2011-2012 Annual Assessment Impact Report

College of Engineering and Applied Sciences

The individual department assessment impact reports can be found in the appendices.

The strength of assessment efforts in the College of Engineering and Applied Sciences include:

1. Assessment of student learning outcomes of the undergraduate programs – During Fall 2011, the College was visited by the Computing Accreditation Commission, Engineering Accreditation Commission, and (Engineering) Technology Accreditation Commission of ABET to evaluate the Computer Science: Theory and Analysis, Aeronautical Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Construction Engineering, Electrical Engineering, Industrial and Entrepreneurial Engineering, Mechanical Engineering, Paper Engineering, Engineering Design Technology, Engineering Management Technology, and Manufacturing Engineering Technology programs. The evaluation findings indicate student learning outcome assessment has met the criteria.

2. Involvement of CEAS faculty in ABET accreditation evaluation and student learning outcome assessment – The College of Engineering and Applied Sciences supported its faculty in professional development and staying current in student learning outcome assessment and ABET accreditation. This is accomplished through faculty participation in workshops, seminars, and conferences organized by ABET and engineering and computer science professional societies, and through participation as ABET program evaluators.

The challenges of assessment efforts in the College of Engineering and Applied Sciences include:

1. Assessment of the graduate programs – Assessment of the graduate programs in the College of Engineering and Applied Sciences has been uneven since graduate program assessment plans were developed in 2009: some programs have conducted assessment and are using the results for continuous improvement; some have collected assessment data and are currently in the process of synthesizing the results; and some programs plan to initiate assessment in 2012-13.

2. Unevenness in using an electronic repository for student learning outcome assessment – Some departments are using TracDAT or developed its own electronic repository (e.g., ftp) for student learning outcome assessment. For these departments, the task of submitting annual assessment impact report is relatively straightforward and easy. Other departments are not using or have kept up entry in TracDAT; for them, the task of creating the department assessment impact report is more laborious.

3. Using TracDAT to meet ABET accreditation reporting requirement – ABET accreditation criteria require programs to report assessment of program educational objectives (how the graduates are performing a few years after graduation) and student learning outcomes (what the students are able to perform upon completion of program). The current format of TracDAT poses a challenge to programs to use it to document and as a repository for both criteria.

   Furthermore, ABET is moving toward the use of Performance Criteria in assessing student learning outcomes. Some departments in the College of Engineering and Applied Sciences initiated the practice of Performance Criteria in assessing student learning outcomes during the 2011 ABET evaluation cycle. The challenge will be adapting TracDAT as a repository to evolving accreditation practices of ABET.

Appendix I – Department of Civil and Construction Engineering Assessment Impact Report

1. What are the student learning outcomes for each program within the department?

   The student learning outcomes for each program within the CCE department are reported in TracDAT.

2. Which student learning outcomes were measured in each year of the report (2010-2011 and 2011-2012 for this report) and how were they measured?

   The student learning outcomes measured for this report and how they were measured are reported in TracDAT.

3. Summarize the key findings for each year of the report, described the changes that were made due to those findings and how the unit will determine if the changes improved learning.

   Key findings for each year of the report, the changes that were made due to the findings, and the metric (benchmark) the program used to determine if changes improved learning are reported in TracDAT.

   In summary, student learning outcomes in both civil and construction engineering programs were achieved by meeting most metrics. The unmet metric was one of ten metrics in outcome L (Graduates are able to explain basic concepts in management, business, public policy, and leadership). The metric requires 75% of students receive at least a 70% or better in the cost-benefit analysis assignment in CCE 4300, but only 62.5% of students were met the requirement. Since those who had taken Engineering Economy, IME 3100, did better in this assignment, requiring Engineering Economy as a prerequisite to CCE 4300 was discussed. After the discussion, faculty concluded to make the final decision next year after observing one more year. Therefore, no specific improvements were required or made during this academic year.

   The CCE department will be initiating graduate program assessment starting 2012-2013 AY. No formal graduate assessment has been performed for the current year.

Department of Computer Science Western Michigan University Assessment Report – July 2012

Program Educational Objectives

Computer Science – Theory and Analysis

1. Graduates will be employable and successful in a variety of professional computing positions.
2. Graduates will possess backgrounds which qualify them to pursue graduate study in computer science.
3. Graduates will exhibit knowledge and skills sufficient for continued intellectual growth in computing.
4. Graduates will possess an awareness and understanding of social and ethical issues in computing.
5. Graduates will be able to communicate orally and in writing.
6. Graduates will be able to work collaboratively with others.

Computer Science General

1. To produce graduates with breadth and depth in computer science sufficient for intellectual growth in the computing discipline.
2. To produce graduates with knowledge and skills sufficient to be employable and successful in a variety of professional computing positions.
3. To produce students with experience in team and collaborative work.
4. To produce students the opportunity for extended study in an area of specialization.

Program Learning Outcomes

Computer Science – Theory and Analysis

a) an ability to apply knowledge of computing and mathematics appropriate to the discipline
b) an ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
c) an ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
d) an ability to function effectively on teams to accomplish a common goal
e) an understanding of professional, ethical, legal, security and social issues and responsibilities
f) an ability to communicate effectively with a range of audiences
g) an ability to analyze the local and global impact of computing on individuals, organizations, and society
h) recognition of the need for and an ability to engage in continuing professional development
i) an ability to use current techniques, skills, and tools necessary for computing practice
j) an ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices
k) an ability to apply design and development principles in the construction of software systems of varying complexity

Computer Science General

The learning outcomes for the Computer Science General Option are largely the same as those of the Theory and Analysis Program; however, there is a diminished emphasis on the more theory related outcomes 2 and 10. In addition, students in this program experience less coverage of oral communications and global impact of computing since they do not take COM 1040 and CS 4980.

Master’s Program

Courses in the M.S. program will provide the following outcomes:

- Ma – demonstrated ability to interpret core theoretical concepts in computer science;
- Mb – demonstrated ability to apply fundamental algorithms and data structures to problem domains;
- Mc – demonstrated ability to analyze problem tractability;
- Md – demonstrated ability to synthesize ideas and select techniques applicable to different circumstances;
- Me – demonstrated specialized knowledge in focus area;
- Mf – preparedness to obtain employment in specialized area;
- Mg – ability to design complete software systems oriented toward particular problems;
- Mh – demonstrated ability to develop, test and manage software systems;
- Mj – ability to determine the veracity and value of published information;
- Mk – ability to synthesize published research ideas.

Ph.D. Program

Courses in the Ph.D. program will provide the following outcomes:

- Pa – demonstrated competency in core knowledge;
- Pb – demonstrated ability to effectively communicate research knowledge;
- Pc – demonstrated specialized knowledge in focus area;
- Pd – preparedness to obtain employment in specialization field;
- Pe – ability to conduct original research projects;
- Pf – ability to develop a research program;
- Pg – demonstrated ability to develop, test and manage software systems.

Measurement of Learning Outcomes

All learning outcomes (a through k) were measured in 2010/2011. The primary techniques used for measuring these were the Faculty Course Assessment Reports (FCARs), Student Exit Interviews, and survey of past graduates of the Theory and Analysis program. The survey of past graduates focused more on educational objectives than on learning outcomes.

In the 2011/2012 cycle the majority of effort was on formalizing a plan and schedule for measurements of the outcomes through the next six years. The plan is complete, and regular assessment will resume in the 2012/2013 year.

The following table maps outcomes to goals and specifies measures for the Master's Program.

Goal	Expected Outcomes	Measures
Provide core theoretical knowledge of computer science foundations	M{a,b,c,d}	• Course-embedded measures • Program requirements
Foster understanding of computer science core concepts	M{a,b,c,d}	• Course-embedded measures • Program requirements
Integrate concepts across computer science fields	M{j,k}	• Interdisciplinary projects and research
Gain in-depth knowledge of at least one computer science sub-discipline	M{e,f,g,h,j,k}	• Fifteen hours (minimum) at the 6000 course level
Foster problem solving skills	M{a,b,c,d,e,f,g,h,k}	• Program requirements • Course outcomes
Introduce research development ability	M{e,j,k}	• Program requirements (M.S. project option, M.S. thesis option) • Course outcomes (e.g., CS 5950, 6030, 7100)
Apply fundamental tools and techniques	M{b,c,d,e,f,g,h,j,k}	• Course-embedded measures

The following table maps outcomes to goals and specifies measures for the Ph.D. Program.

Goal	Expected Outcomes	Measures

Goal	Expected Outcomes	Measures
Gain advanced breadth knowledge of computer science	P{a,d}	• Qualifier exams • Program requirements • Course embedded measures
Gain in-depth knowledge of at least one computer science sub-discipline	P{c,d,e,f,g}	• Qualifier exams • Program requirements
Develop extensive research ability	P{a,b,e,f}	• Dissertation • Program requirements • Publications
Apply specialized tools and techniques	P{d,e,g}	• Dissertation • Qualifier exams • Program requirements

Summary of Findings

The following table summarizes the results obtained from the FCAR reports for class taught in the 2010/2011 year. This table was also presented to our ABET/CAC evaluators. It provides a comparison with 2009/2010.

Percentages of Unacceptable Measures

ABET Outcome	2009-10 (Percent)	2010-11 (Percent)	Comment
a	21	23	Needs improvement.
b	25	18	Criterion met
c	25	15	Criterion met
d	14	6	Criterion met
e	12	8	Criterion met
f	12	16	Criterion met
g	NA	14	Criterion met
h	19	11	Criterion met.
i	14	14	Criterion met
j	32	16	Criterion met
k	11	9	Criterion met

Exit interviews for the 2010/2011 report we actually taken in the preceding year.   Here is a summary of the major findings in the exit interviews.

