committee.

1. Any 300 or 400 level Math, Physical or Life Sciences, or Engineering course not in Materials Engineering.
2. Any graduate level course in Math, Physical or Life Sciences, or Engineering, including Materials Science and Engineering.
3. Any 300 or 400 Materials Engineering Specialization Course NOT in designated specializations.
4. An advisor can approve a 300-400 level business course if proposed as part of a professional plan (e.g. a goal of having a technical sales or marketing career).
5. Math 265.

Table 2. Course and Section Size Summary

Materials Engineering Fall 05, Spring 06

Course No.	Title	Sections in Curr. Year	Avg. Section Enrollment	Type of Class			
				Lecture	Lab.	Rec.	Other
Mat E. 211	Intro. Materials Sci. & Eng.	3	13	4	3		
Mat E 212	Thermodynamics in Mat. Eng.	1	32	3	0		
Mat. E. 214	Structural Charac. Materials	3	10	2	3		
Mat. E. 272	Prin. Mat. Sci. & Eng.	3	140	2			
Mat. E. 313	Professional Practice	1	35	1	3		
Mat. E. 315	Kinetics & Phase Equil. in Matls.	1	37	3	0		
Mat. E. 316	Computational Methods in Matls.	1	35	2	2		
Mat. E. 318	Mechanical Behavior of Matls.	2	18	2	3		
Mat. E. 321	Intro. to Ceramic Science	1	27	3	0		
Mat. E. 322	Intro. to Ceramic Processing	1	14	2	3		
Mat. E. 331	Intro. Electronic. Prop. of Matls.	2	10	3	2		
Mat. E. 332	Semiconductor Matls. & Devices	1	43	3	0		
Mat. E. 341	Metals Processing & Fabrication	2	16	2	3		
Mat. E. 342	Struc./Prop. Relations. In Metals	2	16	2	3		
Mat. E. 351	Intro. to Polymeric Materials	1	30	3	0		
Mat. E. 362	Prin. of Non-Destructive Testing	1	40	3	0		
Mat. E. 362L	Non-Destructive Testing Lab.	1	25	0	3		
Mat. E. 370	Toying with Technology	2	13	2	2		
Mat. E. 413	Professional Practice	1	30	0	6		
Mat. E. 414	Professional Practice	1	26	0	6		
Mat. E. 423	Glass Science & Engineering	1	26	2	3		
Mat. E. 424	Advanced Ceramic Materials	1	31	3	0		
Mat. E. 432	Microelectronic Fabrication Tech.			2	4		
Mat. E. 433	Advanced Electronic Materials	1	10	2	3		
Mat. E. 442	Polymers & Polymer Engineering	1		3	0		
Mat. E. 443	Ferrous Metallurgy	1	35	2	3		
Mat. E. 444	Corrosion & Failure Analysis	1	31	2	2		
Mat. E. 453	Physical & Mech.Prop of Polymers	1	13	2	3		
Mat. E. 454	Polymers Composites &Processing	1	11	3	0		

Table 3. Faculty Workload Summary

Materials Engineering

Faculty Member	Base	FT/PT	Classes Taught	Total Activity Distribution*		
			Course No. (Credit Hours)-term year	Teaching	Research	Other
Akinc, Mufit	B	FT	101(R)-F05	15	35	50 (administration)
Chumbley, Scott	B	PT	534(3)-F05, 444(3)-S06, 391(3)-S06	50	50	Ames Lab.
Constant, Alan	B	FT	272(2)X3-F05 S06, 331(4)-F05,424(3)-S06	80	0	20 (advising)
Constant, Kristen	B	FT	321(3)-F05,X13(4)-F05,414(3)-S06	50	50	
Genalo, Larry	B	FT	ENGR160H(3)-F05, 370(3)X2-F05 S06, 316(3)-S06, Hon302(2)-F05	50	25	25 (administration)
Gleeson, Brian	B	PT	315(3)-F05	20	30	50(Ames Lab. Admin.)
Gschneidner, Karl	3/4A	PT		6	69	Ames Lab
Kessler, Mike	B	FT	ENGR160(3)-S06	50	50	New hire
Lin, Zhiqun	B	FT	351(3)-F05, 453/553(3)-S06	50	50	
Martin, Hogan	B	FT	211L(1)-F05,ENGR160(3)X2-F05 S06,214(3)-S06	80	0	20 (advising)
Martin, Steve	A	FT	423(3)-F05, 533(3)-S06	50	50	
McGee, Thomas	1/2B	PT	322(3)-S06,580(3)-S06	50	0	Phased retirement
Napolitano, Ralph	B	FT	443(3)-F05,341(3)-F05,212(3)-S06	50	50	Ames Lab.
Pecharsky, Vitalij	B	PT	535(3)-F05	50	50	Ames Lab .
Rajan, Krisna	B	FT	501(3)-F05	50	50	New hire
Russell, Alan	B	FT	211(4)-F05, 342(3)-S06	50	50	
Selby, Martha	B	FT	ENGR160(3)x4-F05 S06	80	0	20 (advising)
Shechtman, Danny	1/2B	PT		0	50	Shared - Technion Institute.
Tan, Xiaoli	B	FT	433(3)-F05,318(3)-S06	50	50	
Thompson, Bruce	A	PT	362(3)-S06	10	40	50 (admin.-CNDE)
Trivedi, Rohit	B	PT		50	50	On leave- Ames Lab.
Tsukruk, Vladimir	B	FT	454/554(3)-F05,515(3)-S06	50	50	
Ustundag, Ersan	B	FT	541(3)-F05,502(3)-S06	50	50	

