Industrial Engineering & Engineering Mgmt Assessment Plan

NOTE: The assessment plan and results are depicted in the Criterion 3 and Criterion 4 sections of this program's self-study for accreditation under ABET, Inc. These sections are on the following pages.

CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

The program outcomes are ABET outcomes a-k. While this is fairly consistent with the most engineering programs, it is the specificity of the performance criteria that make it unique to the IEEM curriculum at the South Dakota School of Mines and Technology. The department web site includes an assessment link on the main page. This link includes a reiteration of program objectives, program outcomes, an assessment plan and a summary analysis of key assessments and improvement initiatives. An assessment and strategies matrix has been developed for each program outcome. Each matrix includes performance criteria, strategies, an assessment method, source of assessment, time of collection, responsible person, and evaluation of results. Outcome matrices for each of the program outcomes follow.

(a) Students can apply knowledge of mathematics, science, and engineering

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Proficient in mathematics to a level of differential equations	IENG 216, IENG 311, IENG 362, IENG 441, IENG 471, IENG 486	Trend analysis	FE Exam	Annual	Kellogg	Department Assessment Retreat
2. Apply principles of statistics, operations research, and simulation to Industrial Engineering and Engineering Management applications	IENG 216, IENG 311, IENG 362, IENG 441, IENG 471, IENG 486	Concept inventory	IENG 486	Fall – 2012 & 2015	Matejcik	Department Assessment Retreat
		Embedded exam problems	IENG 362	Fall – 2012 & 2015	Kellogg	Department Assessment Retreat

(b) Students can design and conduct experiments, as well as to analyze and interpret data

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Designs experiments and collects appropriate experimental data	IENG 241L, IENG 311, IENG 321, IENG 475, IENG 486	Embedded Assessment	IENG 475	Spring – 2012 & 2015	Jensen, D	Department Assessment Retreat
2. Demonstrates ability to use basic types of analysis, including graphs, trend analysis, and statistical interpretation, to continually improve a system	IENG 241L, IENG 311, IENG 321, IENG 475, IENG 486	Embedded Assessment	IENG 486	Fall – 2011 & 2014	Matejcik	Department Assessment Retreat

(c) Students can 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

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Understands and incorporates system requirements in the design process, including recognizing and accounting for realistic constraints	IENG 311, IENG 321, IENG 355, IENG 366, IENG 425, IENG 475, IENG 465	Community Project Assessment (rubric)	IENG 321	Spring – 2011 & 2014	Piper	Department Assessment Retreat
2. Utilizes financial statements (income, balance, cash flow, proforma) for managerial control and the design of organizational systems	IENG 215, IENG 216, IENG 217, IENG 355	Project Assessment (rubric)	IENG 355	Spring – 2011 & 2014	Kellogg	Department Assessment Retreat

(d) Students can function on multidisciplinary teams

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Incorporates effective team processing for assigning tasks and responsibilities to each member-specialist for a team project	IENG 241L, IENG 311, IENG 352, IENG 366, IENG 471, IENG 475, IENG 464, IENG 465	Project assessment (rubric)	IENG 465	Spring – 2012 & 2015	Jensen, D	Department Assessment Retreat
2. Completes assigned tasks and holds other team members responsible for completing assigned tasks	IENG 241L, IENG 311, IENG 352, IENG 366, IENG 471, IENG 475, IENG 464, IENG 465	Student Notebook Evaluation	IENG 471	Fall – 2011 & 2014	Jensen, D	Department Assessment Retreat
3. Understands and applies team tools for effective problem solving	IENG 241L, IENG 311, IENG 352, IENG 366, IENG 471, IENG 475, IENG 464, IENG 465	TeamKSA	IENG 462	Fall – 2011 & 2014	Karlin	Department Assessment Retreat

(e) Students can identify, formulate, and solve engineering problems

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Identifies and appropriately deals with systems having conflicting criteria from a variety of stakeholders	IENG 352, IENG 366, IENG 471, IENG 475, IENG 486	Project Poster Assessment (rubric)	IENG 352	Fall – 2012 & 2015	Kellogg	Department Assessment Retreat
2. Incorporates the critical role of humans in the design process	IENG 311, IENG 321, IENG 366, IENG 471, IENG 475	Project Assessment (rubric)	IENG 471	Fall – 2012 & 2015	Jensen	Department Assessment Retreat