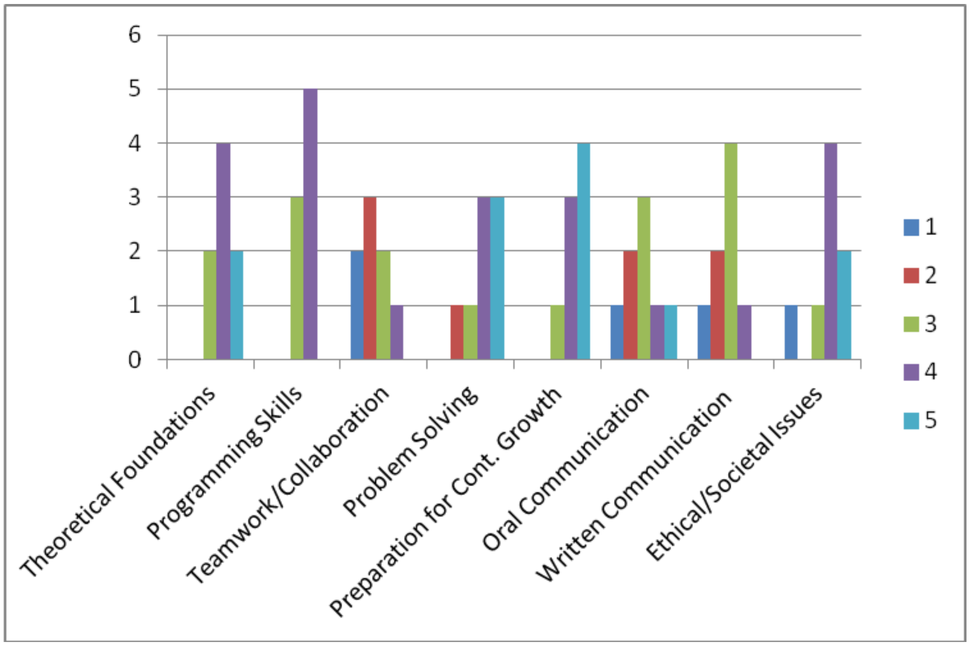
Observations from Spring 2009 Exit Interviews (3 students from the Theory and Analysis, and 8 from the General Major.

- Eight of the students were looking for employment, including 4 who reported having jobs at the time.
- None of the students had applied to graduate school, and one was planning to.
- Two of the students, one in each major, were members of a professional organization (IEEE).
- All eleven reported that courses were offered with sufficient frequency.
- Eight reported that they had sufficient access to instructors and teaching assistants.
- Regarding library usage, 2 reported that they used the library only while researching for papers or oral presentations. Nine reported that they hardly ever used the library.
- On average students reported that they did teamwork in 3.7 courses.
- All students reported having experience with an IDE and debugger. Nine reported use of version control system(s).

Observations from Fall 2009 and Spring 2010 - Exit Interviews (2 students from the Theory and Analysis, and 23 from the General Major.

- Both students in the Theory and Analysis program applied for graduate study. Currently, one is in the master's program in computer science at Western Michigan University, and the other is in a bioinformatics program at the University of Michigan.
- Both of the Theory and Analysis graduates reported membership in ACM and IEEE, while only two of the remaining 23 reported a professional membership.
- The average number of years to completion among all students was 6.1. The two in Theory and Analysis reported 5 and 13 years. The extended time for the latter was for personal reasons and changing majors.
- Nineteen of the students, including both Theory and Analysis majors, reported that courses were offered with sufficient frequency.
- All students reported sufficient access to faculty and teaching assistants.
- Four students, including one of the Theory and Analysis majors, reported using the library for researching papers and oral presentations, while 20 reported that they hardly ever used the library.
- On average graduates from the Theory and Analysis reported team work in 4.5 courses, and graduates from the general major reported an average of 3.5.
- Use of IDEs, debuggers, and version control systems were reported by 24, 23, and 23 (respectively) graduating seniors, and these included both Theory and Analysis graduates. Four reported use of a profiler, and twelve reported use of a documentation tools.

The following chart summarizes the numerical responses form graduates on the listed key items. These were on a scale of 1 to 5 (weak to strong).



Considering a response of 1 or 2 to be unsatisfactory, we obtain the following percentages.

Skill/Preparation	Satisfactory	Unsatisfactory
Theoretical Foundations	100%	0%
Programming Skills	100%	0%
Teamwork/Collaboration	37.5%	62.5%
Problem Solving	87.5%	12.5%
Preparation for Continued Growth	100%	0%
Oral Communication	62.5%	37.5%
Written Communication	62.5%	37.5%
Ethical/Societal Issues	87.5%	12.5%

We also had a meeting of our Advisory Board in April of 2012. With that input and results from above, the following summarize recent and projected changes.

In the most recent years the following changes have been instituted at the undergraduate level:

- Increased coverage of the C language in CS 2230;
- Increased tutoring access for students in CS 2230;
- Addition of database coverage in the core curriculum;

Proposed/Upcoming plans for change:

- Make database concepts a significant portion of the curriculum;
- Work on improvement of learning outcome a;
- Eliminate the Computer Science General Major program;

- Revise the Theory and Analysis program to bring it into line with new criteria for accreditation; This actually will enable reducing or altering some of the requirements, particularly in science and mathematics.
- Introduce a new program in information technology which is very hands-on and applied.
- Introduce discrete structures class oriented toward computer science.

Graduate Program Recommendations

In the past year our department has focused on program planning and formal measurements for the graduate program outcomes were not done. Program planning is ongoing, with a scheduled review in November of 2012. Highlights of potential recommendations from our external reviewer are listed below. These will be given consideration as we progress.

Masters

- Streamline and simplify the 4000, 5000, and 6000-level classes;
- Simplify the M.S. program requirements.

Ph.D.

- Aim for quality rather than quantity.
- Aim for a Ph.D. program size where all the active students in good standing are fully supported for at least 4-5 years.
- Aim for increased fund raising from corporate sponsors or individual donors to generate a fellowship pool for the department.
- Modify/clarify the course credit rules specified for the program.
- Modify/clarify qualifying requirements for the program.

Summary of Key Changes

At the undergraduate level, we have instituted the following changes:

- Added more coverage of the C programming language in CS2230, and provided increased tutoring by qualified students for students confronted with learning C in CS 2230. The effectiveness of this will be measured via FCARs, input from the instructor, and feedback from students, both informal and via exit interviews with graduating seniors.
- In response to both faculty and Advisory Board input, we added a required database component. Initial feedback regarding the database component is that it currently is not sufficient and consistent. New plans for program changes call for increasing even more this component, perhaps even requiring a course in database. (Currently our course in database is optional.) The effectiveness of this cannot be measured until it is fully in place. It will be done via FCARs, faculty input, Advisory Input, and student input.
- The effectiveness of changes to improve Outcome (a) will be done via Faculty Course Assessment Reports. We will work toward lowering the unsatisfactory rating so that it is below the 20% threshold.

- Changes in the Theory and Analysis program will be measured via maintenance of ABET/CAC accreditation of that program.
- The addition of a new program in Information Technology will involve the establishment of educational objectives and learning outcomes, which will be measured when the program is implemented. While we won't begin with ABET accreditation as a requirement for the program, our plan is for it to evolve to an accredited program.

At the graduate level a number of changes designed for improvement of both the master's program and the Ph.D. program have been suggested. They are listed above. Many of these constitute tasks to be done, and the measurement will be whether or not the changes have been instituted. At the current time, measurements of the effectiveness of the others have not been established; however, as we proceed with changes, we will identify outcomes and measurements and carry those out.

Appendix III – Department of Electrical and Computer Engineering Assessment Impact Report

1. What are the student learning outcomes for each program within the department?

   The student learning outcomes for each program within the ECE department are reported in TracDAT.

2. Which student learning outcomes were measured in each year of the report (2010-2011 and 2011-2012 for this report) and how were they measured?

   The student learning outcomes measured for this report and how they were measured are reported in TracDAT.

3. Summarize the key findings for each year of the report, described the changes that were made due to those findings and how the unit will determine if the changes improved learning.

   Key findings for 2010-2011, the changes that were made due to the findings and the metric the program used to determine if changes improved learning are reported in TracDAT.

   For undergraduate programs, based on the assessment data gathered, a key finding was that for the most part the programs are achieving their outcomes. Those instances where we were not resulted in the introduction of a new programming course in the electrical engineering program, the adoption of a rule that students must achieve a C or better in all prerequisite courses to be admitted to a course and that at least 16 hours ECE course work must be completed at WMU to be awarded the degree. Student's success rate in post requisite courses and in the course that uses the new programming course will be used to determine if the changes improve performance

   Outcomes for our graduate programs are assessed every 3 years and were assessed in the 2011-12 AY and the findings showed that for the most part, outcomes were being achieved. The process did however result in the following recommendations for change:

   1. Improved screening of student records prior to admission;
   2. Refinement of the process to insure that each graduate student completes an annual review with a faculty.

   Determination of effectiveness of these changes will be via assessment of achievement the program's outcomes over the next 3 year cycle.

Appendix IV – Department of Industrial and Manufacturing Engineering Assessment Impact Report

1. What are the student learning outcomes for each program within the department?

The Student Outcomes for each program are as follows.

BSE: The *Bachelor of Science in Industrial and Entrepreneurial Engineering (IEE)*.

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 multidisciplinary 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 understanding of the entrepreneurial process and how to design, develop, and bring new products and processes to market.

BS: The *Bachelor of Science in Engineering Management (UEM)*

a. Ability to select and apply the knowledge, techniques, skills, and modern tools of their disciplines to broadly-defined engineering technology activities.
b. Ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies.
c. Ability to conduct standards tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes.
d. Ability to design systems, or processes for broadly-defined engineering technology problems appropriate to program educational objectives.
e. Ability to function effectively as a member or leader on a technical team.
f. Ability to identify, analyze, and solve broadly-defined engineering technology problems.
g. Ability to communicate effectively regarding broadly-defined engineering technology activities.
h. An understanding of the need for and an ability to engage in self-directed continuing

professional development.
i. An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity.
j. Knowledge of the impact of engineering technology solutions in a societal and global context.
k. Commitment to quality, timeliness, and continuous improvement.

BS: The *Bachelor of Science in Engineering Design Technology (EDT)*

a. Ability to select and apply the knowledge, techniques, skills, and modern tools of their disciplines to broadly-defined engineering technology activities.
b. Ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies.
c. Ability to conduct standards tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes.
d. Ability to design systems, or processes for broadly-defined engineering technology problems appropriate to program educational objectives.
e. Ability to function effectively as a member or leader on a technical team.
f. Ability to identify, analyze, and solve broadly-defined engineering technology problems
g. Ability to communicate effectively regarding broadly-defined engineering technology activities.
h. An understanding of the need for and an ability to engage in self-directed continuing professional development.
i. An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity.
j. Knowledge of the impact of engineering technology solutions in a societal and global context.
k. Commitment to quality, timeliness, and continuous improvement.