* A number of faculty members have a continuous appointment with Ames Lab or CNDE which pays part of their academic salary

Table 4. Faculty Analysis

Name	Rank	FT or PT	Highest Degree	Institution from which Highest Degree Earned Year	Years of Experience			Prof. Regi-stration	Level of Activity (high, med, low, none) in:		
					Govt./Indust. Practice	Total Faculty	This Institution		Prof. (Society)	Research	Consulting/ Work in Industry
Akinc Mufit	**Prof.**	**FT**	**Ph.D.**	**ISU '77**	**3**	**29**	**25**		**Medium,** ACerS, NICE, MRS, TMS	**Medium**	**Low**
Chumbley, Scott	**Prof.**	**PT**	**Ph.D.**	**U. Illinois U-C, '86**	**14**	**14**	**19**		**Low** TMS/ASM, EMSA, MRS	**high**	**Low**
Constant, Alan	**lecturer**	**FT**	**Ph.D.**	**Northwestern U., 87**	**4**	**7**	**12**		**None**	**Low**	**Medium**
Constant, Kristen	**Assoc. Prof.**	**FT**	**Ph.D.**	**Northwestern U., 90**	**1**	**14**	**13**		**Low** ASEE, MRS, ACerS, TMS	**Medium**	**None**
Genalo, Larry	**Prof.**	**FT**	**Ph.D.**	**ISU, 77**	**1**	**33**	**33**		**Medium** ASEE, AMS	**Medium**	**Low**
Gleeson, Brian	**Prof**	**PT**	**Ph.D.**	**UCLA, '89**	**5**	**14**	**8**		**Medium** TMS/ASM, MRS	**high**	**Medium**
Gshneidner, Karl	**Dist. Prof.**	**PT**	**Ph.D.**	**ISU, 57**	**28**	**28**	**35**		**High** TMS,ASM, AIME, MRS,ACS,APS,IEEE	**High**	**Medium**
Kessler, Michael	**Asst. Prof.**	**FT**	**Ph.D.**	**U. Illinois U-C, '02**	**0**	**4**	**1**		**Medium** ASME, SAMPE, SAE, ASEE, SEM, NATAS	**high**	**Low**
Lin, Zhiqun	**Asst. Prof.**	**FT**	**Ph.D.**	**U. Mass. '02**	**0**	**2**	**2**		**Low** APS, MRS, ACS	**high**	**None**
Martin, Michael	**lecturer**	**FT**	**Ph.D.**	**Cornell U. '93**	**1**	**5**	**5**		**None**	**None**	**None**
Martin, Steve	**Prof.**	**FT**	**Ph.D.**	**Purdue U., '86**	**0**	**20**	**20**		**Medium** ACerS, ASEE, MRS, ECS, ISSSI	**High**	**Medium**
McGee, Thomas	**Prof.**	**PT***	**Ph.D.**	**ISU, '61**	**8**	**50**	**50**	**IOWA**	**Medium** ASEE, ACerS, NICE,	**Low**	**Low**
Napolitano, Ralph	**Assoc. Prof.**	**FT**	**Ph.D.**	**Georgia Tech., '96**	**13**	**6**	**6**		**Medium** TMS, ASM, MRS, ASEE, ISS, MSE, AAAS	**High**	**Low**
Pecharsky, Vitalij	**Prof.**	**PT**	**Ph.D.**	**Lviv U., Ukraine, '79**	**6**	**17**	**7**		**Low,** ICDD, TMS, ASEE	**High**	**Low**

Table 5. Support Expenditures

(Materials Science & Engineering)

Fiscal Year	1 2004 (prior to previous year)	2 2005 (previous year)	3 2006* (current year)	4 2007 (year of visit)
Expenditure Category				
Operations[1] (not including staff)	506,553	287,171	278,741	278,741
Travel[2]	57,045	89,104	24,081	24,081
Equipment[3]	595,931	513,740	420,044	420,044
Institutional Funds	49,926	111,777	122,935	122,935
Grants and Gifts[4]	546,005	401,963	297,109	297,109
Graduate Teaching Assistants	64,003	22,158	52,771	52,771
Part-time Assistance[5] (other than teaching)	104,341	82,582	54,514	54,514

*The current fiscal year reflects actual expenditures through January 2006 and estimated expenditures through the remaining fiscal-year end.

B. Course Syllabi