(f) Students have an understanding of professional and ethical responsibility

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Understands and can apply ethics in engineering design and analysis	IENG 331, IENG 366, IENG 462, IENG 465	Trend Analysis	FE Exam	Annual	Kellogg	Department Assessment Retreat
		Course embedded	IENG 366	Spring – 2011 & 2014	Karlin	Department Assessment Retreat
2. Able to carry out responsibilities in a professional and ethical manner	IENG 241L, IENG 311, IENG 321, IENG 366, IENG 462, IENG 465	Defining Issues Test (DIT)	IENG 462	Spring – 2010 & 2013	Karlin	Department Assessment Retreat

(g) Students can communicate effectively

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Communicates effectively in written form through words, graphs, and tables	IENG 311, IENG 321, IENG 354, IENG 366, IENG 471, IENG 465	Project assessment (rubric)	IENG 321	Spring – 2013 & 2016	Piper	Department Assessment Retreat
2. Demonstrates knowledge of basic formats of technical and managerial communications including memos, technical reports, resumes, and technical presentation	IENG 311, IENG 321, IENG 354, IENG 366, IENG 471, IENG 465	Project assessment (rubric)	IENG 354	Fall – 2012 & 2015	Kellogg	Department Assessment Retreat
		Project assessment (rubric)	IENG 366	Spring – 2013 & 2016	Karlin	Department Assessment Retreat
3. Effectively communicates orally using a prepared technical presentation	IENG 311, IENG 321, IENG 366, IENG 471, IENG 465	Presentation assessment (rubric)	IENG 366	Spring – 2013 & 2016	Karlin	Department Assessment Retreat
		Presentation assessment (rubric)	IENG 465	Spring – 2013 & 2016	Jensen, D	Department Assessment Retreat

(h) Students have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Considers broader context when evaluating impact of potential engineering solutions	IENG 215, IENG 241L, IENG 302, IENG 311, IENG 321, IENG 366, IENG 441, IENG 471, IENG 475, IENG 462, IENG 465	HBDI	IENG 241L	Spring – 2013 & 2016	Kellogg & Kerk	Department Assessment Retreat
		Reasoning with Current Issues (RCI)	IENG 462	Fall – 2012 & 2015	Karlin/Kellogg	Department Assessment Retreat
2. Develops major sections (marketing plan, financial) of an effective business plan for a new product or enterprise	IENG 215, IENG 216, IENG 217, IENG 302, IENG 354, IENG 355	Project Assessment (rubric)	IENG 354 & IENG 355	Fall – 2012 & 2015 Spring – 2013 & 2016	Kellogg	Department Assessment Retreat

(i) Students have a recognition of the need for, and an ability to engage in life-long learning

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Demonstrates commitment to continuous learning through involvement in co-curricular activities	IENG 241L IENG 462	Course Embedded	IENG 241L	Spring – 2012 & 2015	Kellogg & Kerk	Department Assessment Retreat
2. Demonstrates increase in cognitive development	IENG 241L, IENG 311, IENG 352, IENG 366, IENG 425, IENG 471,IENG 462, IENG 465	RCI	IENG 462	Fall – 2011 & 2014	Karlin/Kellogg	Department Assessment Retreat

(j) Students have a knowledge of contemporary issues

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Appreciates the importance of diversity to effective teams	IENG 241L, IENG 366, IENG 465, IENG 471	Course Embedded / HBDI	IENG 241L	Spring – 2012 & 2015	Kellogg & Kerk	Department Assessment Retreat
2. Understands current management techniques and their application in engineering management systems	IENG 366, IENG 425, IENG 486	Course Embedded	IENG 366	Spring – 2012 & 2015	Karlin	Department Assessment Retreat

(k) Students can use the techniques, skills, and modern engineering tools necessary for engineering practice

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Demonstrates competence in modern Industrial Engineering tools and software for simulation, statistics, optimization, facilities, and ergonomics	IENG 241L, IENG 311, IENG 355, IENG 366, IENG 441, IENG 471, IENG 475, IENG 464, IENG 465	Course Embedded	IENG 441	Spring – 2011 & 2014	Matejcik	Department Assessment Retreat
		Course Embedded	IENG 475	Spring – 2011 & 2014	Jensen, D	Department Assessment Retreat
2. Demonstrates competence in modern Engineering Management tools and software for financial decision making, project management, organizational management, statistics, and optimization	IENG 241L, IENG 311, IENG 355, IENG 366, IENG 441, IENG 471, IENG 475, IENG 464, IENG 465	Course Embedded	IENG 311	Fall – 2010 & 2013	Piper	Department Assessment Retreat
		Course Embedded	IENG 464	Fall – 2010 & 2013	Jensen, D	Department Assessment Retreat