BS: The *Bachelor of Science in Manufacturing Engineering Technology (MFT)*.

a.	Ability to select and apply the knowledge, techniques, skills, and modern tools of their disciplines to broadly-defined engineering technology activities
b.	Ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies
c.	Ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes
d.	Ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives
e.	Ability to function effectively as a member or leader on a technical team
f.	Ability to identify, analyze, and solve broadly-defined engineering technology problems
g.	Ability to communicate effectively regarding broadly-defined engineering technology activities
h.	An understanding of the need for and an ability to engage in self-directed continuing professional development
i.	An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity
j.	Knowledge of the impact of engineering technology solutions in a societal and global context
k.	Commitment to quality, timeliness, and continuous improvement

PhD: The *Doctor of Philosophy in Industrial Engineering*

The student outcomes of the Industrial Engineering PhD program are to:

1. Demonstrate knowledge of appropriate course work by successfully completing the comprehensive exam

2. Demonstrate individual research capability by proposing a research topic

3. Successfully complete and defend the dissertation.

MS/E Program/Curricula

The student outcomes for each of the three IME master's degree programs consist of the demonstration of an understanding of the content in the core courses required by each degree. This includes 6 courses for the Industrial Engineering and Engineering Management programs and 5 courses for the Manufacturing Engineering program.

2. Which student learning outcomes were measured in each year of the report (2010-2011 and 2011-2012 for this report) and how were they measured?

Undergraduate Student Outcomes are primarily measured using the performance criteria specified under each of the program educational objectives (PEOs). Each Student Outcome has several performance criteria used for assessment. The relationships among PEOs, Student Outcomes, performance criteria, and methods of assessment are clearly displayed in the SLO chart. The primary method of assessing Student Outcomes is through the use of Performance Report Summaries (PRS). Course coordinators generate a PRS for selected cells of the SLO chart corresponding to their course(s). For this past ABET general review, we have generated PRSs for all cells containing assessments in the SLO charts. These assessments are course-specific items and include: homework assignments, quizzes, exam questions, case studies, semester projects, senior projects, and laboratory work.

To illustrate the use of the SLO chart, consider Student Outcome "b" from the IEE Program. Student Outcome b is: "An ability to design and conduct experiments, as well as to analyze and interpret data." There are three performance criteria assessed for this outcome: B1 - Gathers and uses data to assess processes and products; B2 - Uses experiments and their results to improve a process; and B3 - Uses decision making tools to analyze or improve a process or system.

The table below shows how each of these three performance criteria for Student Outcome b is assessed in the IEE program by course and assessment item. (Note that the "80/70" and similar notations are shorthand for "80% of the students scored 70% or higher on the associated assessment item." These measures are the performance targets, not the actual student performance.)

Performance Criterion	Course	Activity
B1 - Gathers and uses data to assess processes and products.	IME 2050	Time Study Assignment 80/70
B1 - Gathers and uses data to assess processes and products.	IME 2610	Descriptive Stat and Graphical Assessment 75/70
B1 - Gathers and uses data to assess processes and products.	IME 2620	Control Chart Assessment 80/70
B2 - Uses experiments and their results to improve a process.	IME 3300	Semester Project Report 70/75
B3 - Uses decision making tools to analyze or improve a process or system.	IME 4160	Forecasting Lab 80/70

Note that Student Outcome b is measured in five distinct places in the IEE program. Each student outcome (*a* - *l*) is measured using this same procedure for each of the undergraduate programs. See the SLO charts for each program for the complete assessment plans. The record year, 2010-11, is the first academic year subject to the SLO chart-based assessment processes. As such, we targeted the measurement of all cells in the SLO charts. From this point forward, we plan to assess each cell in the SLO chart at least every three years. This will ensure that all cells are assessed during the six-year ABET review cycle. What follows is the assessment data for each undergraduate program based on the discussion above.

Evidence that the department uses to track the PhD student outcomes includes: i) the percentage of students that successfully pass the comprehensive exam, ii) the percentage of students that successfully propose a research topic, and the percentage of students that successfully complete the dissertation.

Because the IME masters degree programs are designed to prepare a student to go into professional practice or into a PhD program, the Student Outcomes for each of the IME masters degree programs were developed to make sure that every graduate has the required knowledge for their respective career direction. This required knowledge base is housed in each programs core courses. It is the expectation of the program faculty that a student should achieve a B or better in each program core course to demonstrate a high level of mastery of all student outcomes. Thus, the department uses the percentage of students that achieve a B or better in all core courses as a metric to monitor our graduates' level of mastery.

3. Summarize the key findings for each year of the report, described the changes that were made due to those findings and how the unit will determine if the changes improved learning.

BSE-IEE Results

The analyses of the IEE student outcomes suggests good performance overall. However, based on the current pass through the continuous improvement cycle, the student outcome analyses identified opportunities for improvement in both our teaching and our assessment methods/metrics. Some key findings from the analyses of the student outcomes were as follows:

- Ensure metrics are calibrated correctly. With this being our first pass through the complete assessment cycle using our new PRS system, some metrics were initially set too high and some metrics were set too low. In some cases, this was due to the instructor's expectations not being reflective of a student's performance on the assigned task, especially in the case of a new assignment. More realistic targets are being set which will still maintain student success with the associated outcome.
- Instructors recognized the need to cover example problems in their entirety, rather than focusing on subsets of the problem. Additionally, some situations call for multiple examples of the same concept. This provides a more systemic view of the problem-solving and tool selection processes.
- When one assignment requires the successful completion of a previous assignment, the assignments must be spaced so that the student has appropriate feedback prior to preparing the next assignment. While this is not always possible, it is important that we identify critical places in the IEE curriculum where this must be upheld.
- More detailed instructions for assignments, presentations and reports are needed. Several instructors mentioned that critical elements of assignments were omitted by students due in part to the fact that students did not perceive the importance or the need to include the

item in their assignment. In most cases, the recommendation was to write better instructions for the associated assignment.

- Two specific student outcomes (*h*. and *i*.) will be monitored closely to track student attainment of satisfactory levels of performance. Low performance was mostly due to student's placing emphasis on the less important content within the assigned tasks. Additional instructor guidance and feedback will be considered. We note that alumni of the IEE program reported high competency on pursuing professional growth (see Criterion 4A – GPA = 3.8/4.0), so some of the performance shortfall may be attributed to unnecessarily high expectations on the part of the instructor. The IEE faculty would rather keep its high expectations of students in place than to continually lower its metrics (standards), which could have the potential effects of diluting the quality of the program.

The following table identifies the next academic year in which the Performance Report Summaries (PRS) will be collected for each student outcome. In the year identified, all PRS for that student outcome will be collected, not just the ones that did not meet their associated performance criteria during the previous review. If 50% (or less) of the assessment items associated with a student outcome did meet their expected performance level, then the PRS will be collected in two years from the last review. Otherwise, the next scheduled review for a student outcome is set to three years from the last review.

IEE Student Outcome	**Comparison of student performance to metrics of the corresponding assessment items for the Student Outcome** (number and percentage meeting or exceeding metric)	**Next Year of Scheduled Review (*i.e.*, collection of PRS for assessment)**
a. An ability to apply knowledge of mathematics, science, and engineering.	3 of 4 (75%)	2013-2014
b. An ability to design and conduct experiments, as well as to analyze and interpret data.	3 of 5 (60%)	2013-2014
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.	2 of 3 (67%)	2013-2014
d. An ability to function on multidisciplinary teams.	3 of 4 (75%)	2013-2014
e. An ability to identify, formulate, and solve engineering problems.	4 of 5 (80%)	2013-2014
f. An understanding of professional and ethical responsibility.	3 of 3 (100%)	2013-2014
. An ability to communicate effectively.	6 of 7 (86%)	2013-2014
h. The broad education necessary to	1 of 2 (50%)	2012-2013

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.	1 of 2 (50%)	2012-2013
. A knowledge of contemporary issues.	2 of 3 (60%)	2013-2014
. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	2 of 4 (50%)	2012-2013
An understanding of the entrepreneurial process and how to design, develop, and bring new products and processes to market.	3 of 4 (75%)	2013-2014

BS-UEM Results

The analysis of the UEM outcomes shows generally good performance, based on this first pass through the assessment cycle. However, the outcome analysis shows several opportunities for improvement—in both teaching and in our assessment methods.

Here are some key findings from the analysis of outcomes in the UEM curriculum:

- Ensure metrics are calibrated correctly. With this being our first pass through the complete assessment cycle, some metrics were set too high based on the instructor's expectations not being reflective of a student's first performance on the assigned task.
- Instructors recognized the need to cover example problems in class in their entirety, rather than focusing on subsets of the problem. This provides a more systemic view of the problem-solving and tool selection processes.
- When assignments require accretive knowledge and skill development, make sure that assignments are spaced apart so the student has instructor feedback on a graded assignment prior to preparing the next assignment. While this is not always possible, it is important that we identify critical places in the UEM curriculum where this must be upheld.
- When a critical element of the assignment may be missed by the student (e.g., NSPE ethics codes or narrative to support a graph or other exhibit), the instructor should put the need for this content in the assignment instructions, providing this does not compromise the content being assessed in the assignment.

In specific, several outcomes require more detailed attention to improve the student attainment of satisfactory levels of performance on the measured items.

- Outcome a requires the most attention, with only 33% of the outcome measures being met. Lower performance on this metric was mostly because of more instructor guidance needed and feedback on the assignments leading up to this one. We note that graduates of the UEM program report high competency on this outcome (3.5/4.0), so some of the performance shortfall may be attributed to unnecessarily high expectation on the part of the instructor. The UEM faculty would rather keep its high expectations of students in place than continually lower its metrics which would have the potential effects of diluting the quality of the program and lowering the reported attainment of outcomes by UEM graduates.

- For outcomes having fewer than three metrics, the assessment of student attainment is tougher to gauge. For this UEM assessment cycle, outcomes c and k have two metrics. In our next assessment cycle, we will aim for a minimum of three reported metrics so we have more useful information to assessment attainment of these outcomes.

EM Student Outcome	Next Assessment Due
Ability to select and apply the knowledge, techniques, skills, and modern tools of their disciplines to broadly-defined engineering technology activities.	June 2013
Ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies.	June 2014
Ability to conduct standards tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes.	June 2013
Ability to design systems, or processes for broadly-defined engineering technology problems appropriate to program educational objectives.	June 2013
Ability to function effectively as a member or leader on a technical team.	June 2014
Ability to identify, analyze, and solve broadly-defined engineering technology problems.	June 2014
Ability to communicate effectively regarding broadly-defined engineering technology activities.	June 2014
An understanding of the need for and an ability to engage in self-directed continuing professional development.	June 2014
An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity.	June 2014
Knowledge of the impact of engineering technology solutions in a societal and global context.	June 2014
Commitment to quality, timeliness, and continuous improvement.	June 2013

BS-EDT Results

The analysis of the EDT outcomes shows generally good performance, based on this first pass through the assessment cycle. However, the outcome analysis shows several opportunities for improvement—in both teaching and in our assessment methods.

Here are some key findings from the analysis of outcomes in the EDT curriculum:

- Ensure metrics are calibrated correctly. With this being our first pass through the complete assessment cycle, some metrics were set too high based on the instructor’s expectations not being reflective of a student’s first performance on the assigned task.

- Instructors recognized the need to cover example problems in class in their entirety, rather than focusing on subsets of the problem. This provides a more systemic view of the problem-solving and tool selection processes.
- When a critical element of the assignment may be missed by the student , the instructor should put the need for this content in the assignment instructions, providing this does not compromise the content being assessed in the assignment.

In specific, several outcomes require more detailed attention to improve the student attainment of satisfactory levels of performance on the measured items.

- Outcomes a and f require the most attention, with only 60% (outcome a) and 67% (outcome f) of the outcome measures being met. Lower performance on the outcome a metrics was mostly because of the need to calibrate our metrics after first use, provide more guidance on assignments, and to check for comprehension on the student's part. Lower performance on the outcome f metrics was mostly because of more instructor guidance needed and feedback on the assignments leading up to this one.
- We note that graduates of the EDT program report high competency on these outcomes (3.4-3.8/4.0), so some of the performance shortfall may be attributed to unnecessarily high expectation on the part of the instructor. The EDT faculty would rather keep its high expectations of students in place than continually lower its metrics which would have the potential effects of diluting the quality of the program and lowering the reported attainment of outcomes by EDT graduates.

The following table shows when each outcome will be assessed in the future. Our plan is to assess outcomes every three years for those outcomes having 51% or more of their metrics met; the rest will be assessed every two years.

EDT Student Outcome	**Next Assessment Due**
a. Ability to select and apply the knowledge, techniques, skills, and modern tools of their disciplines to broadly-defined engineering technology activities.	June 2014
b. Ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies.	June 2014
c. Ability to conduct standards tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes.	June 2014
d. Ability to design systems, or processes for broadly-defined engineering technology problems appropriate to program educational objectives.	June 2014
e. Ability to function effectively as a member or leader on a technical team.	June 2014

f. Ability to identify, analyze, and solve broadly-defined engineering technology problems.	June 2014
g. Ability to communicate effectively regarding broadly-defined engineering technology activities.	June 2014
h. An understanding of the need for and an ability to engage in self-directed continuing professional development.	June 2014
i. An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity.	June 2014
j. Knowledge of the impact of engineering technology solutions in a societal and global context.	June 2014
k. Commitment to quality, timeliness, and continuous improvement.	June 2014

BS-MFT Results

The analysis of the MFT outcomes shows generally good performance, based on this first pass through the assessment cycle. However, the outcome analysis shows several opportunities for improvement—in both teaching and in our assessment methods.

Here are some key findings from the analysis of outcomes in the MFT curriculum:

- Ensure metrics are calibrated correctly. With this being our first pass through the complete assessment cycle, some metrics were set too high based on the instructor's expectations not being reflective of a student's first performance on the assigned task.
- Instructors recognized the need to link homework assignments to lab assignments, to help students perform better when in the time-constrained lab environment.
- When assignments require accretive knowledge and skill development, make sure that assignments are spaced apart so the student has instructor feedback on a graded assignment prior to preparing the next assignment. While this is not always possible, it is important that we identify critical places in the MFT curriculum where this must be upheld.

In specific, several outcomes require more detailed attention to improve the student attainment of satisfactory levels of performance on the measured items.

- Outcomes a, d, e, i, and k require the most attention, with only 50% of the outcome measures being met. Lower performance on these outcomes was mostly because of more instructor guidance needed and feedback on the assignments leading up to this one. We note that graduates of the MFT program report high competency on these outcomes (3.4-3.8 out of 4.0), so some of the performance shortfall may be attributed to unnecessarily high expectation on the part of the instructor. The MFT faculty would rather keep its high expectations of students in place than continually lower its metrics which would have the potential effects of diluting the quality of the program and lowering the reported attainment of outcomes by MFT graduates.

- For outcomes having fewer than three metrics, the assessment of student attainment is tougher to gauge. For this MFT assessment cycle, outcomes d, e, i, and k have one or two metrics. In our next assessment cycle, we will aim for a minimum of three reported metrics so we have more useful information to assessment attainment of these outcomes.

The following table shows when each outcome will be assessed in the future. Our plan is to assess outcomes every three years for those outcomes having 51% or more of their metrics met; the rest will be assessed every two years.

FT Student Outcome	**Next Assessment Due**
Ability to select and apply the knowledge, techniques, skills, and modern tools of their disciplines to broadly-defined engineering technology activities.	June 2013
Ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies.	June 2014
Ability to conduct standards tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes.	June 2014
Ability to design systems, or processes for broadly-defined engineering technology problems appropriate to program educational objectives.	June 2013
Ability to function effectively as a member or leader on a technical team.	June 2013
Ability to identify, analyze, and solve broadly-defined engineering technology problems.	June 2014
Ability to communicate effectively regarding broadly-defined engineering technology activities.	June 2014
An understanding of the need for and an ability to engage in self-directed continuing professional development.	June 2014
An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity.	June 2013
Knowledge of the impact of engineering technology solutions in a societal and global context.	June 2014
Commitment to quality, timeliness, and continuous improvement.	June 2013

PhD-IE Results

Evidence that the department uses to track these student outcomes includes: i) the percentage of students that successfully pass the comprehensive exam, ii) the percentage of students that successfully propose a research topic, and the percentage of students that successfully complete the dissertation.

Academic Year	Percentage of students that successfully pass the comprehensive exam	Percent of students that successfully propose a research topic	Percentage of students that successfully complete and defend the dissertation
2010-2011	100% (n = 3)	100% (n = 3)	100% (n = 3)
2011-2012	100% (n=1)	100% (n = 1)	100% (n = 2)

Based on the percentages above, our students are achieving the objectives that we have set forth for the successful completion of the PhD program. In addition, it appears that the high success rates are based on the appropriate timing at which the students are completing each step in the process to meet the student outcomes.

The most significant change to the program over the reporting period was to provide a greater focus on current research topics in the comprehensive exam by including a research activity within the student's chosen area of study. In addition, based on changes nationally, the program requirements were reduced to 75 credit hours beyond the bachelor's degree.

Presenting and publishing has become an integral component of the culture of the Industrial Engineering PhD program. Presentations and papers have been successfully completed by the PhD students each year for entities such as the Institute for Industrial Engineers (IIE), the Institute for Operations Research and the Management Sciences (INFORMS), the American Foundry Society (AFS), International Society for Ergonomics and Occupational Safety (ISOES), the International Journal of Industrial Engineering (IJIE), and the International Journal of Industrial Ergonomics (IJIE). In addition, students have been consistently funded through departmental DA/DGA appointments and research funding from the Human Performance Institute, Engineering Management Research Laboratory, and the WMU Foundry. All full-time PhD students receive full or partial appointments or fellowships.

MS/E Program/Curricula Results

Recall that the student outcomes for each of the three IME master's degree programs consist of the demonstration of an understanding of the content in the core courses required by each degree. This includes 6 courses for the Industrial Engineering and Engineering Management programs and 5 courses for the Manufacturing Engineering program. It is the expectation of the program faculty that a student should achieve a B or better in each program core course to demonstrate a high level of mastery of all learning outcomes. Thus, the department uses the percentage of students that achieve a B or better in all core courses as a metric to monitor our graduates' level of mastery.

Percentage of graduates that received a 3.0 or better in each core program course for graduates in the following academic year:	**MSE – Industrial Engineering (6 core)**	**MS - Engineering Management (6 core)**	**MS - Manufacturing Engineering (5 core)**
2010-2011	**62.5%** (10 out of 16)	**61.9%** (13 out of 21)	**0.0%** (0 out of 1)
2011-2012	**100.0%** (4 out of 4)	**66.6%** (14 out of 21)	**50.0%** (1 out of 2)

Based on the table above, a majority of our graduates (> 60%) leave the program with a high level of mastery of all learning outcomes. While the program faculties are always striving to increase this percentage through course improvements and content updates, it is important that one does not conclude that the remaining students are graduating without an adequate level of mastery of the learning objectives. In addition to achieving a WMU Graduate GPA of 3.0 or higher to graduate from an IME masters program, a student must also achieve a C or better in each program core course to graduate. Therefore, a second display of data was developed. This second display is based on the distribution of the number of core courses in which graduates received a CB or a C. In the following table, the distribution of graduates that received a CB or C in zero, one, two or three core courses is given. In no case during the reporting period did a graduate receive a CB or C in more than three courses. (Note that "zero courses" corresponds to those graduates that received a B or better in all core courses.)

Percentage (count) of students receiving a CB or C in zero, one, two or three core courses in academic year:	**MSE – Industrial Engineering (6 core)**	**MS - Engineering Management (6 core)**	**MS - Manufacturing Engineering (5 core)**
2010-2011	**0 courses: 62.5% (10)** **1 course: 18.7% (3)** **2 courses: 12.5% (2)** **3 courses: 6.3% (1)**	**0 courses: 61.9% (13)** **1 course: 33.3% (7)** **2 courses: 4.8% (1)**	**0 courses: 0.0% (0)** **1 course: 100% (1)**
2011-2012	**0 courses: 100% (4)**	**0 courses: 66.6% (14)** **1 course: 28.6% (6)** **2 courses: 4.8% (1)**	**0 courses: 50.0% (1)** **1 course: 50.0% (1)**

Approximately 77% of graduates that do not receive a B or better in all core courses only missed this mark by one course. And in this one course, the course grade was a CB or C. Thus, approximately 94% of our graduates during the reporting period received a B or better in at least 5 core courses which demonstrates a high-level of mastery of the majority of the student outcomes and an adequate level of mastery of the remaining student outcomes.