B. Relationship of Student Outcomes to Program Educational Objectives

To maintain the nation's economic competitiveness and improve the quality of life for people around the world, engineers need, in addition to technical skills, team skills, leadership skills, a better understanding of business processes, an ability to innovate and think outside of the box, and an ability to communicate effectively and organize work in a diverse

environment. Consider objective one: graduates will be able to contribute to the success of companies through effective problem solving. Effective problem solving requires true conceptual understanding of industrial engineering and engineering management theory (outcome a) as well as proficiency in modern engineering tools (outcome k). And, in the past, those technical skills were generally sufficient. However, effective problem solving in today's environment requires an ability to work with others (outcome d), view problems from multiple perspectives and a variety stakeholders (outcome e), determine additional information that is required (outcome b) and be able to communicate effectively with both internal and external constituents (outcome g). Further engineering solutions must consider long term societal, economic, or environmental impacts (outcome k).

Similar analysis holds for objectives 2 through 4. The matrix below describes the contribution from each of the outcomes to the overall program objectives.

	Objective			
Outcome	1	2	3	4
a	■	■		
b	■	■		
c		■	■	
d	■		■	
e	■	■		■
f				■
g	■	■	■	
h	■		■	■
i				■
j		■	■	■
k	■	■	■	

Figure 3.1 Mapping Program Outcomes to Program Objectives

Every required course offered by the department has a set of learning outcomes which are mapped to program outcomes. These may be found in appendix A. In addition, each outcome has a stated performance criteria as well as courses that contribute to meeting that performance criterion. These are listed under strategies in each outcome matrix. Information as to how that course meets part of the criteria are given in the course reports that will be available with the program course notebooks during the site visit. The matrix below shows the relationship of each course to the program outcomes.

	outcome										
course	a	b	c	d	e	f	g	h	i	j	k
215											
216											
217											
241L											
248											
302											
311											
321											
331											
352											
354											
355											
362											
366											
425											
431											
441											
462											
464&465											
471											
475											
486											

Figure 3.2 Mapping Course Learning Outcomes to Program Outcomes

General Education Program

Learning outcomes in the General Education program can be aligned with the ABET a-k outcomes since a sub-set of high enrollment courses account for nearly all General Education credit hours. The following tables are based on an analysis of all students between 2012 to the present. The General Education courses listed in the tables below account for the courses that 70% to 90% of all students take to meet a given core outcome. The blue shading indicates which ABET (a) trough (k) outcomes these courses address to a high degree.

Objective #1: *Students will write effectively and responsibly and understand and interpret the written expression of others.*											
ABET Outcomes → **High-Enrollment GenEd courses that meet Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
ENGL 101 - Composition I											
ENGL 201 - Composition II											
ENGL 279 - Technical Communications I											
ENGL 289/289L - Technical Communications II											

GEP Objective #2: *Students will communicate effectively and responsibly through speaking and listening.*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
SPCM 101 - Fundamentals of Speech							■				
ENGL 279 - Technical Communications I							■				
ENGL 289 - Technical Communications II							■				

GEP Objective #3: *Students will understand the organization, potential, and diversity of the human community through study of the social sciences*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
PSYC 101 - General Psychology						■		■	■	■	
SOC 100 - Introduction to Sociology						■		■	■	■	
HIST 151 - American History I						■		■	■		
GEOG 101 – Introduction to Geography								■	■	■	
POLS 100 – American Government						■	■	■	■	■	

GEP Objective #4: *Students will understand the diversity and complexity of the human experience through study of the arts and humanities*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
HIST 121 - Western Civilization I						■		■	■		
HIST 122 - Western Civilization II								■	■		
HUM 100 - Introduction to Humanities						■		■	■	■	
PHIL 100 - Introduction to Philosophy						■		■	■	■	
ENGL 210 – Introduction to Literature						■	■	■	■		

GEP Objective #5: *Students will understand and apply fundamental mathematical processes and reasoning.*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
MATH 102/102L - College Algebra	■										