Recent changes to the IME masters degree programs have made based on current national trends and feedback from our constituents. These changes have included: i) reducing the number of required program credits hours to 30 for both the thesis and non-thesis options, ii) revising program requirements to allow students to participate in supervised practical industrial training, and iii) creating a new accelerated bachelor/master degree program (ADP) that links the new undergraduate Industrial & Entrepreneurial Engineering (IEE) degree with the MSE Industrial Engineering program. Similar accelerated programs are also being considered for the Manufacturing degree. All Industrial Engineering and Engineering Management core courses are offered on a rotating basis in the Grand Rapids Regional Center using graduate IME faculty. Beginning in the Fall 2012 semester, this will also be true in the Holland area. The move back to Holland is in response to increasing industrial demand following a 4-year hiatus for this market.

Presentations and papers have been successfully completed by the MS/E students each year for entities such as the Institute for Industrial Engineers (IIE), the Institute for Operations Research and the Management Sciences (INFORMS), the American Foundry Society (AFS), International Society for Ergonomics and Occupational Safety (ISOES), the International Journal of Industrial Engineering (IJIE), the International Journal of Industrial Ergonomics (IJIE), and the American Society for Engineering Education (ASEE). In addition, students have been consistently funded through departmental GA appointments and research funding from the Human Performance Institute.

Appendix V – Department of Manufacturing Engineering Assessment Impact Report

1. What are the student learning outcomes for each program within the department?

   The student learning outcomes for each program within the MFE department are reported in TracDAT.

2. Which student learning outcomes were measured in each year of the report (2010-2011 and 2011-2012 for this report) and how were they measured?

   The student learning outcomes measured for this report and how they were measured are reported in TracDAT.

3. Summarize the key findings for each year of the report, described the changes that were made due to those findings and how the unit will determine if the changes improved learning.

   Key findings for each year of the report, the changes that were made due to the findings, and the metric (benchmark) the program used to determine if changes improved learning are reported in TracDAT.

   The key finding was that students were not doing as well as expected on the exit exam ((Fundamentals of Manufacturing, Self Assessment), which we use as an indicator (precursor) to Manufacturing Engineering Certification (professional recognition). The department purchased a set of review books (study materials) for the students to utilize in preparation for the exam (the exam is a CD based self administered test). This year, the results were much improved (went from all students failing the exam, to all students passing the exam); we will continue to use the review materials (books) for the students to prepare for the exam.

Appendix VI – Department of Mechanical and Aeronautical Engineering Assessment Impact Report

1. What are the student learning outcomes for each program within the department?

   The student learning outcomes for each program within the MAE department are reported in TracDAT.

2. Which student learning outcomes were measured in each year of the report (2010-2011 and 2011-2012 for this report) and how were they measured?

   The student learning outcomes measured for this report and how they were measured are reported in TracDAT.

3. Summarize the key findings for each year of the report, described the changes that were made due to those findings and how the unit will determine if the changes improved learning.

   Key findings for each year of the report, the changes that were made due to the findings, and the metric (benchmark) the program used to determine if changes improved learning are reported in TracDAT.

   For undergraduate programs, based on the assessment data gathered, we have made improvements in the assessment process and the course and curriculum levels, and introduced new courses. In addition, we have developed a plan to improve the ME curriculum by introducing courses in modeling and simulations. For AE program, we will convert it from aeronautical to aerospace engineering in fall 2012. A new M.S. program in aerospace engineering will be developed in the coming year.

   For our graduate programs, data have been collected but not analyzed yet. The changes resulting from the assessment data will be reported on TracDAT.

Appendix VII – Department of Paper Engineering, Chemical Engineering, and Imaging Assessment Impact Report

I. Student Learning Outcomes

ABET requires the attainment of student learning outcomes and program objectives. Student learning outcomes are ABET Criterion 3 a-k that describe what students are expected to attain by the time of graduation assessed through course reports and surveys. Program Educational Objectives are defined as what graduates are expected to attain within a few years after graduation and are assessed by surveying alumni and employers.

Student learning outcomes can be found on the department webpage and are displayed in the department office. The chemical and paper engineering programs have documented student learning outcomes that prepare graduates to attain the program educational objectives.

Student learning outcomes for chemical and paper engineering are as follows:
(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 multidisciplinary 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.

Our Programs Educational Objectives for all undergraduate programs are:

Our graduates are expected within a few years of graduation to attain the following in the areas of career growth, professional development, innovation, and service:

Career Growth: as measured by metrics such as achieving proficiency in current position, increasing responsibility, diversity of job functions, recognition, progression and/or job advancement.

Professional Development: as measured by metrics such as pursuing additional educational activities, professional certifications, leadership effectiveness, staying current with evolving technologies or demonstrating initiative.

Service: as measured by metrics such as involvement in their communities, professional societies, industry or humanitarian endeavors.

Innovation and Entrepreneurship: as measured by metrics such as the development of new processes, devices, methods, patents, and or founding a business.

Graphic and Printing Science

Student learning outcomes for the Graphic and Printing Science program are as follows:

(a) an ability to apply knowledge of applied science, printing technology, business, and communication media

(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 multidisciplinary teams

(e) an ability to identify, formulate, and solve technical 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 professional tools necessary for professional practice.

II. Procedure for Measuring Student Learning Outcomes and Program Educational Objectives

All student learning outcomes are measured every year in all required courses. Each course has several student learning outcomes assigned to it for assessment purposes, based on input from the faculty as to which student learning outcomes best fit a particular course. When looked upon the curriculum as a whole, the breadth of the student learning outcomes is probably being over assessed at this point in time. The faculty are planning to change the assessment of the learning outcomes to a rotating three year cycle to simplify the process. Each of the learning outcomes will be assessed across the curriculum once every three years, which will allow for two complete assessments of all learning outcomes during the six-year cycle between ABET accreditation visits.

Program Educational Objectives are measured every three years by alumni and employer surveys.

The ongoing assessment procedure is attached as Appendix A. Assessment includes: course assessment using exams, homework, lab reports and oral presentations. In addition, student surveys, alumni and employers surveys, and senior exit interviews are also used.

Graduate Program Assessment Impact summary is attached in Appendix B.

The Summary of Assessment of Student Learning Outcomes and Program Educational Objectives is attached in Appendix C

III. Summary of Key Findings

There have been three major modifications to the curriculum since the last review. All have been driven in whole or part based on program assessment. The first major change was the addition of a biology component to the program with concomitant deletion of the course in the statics and mechanics of materials. This change was the result of extensive discussion with the Industrial Advisory Board about the future direction of chemical engineering and need for chemical engineers to understand some biology. This discussion started in 2004, initiated by some of the reports done by the Frontiers in Chemical Engineering Education group. As part of the discussion, the IAB was also asked to consider what could be deleted from the program if one or more courses in the biological sciences were added. The IAB proposed that a basic course in biology and a course in biotechnology be added and that the single course in statics and mechanics be deleted. This suggestion was reviewed and endorsed by the student chapter of AIChE. It was approved by the faculty and became effective in a year. To help develop the bioprocess engineering course, students pursuing the Life Science option were given the option of taking either the statics and mechanics course (ME 2530) or the new bioprocess engineering course (CHEG 3550). Most students chose to take CHEG 3550 if they had not already taken ME 2530.

A second major change was driven by an internal assessment of our ability to continue to supply quality laboratory experiences in the face of increasing enrollment and stagnant or declining resources. The faculty believe that quality laboratory experiences are a significant component of a "job ready" graduate. Ideally, the laboratory would be held in conjunction with the class that presents the theoretical framework. Historically, we had laboratory classes in CHEG 3110: Unit Operations – Fluids, CHEG 3120: Unit Operations – Heat Transfer and CHEG 4200: Separation Processes. CHEG 3300: Mass Transfer was the only unit operations course without a laboratory component. Our goal was to have teams of two or three students execute the experiments and write (and possibly present) the report. When class sizes started to exceed 30 on a continuing basis, it became nearly impossible to schedule sufficient lab time to accommodate the necessary teams. This was due to lack of duplicate equipment, insufficient TA support, and scheduling issues. As a result, the faculty reviewed the curriculum to determine how best to accommodate the labs within our resource constraints. The final proposal was to remove the labs from CHEG 3110 and CHEG 3120, eliminate CHEG 4200, and combine all unit operations lab work into one laboratory course that we would offer in the Spring and Summer I semesters. In essence, this two credit lab course replaced the three credit CHEG 4200 course. It also added one lecture hour per week to both CHEG 3110 and 3120 thus permitting greater coverage of fluid mechanics and heat transfer. The loss of the Separation Processes (CHEG 4200) course put an additional burden on the mass transfer course (CHEG 3300) to ensure proper exposure to appropriate material. Of necessity, some coverage of mass transfer and separation issues was lost. The unit operation lab (CHEG 4810) was first offered in

Summer I, 2010, and modifications and fine turning are in process. While there have been some start-up issues, especially with some newly designed experiments, the extended lab seems to be going well and reasonably well received by the students.

IV. Identifying Opportunities for the PCI Department

The Academic Program Planning (APP) Committee for the PCI department, as well as the PCI Graduate Committee met to discuss future opportunities for the department in light of our recent history. These committees brought topics and recommendations to the PCI faculty as a whole in January and February 2012, for further discussion and feedback. Topics discussed have gone beyond curriculum review and updates, and have included such items as student recruitment and retention, enhancing research activities, and changing the name of the PCI Department to enhance marketing opportunities for our programs outside the university. These discussions have resulted in the recommendations that will now be presented.

Recommendations for the Undergraduate Paper Engineering and Paper Science Programs

The PCI faculty recognizes that the current low enrollment in Paper Engineering and Paper Science has resulted in a skewed distribution of faculty time and effort within the PCI department. The department will need to take actions to balance available resources and move the department forward. The department will develop a recruitment strategy in coordination with its Paper Technology Foundation members, alumni, and student organizations. In addition to improving its recruitment practices, department faculty will meet and develop and discuss student mentoring and retention.

The PCI department faculty will look at further synergy with the Chemical Engineering degree options, including possible degree minors or a potential dual degree program. The PCI department faculty will also look at other curriculum updates and changes, and new methods of content delivery such as on-line courses. Critical review of the program is needed to include biomass processing and materials and new uses for cellulose. The goal is to strengthen the PCI department by increasing the number of students enrolled in the Paper Engineering and Paper Science degree programs as well as having any changes provide benefits to the Graphic and Printing Science and Chemical Engineering programs.

Recommendations for the Undergraduate Chemical Engineering Program

The PCI Curriculum Committee will review and update all options in the BS in Engineering (Chemical) degree program to reflect changes in course titles and content that has occurred over time, both within the department and elsewhere at WMU.

The establishment of an MS in Engineering (Chemical) Accelerated degree program will need to work within the existing undergraduate degree requirements, and may even be offered as an additional option or track within the undergraduate Chemical Engineering curriculum.

Additional space and equipment is needed for undergraduate teaching laboratories due to the steady growth in student enrollment. A part-time or full-time staff position to support the undergraduate laboratories is needed, which work was previously done by Harold Hladky, a Master Faculty Specialist who retired in June 2011.

Recommendations for the Undergraduate Graphic and Printing Science Program

The graphic and printing industry continues to evolve with current areas of growth being in non-impact printing and flexo packaging. The introduction of a new Packaging Track in the GPS undergraduate curriculum will include polymer material courses and on-line courses offered by Michigan State University. This will broaden the types of materials and substrates students are prepared to work with and better prepare those who wish to pursue science based research as part of a graduate degree program.

The PCI Curriculum Committee will review and update all options in the BS in Graphic and Printing Science degree program to reflect changes in course titles and content that has occurred over time, both within the department and elsewhere at WMU.

Recommendations for the PCI Graduate Program

We recommend revising the graduate degree titles to be as shown below, and adjusting the content requirements of the degrees and qualifying exams as needed.

MS in Paper and Printing Science
- MS in Paper and Printing Science (Accelerated)
- MS in Engineering (Chemical) - current degree title, no change needed
- PhD in Paper and Printing Science
- PhD in Engineering - Interdisciplinary degree now available through CEAS

The new degree titles and new content focus will result in the removal of CHEG 2960 Material and Energy Balances as a condition of admission for the MS or PhD in Paper and Printing Science, and will also remove Unit Operations as a topic area in the PhD Level I Qualifying exams. The engineering content of the current MS and PhD in Paper and Printing Science and Engineering does not fit well with the background of the majority of applicants for these degrees, and engineering is not a focus of their graduate research or eventual employment. Removing the engineering content may also decrease the time to degree, as the background of the students should allow them to take fewer undergraduate courses in preparation for the PhD Level I Qualifying Exams.

The new degree titles would cause the removal of PAPR 6910 Pulp and Paper Operations II; PAPR 6930 Environmental Systems Engineering; and PAPR 6960 Paper Industry Control Systems from the university Graduate Catalog. These courses are repetitive with engineering topics in place under the MS in Engineering (Chemical) degree program, or are focused on engineering content no longer included in the renamed degree programs.

The PCI faculty will pursue creation of an MS in Engineering (Chemical) Accelerated degree program, which will make pursuit of an MS degree a more attractive option for current undergraduate students.

Better allocation of space is needed for the department to be able to increase its number of graduate students and research activities. This space should be separate from the undergraduate teaching laboratories.

Finally, we propose to change the name of the department to Chemical and Paper Engineering to reflect the two ABET accredited programs in the department (Chemical Engineering and Paper Engineering). This will present a clear description of the department to potential research sponsors. All of the courses in the department will retain their current prefix of CHEG, PAPR, and GPS.

This is an alignment of the departmental name consistent with other comparable programs in the nation. It will help the department faculty by increasing their visibility with funding agencies such as NSF and NIH and industry.

Appendix A: Department Procedure for ABET Assessment

Memo

Western Michigan University
Department of Paper Engineering, Chemical Engineering and Imaging

To: PCI Faculty
From: Assessment Committee
Date: June, 2011
Re: Assessment Process Procedure

ABET requires an ongoing assessment process. To that end, we need to continue the type of assessment work that we did for the Interim Visit last fall, with the exception that we do not need to retain examples of student work. Thus, the basic steps in our assessment process are:

The course retrospective remains our major vehicle for documentation of achievement of program outcomes. The course retrospective should contain, at a minimum:
What went OK
What didn't go OK / Needs Improvement
Grade distribution
Outcomes assessment – one section for each outcome being assessed
Outcomes survey results
Review the attached tables to determine which Criterion 3 outcomes are being assessed in your course(s)
Over the course of the semester, measure the achievement level of the outcomes using multiple instruments (e.g. homework problems, exam questions, quizzes, lab reports) to measure the achievement of each outcome multiple (2-5) times.
If changes were proposed at the last course offering and were implemented in the current offering, ensure that the impact of these changes is assessed..
As a component of the course retrospective, analyze the achievement level for each outcome. A summary table of achievement for each instrument and an overall achievement level should be part of the analysis.
Determine if the desired level (75% of the students achieving at least the 75% level) is being met. If the desired level is not being met, propose changes, either at the course or curriculum level.
As appropriate, discuss the impact of previous changes.
Survey the students at the end of the semester to obtain their input as to the achievement level of all Criterion 3 outcomes associated with the course. Summarize these result in the course retrospective.
The retrospective should be completed by the 5th week of the following semester. Submit a written copy to Annette to be placed in the appropriate course notebook. Submit an electronic copy to the chair of the assessment committee.
ABET has also revised the criteria that need to be considered in a self-study. There are minor modifications to the wording and description of the various program names. The most significant change is the insertion of a new Criterion 4:
Each program must show evidence of actions to improve the program. These actions should be based on available information, such as results from Criterion 2 and 3 processes.
It is not clear what constitutes "evidence of actions to improve the program", but we need to be thinking about how we show improvement in outcomes achievement. Thus, if an outcome is not met in one semester and we take actions to fix that, then we need evidence the change worked (or didn't work as the case may be). We will need to have ongoing discussion about the improvement process.

Course Support for Criterion 3 Student Learning Outcomes: Chemical Engineering

	Instructor	A	B	C	D	E	F	G	H	I	J	K
CHEG 1010 (Fall)	**Kline**				X	X		X				
CHEG 1810 (Spring)	**Parker**											X
CHEG 2610 (Fall)	**T. Joyce**				X		X		X		X	
CHEG 2810 (Fall)	**Parker**		X		X			X				X
CHEG 2960 (Spring)	**Kline**	X				X		X				X
CHEG 3110 (Fall)	**Young**	X		X		X	X					
CHEG 3120 (Spring)	**Aravamuthan**	X		X		X	X	X	X			X
CHEG 3200 (Fall)	**Parker**	X		X		X						X
CHEG 3300 (Spring)	**Cameron**	X	X	X		X	X	X				X
CHEG 3550 (Spring)	**Young**	X		X		X	X	X	X		X	X
CHEG 3810 (Fall)	**Parker**			X								X
CHEG 4100 (Fall)	**Young**	X										
CHEG 4200 (Spring)	**Parker**		X	X		X	X					X
CHEG 4600 (Fall)	**Kline**			X		X		X		X		
CHEG 4810 (Spring)	**Hladky**		X		X			X				X
CHEG 4830 (Fall)	**Aravamuthan**	**X**	X	X	X			X				X
CHEG 4870 (Spring)	**Kline**			X				X				

Criteria: Engineering programs must demonstrate that their students attain:

(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 social 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

Course Support for Criterion 3 Student Learning Outcomes: Paper Engineering

	Instructor	A	B	C	D	E	F	G	H	I	J	K
PAPR 1000 (Fall/Spring)	**M. Joyce**	X	X									
PAPR 2040 (Spring)	**Pekarovic**	X	X									
PAPR 2520 (Spring)	**Qi**						X		X			
PAPR 2550 (Fall)	**Qi**				X			X				
PAPR 3030 (Fall)	**Cameron**		X			X		X				
PAPR 3040 (Spring)	**Pekarovic**					X			X			
PAPR 3100 (Fall)	**AbuBakr**							X				
PAPR 3420 (Spring)	**M. Joyce**		X							X	X	
PAPR 4300 (Spring)	**Qi**	X										
PAPR 4400 (Fall)	**T. Joyce**									X		
PAPR 4600 (Fall)	**Aravamuthan**			X		X						
PAPR 4850 (Fall)	**T. Joyce**						X	X		X		
PAPR 4860 (Spring)	**Aravamuthan**		X	X				X				
CHEG 1810 (Spring)	**Parker**											X
CHEG 2610 (Fall/Spring)	**T. Joyce**				X		X		X		X	
CHEG 2960 (Spring)	**Kline**	X				X						
CHEG 3110 (Fall)	**Young**					X						
CHEG 3120 (Spring)	**Aravamuthan**	X										
CHEG 4811 (Spring)	**Hladky**		X					X				
CHEG 4830 (Fall)	**Aravamuthan**		X		X							

Criteria: Engineering programs must demonstrate that their students attain:

(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 social 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

Course Support for Criterion 3 Student Learning Outcomes: Graphic and Printing Science

Course	Instructor	A	B	C	D	E	F	G	H	I	J	K
GPS 1500	**Lemon**								**X**			**X**
GPS 1570	**Joyce**		**X**	**X**	**X**	**X**						
GPS 2150	**Pekarovicova**			**X**		**X**						
GPS 2510	**Fleming**	**X**		**X**			**X**	**X**				
GPS 2570	**Fleming**	**X**		**X**			**X**	**X**				**X**
GPS 3100	**Ahleman**		**X**					**X**			**X**	**X**
GPS 3500	**Lemon**			**X**								**X**
GPS 3570	**Pekarovicova**	**X**	**X**			**X**		**X**				
GPS 3580	**Ahleman**	**X**		**X**			**X**	**X**			**X**	**X**
GPS 3590	**Pekarovicova**	**X**				**X**	**X**				**X**	
GPS 4400	**Pekarovicova**								**X**		**X**	
GPS 4570	**Fleming**			**X**	**X**		**X**			**X**		**X**
GPS 4580	**Fleming**		**X**	**X**	**X**			**X**			**X**	**X**
GPS 4620	**Ahleman**											
GPS 4630	**Ahleman**											
GPS 4660	**Ahleman**											**X**
GPS 4850			**X**				**X**	**X**		**X**		**X**
GPS 5100	**Pekarovicova**	**X**				**x**	**x**	**x**			**x**	**x**
Total		**6**	**4**	**7**	**3**	**4**	**7**	**7**	**2**	**2**	**6**	**8**
Senior Exit Interview		X	X	X	X	X	X	X	X	X	X	X
placement												

Criteria: The imaging program must demonstrate that students attain:

(a) An ability to apply knowledge of mathematics, sciences, business, and applied sciences
(b) An ability to design and conduct experiments, as well as to analyze and interpret data
(c) An ability to formulate or design a system, process or program to meet desired needs

(d) An ability to function on multi-disciplinary teams
(e) An ability to identify and solve applied science 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 solutions in a global 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 scientific and technical tools necessary for professional practice.

Appendix B: Summary Graduate Program Assessment Impact Report
Introduction

The Department of Paper Engineering, Chemical Engineering, and Imaging (PCI) at Western Michigan University offers MS and PhD degrees in Paper and Imaging Science and Engineering. This document outlines the Graduate Program assessment process to be followed by the PCI Department.

PCI Graduate Program Objectives

In order to assist and guide faculty, staff, and students in carrying out the PCI Mission and Vision, objectives for the PCI Graduate Program have been established, as found below, and as published on the departmental website.

1. Graduates will be able to generate knowledge and be ready, willing and able to accept expected research and development responsibilities upon employment and assist industry in the design and development of technologies and products based on sound theoretical principles.
2. Graduates will actively participate in the development of the profession through contributions to society, life-long learning and support of the appropriate professional societies.
3. Graduates can function effectively as both team members and team leaders, understanding the basic dynamics of team behavior, communication and leadership skills.
4. Graduates will display a reasoned understanding of the role of research and development in the global environment, including social needs, cultural awareness and environmental sensitivity and complexity, and professional ethics.
5. Doctoral graduates will be ready to pursue academic careers and technical management.

Program Learning Outcomes

Student Learning Outcomes have been established for each of the MS and PhD degree programs, as shown below. The PCI Department uses the Student Learning Outcomes as the basis for the collection and analysis of data to support graduate program review and continuous improvement activities.

Student Learning Outcomes for the MS Program

M1. An advanced ability to use the techniques, skills, and modern engineering and applied sciences tools necessary to design a system, component, or process to meet the desired needs.
M2. An advanced ability to identify, formulate, and solve engineering and applied sciences problems.
M3. An ability to communicate effectively with a broad constituency in written, oral, and visual formats and styles.

Student Learning Outcomes for the PhD Program

D1. An advanced ability to use the techniques, skills, and modern engineering and applied sciences tools necessary to design a system, component, or process to meet the desired needs.

D2. An advanced ability to identify, formulate, and solve engineering and applied sciences problems.
D3. An ability to communicate effectively with a broad constituency in written, oral, and visual formats and styles.
D4. A working knowledge of current research and technology in the students' chosen field of specialty.

Collection of data for review and analysis will follow the mechanism and methods already established within the PCI Department for assessment and review of the PCI undergraduate programs, especially as related to ABET accreditation activities. Specific data collection activities for Graduate Program Assessment are summarized in Table 1.

Table 1. PCI Graduate Program Assessment - Collection of Data

Learning Outcome	Type of Measure	Method of Measuring and Benchmark	Frequency of Measure
M1 and D1	Instructor course retrospective, IMAG 6200 and PAPR 6500	Review of exam questions, projects, or papers from required PCI graduate courses. 75% of students achieve 80% level of success.	Each time course is taught
M2 and D2	Instructor course retrospective, IMAG 6200 and PAPR 6500	Review of exam questions, projects, or papers from required PCI graduate courses. 75% of students achieve 80% level of success.	Each time course is taught
M3 and D3	Instructor course retrospective, PAPR 7250	Review of projects, papers, and presentations from PCI graduate seminar. 75% of students achieve 80% level of success.	1 semester per academic year
D4	Written survey of dissertation faculty committee **(to be developed)**	Analysis of dissertation defense presentation	Each student defending, tracked by Graduate Committee
M1, M2, D1, and D2	Enrollment and degree completion statistics of students entering the PCI Graduate Program	80% of students complete MS degrees within 2 calendar years of initial enrollment. 80% of students complete PhD degrees within 4 calendar years of initial enrollment.	Each student, tracked by Graduate Committee
D1 and D2	Level I Qualifying Exams	80% of students complete the Level I qualifying exams on their first attempt	Each student, tracked by Graduate Committee
M3 and D3	Annual Graduate Student Review Report **(to be modified)**	Compilation of statistics or qualitative comments from selected topics within report **(to be determined).**	Annually, tracked by Graduate Committee
D4	Level II Qualifying Exam	80% of students complete dissertation proposal defense on their first attempt	Each student, tracked by Graduate Committee

Additional Assessment Materials

Major graduate program curriculum modification activities, such as initiating new courses or removing current courses, will be compiled from meeting minutes from the PCI Graduate Committee and the PCI Curriculum Committee. When practical, graduate program alumni will be surveyed by e-mail (to be developed) as part of the bi-annual graduate assessment report to gain knowledge about the perceived level of success of curriculum changes; their current career placements and activities; and to keep abreast of emerging topics in the disciplines. Changes in course content or other modifications to the identified individual courses to be tracked (IMAG 6200, PAPR 6500, and PAPR 7250) will be included in the instructor course retrospectives.

Graduate Program Assessment Timeline

A bi-annual report will be completed by the PCI Graduate Committee, and conveyed to the PCI faculty for review, discussion, and appropriate actions.

Appendix C: Assessment Summary of Student learning Outcomes and Program Educational Objectives

Result Summary of Student learning Outcome Assessment

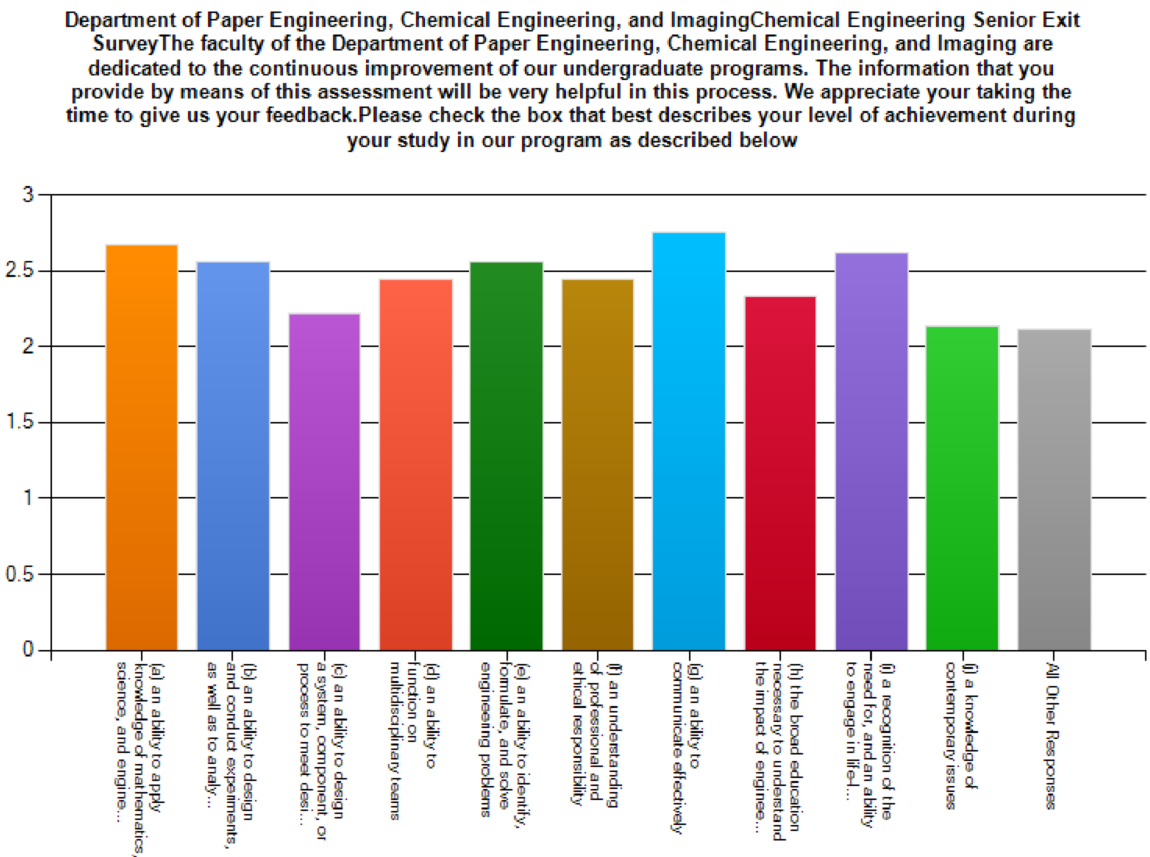
Criterion 3 Student Learning Outcomes	Number of Assess. Instr.	Successful assessment instruments		Comments
		No.	%	
a. Apply knowledge of mathematics, science, and engineering.	27	17	64	Principal issue is in CHEG 2960: Material and Energy Balances and poor performers do not pass the course.
b. Design and conduct experiments and analyze and interpret data	25	21	84	
c. Design a system, component or process within realistic constraints	2	2	100	
d. Function on multi-disciplinary teams	7	7	100	
e. Identify, formulate and solve engineering problems	28	20	71	Outcome not met due to exam performance in CHEG 2960 and CHEG 3300. Significant fraction of students will be repeating each course.
f. Understand professional and ethical responsibility	6	6	100	
g. Communicate effectively	16	16	100	
h. Understand the impact of engineering solutions in various contexts (global, economic, social, environmental)	6	6	100	
i. Recognize the need and be able to engage in life-long learning				
j. Know contemporary issues	7	7	100	
k. Use necessary techniques, skills, and modern engineering tools	**26**	**25**	**95**	

Summary of Senior Exit Interview Survey Results 2010-2011

		2010-2011		

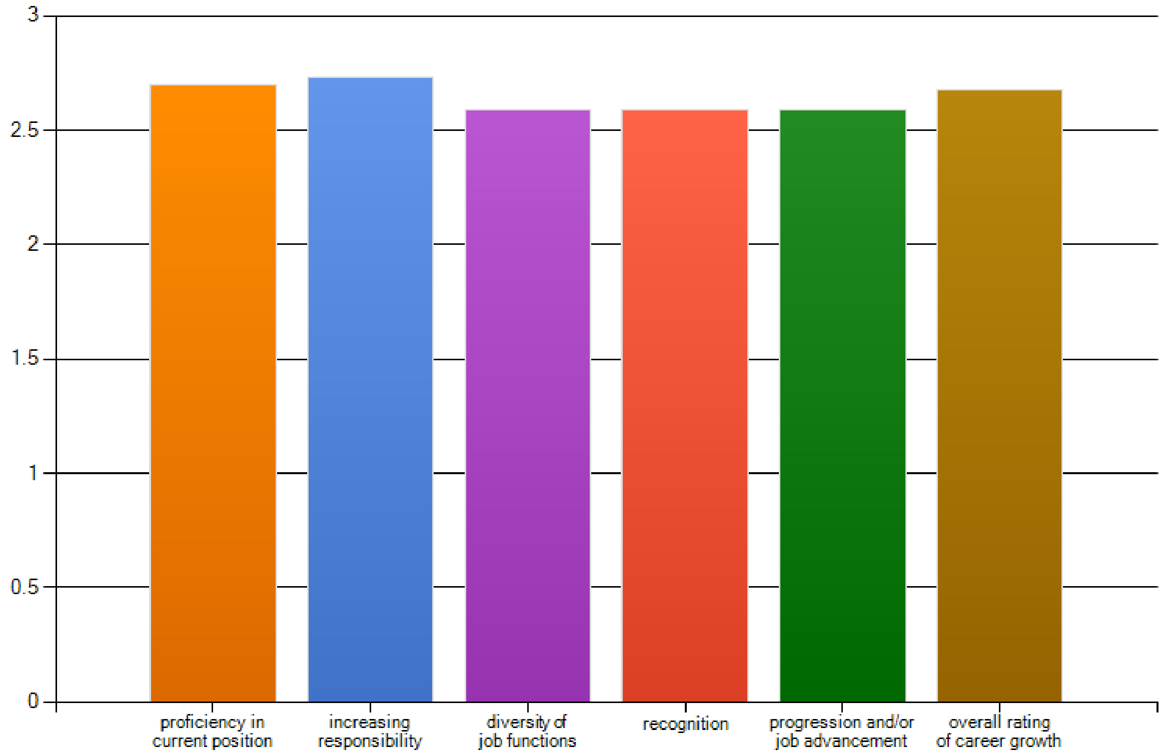
	To a Limited Extent (1)	To a Moderate Extent (2)	To a Great Extent (3_	
Criterion 3		**No. of Responses**		**Average**
A	1	5	35	2.83
B		13	27	2.68
C	2	16	23	2.51
D	2	11	28	2.63
E		8	33	2.80
F	3	13	25	2.54
G	2	10	29	2.66
H	3	15	23	2.49
I	3	16	22	2.46
J	2	24	16	2.39
K		16	25	2.61

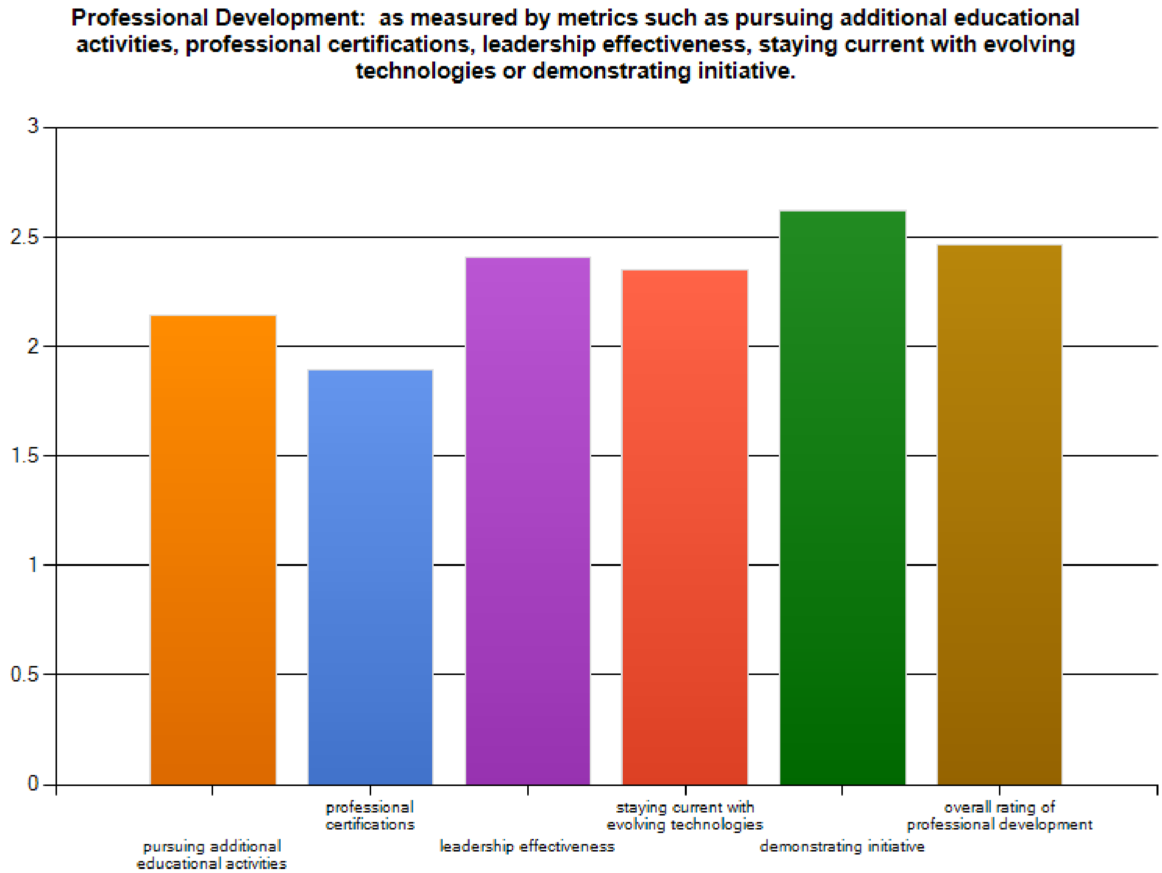
Summary of Senior Exit Interview Survey Results 2011-2012



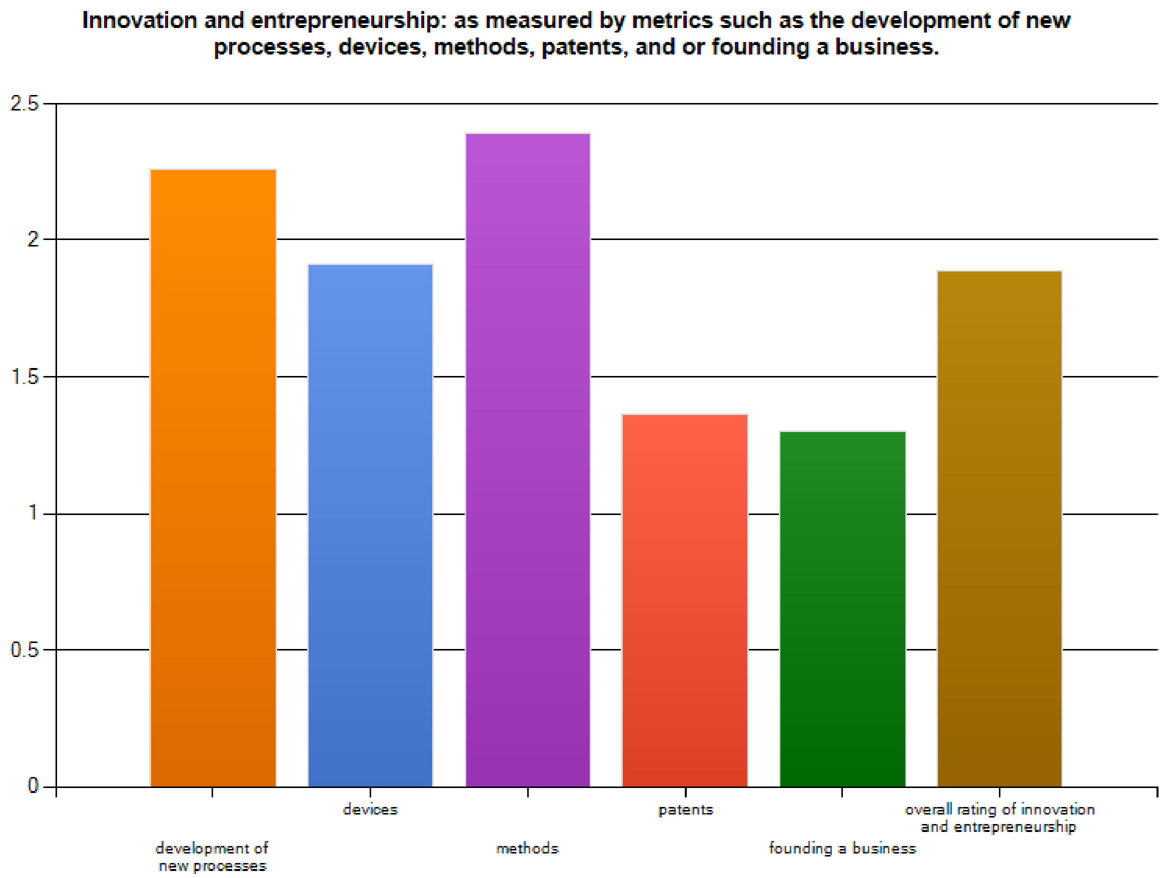
2011 Alumni Survey

Career Growth: as measured by metrics such as achieving proficiency in current position, increasing responsibility, diversity of job functions, recognition, progression and/or job advancement.





Professional Development: as measured by metrics such as pursuing additional educational activities, professional certifications, leadership effectiveness, staying current with evolving technologies or demonstrating initiative.
3
2.5
2
1.5
1
0.5
0
pursuing additional educational activities
professional certifications
leadership effectiveness
staying current with evolving technologies
demonstrating initiative
overall rating of professional development


Innovation and entrepreneurship: as measured by metrics such as the development of new processes, devices, methods, patents, and or founding a business.
2.5
2
1.5
1
0.5
0
development of new processes
devices
methods
patents
founding a business
overall rating of innovation and entrepreneurship

Service: as measured by metrics such as involvement in their communities, professional societies, industry or humanitarian endeavors.