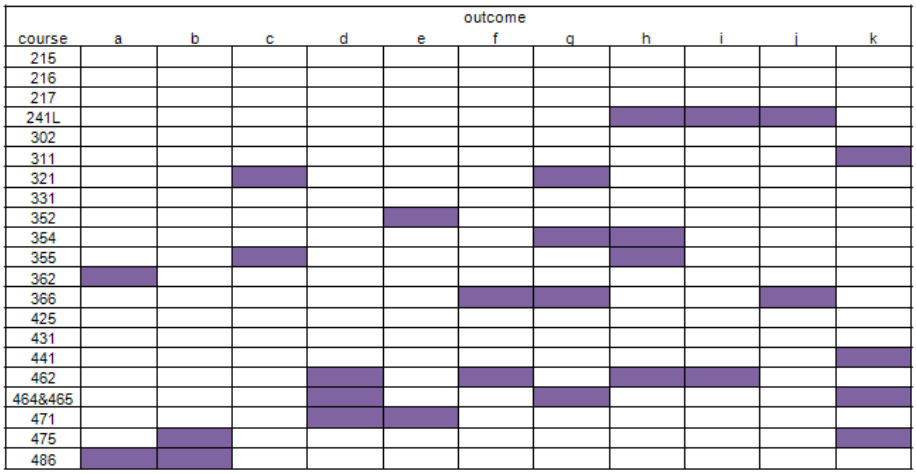
GEP Objective #6: *Students will understand the fundamental principles of the natural sciences and apply scientific methods of inquiry to investigate the natural world.*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
Chemistry 112 – General Chemistry	■										
CHEM 114 – General Chemistry II	■										
GEOL 201 – Physical Geology	■										
Physics 213 – University Physics I	■										
Physics 211 – University Physics II	■										

Objective #7: *Students will recognize when information is needed and have the ability to locate, organize, critically evaluate, and effectively use information from a variety of sources with intellectual integrity*											
ABET Outcomes → **High-Enrollment GEP courses meeting Objective ↓**	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
ENGL 101 - Composition I							■				
ENGL 201 - Composition II							■				
ENGL 279 - Technical Communications I				■		■	■				■
ENGL 289 - Technical Communications II				■		■	■				■

CRITERION 4. CONTINUOUS IMPROVEMENT

A. Student Outcomes

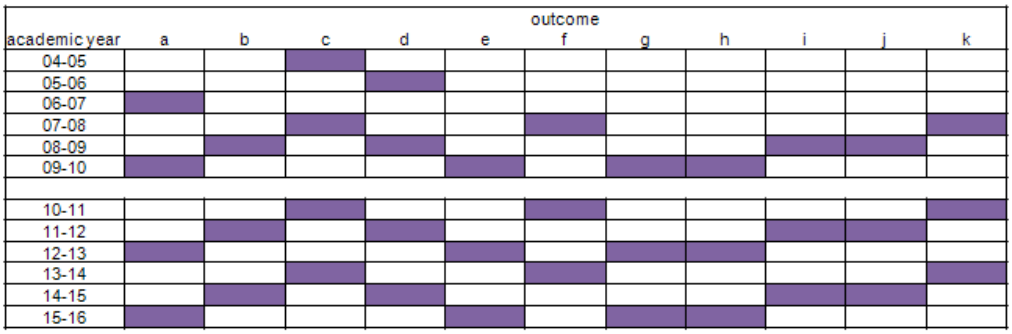
The basic assessment and evaluation process is described in each of the outcome matrices given above. Courses for which assessment data is collected is shown in the matrix (Figure 4.1) below.



	outcome										
course	a	b	c	d	e	f	g	h	i	j	k
215											
216											
217											
241L								■	■	■	
302											
311											■
321			■				■				
331											
352					■						
354							■	■			
355			■					■			
362	■										
366						■	■			■	
425											
431											
441											■
462				■		■		■	■		
464&465				■			■				■
471				■	■						
475		■									■
486	■	■									

Figure 4.1 Sources for Program Assessment by Course

Not all data is collected every year for every course. The matrix in Figure 4.2 below shows how often assessment data is collected.



	outcome										
academic year	a	b	c	d	e	f	g	h	i	j	k
04-05			■								
05-06				■							
06-07	■										
07-08			■			■					■
08-09		■		■					■	■	
09-10	■				■		■	■			
10-11			■			■					■
11-12		■		■					■	■	
12-13	■				■		■	■			
13-14			■			■					■
14-15		■		■					■	■	
15-16	■				■		■	■			

Figure 4.2 Sources for Program Assessment by Year

Evidence of achievement levels for each program outcome may be found in the outcome notebooks for the industrial engineering and engineering management program at the time of the site visit. Each outcome notebook will contain the outcome matrix and assessment data that supports the level of achievement. Assessment data can be correlated back to course notebooks that contain samples of student work; e.g., home work, exams, laboratory reports, posters, and/or project reports. Course notebooks will also be available in the resources room at the time of the visit. Where available, outcome notebooks will also include complementary information and assessment from outside the department; e.g; general education courses and student affairs Mines Advantage program. A summary of the program outcomes, level of achievement, and sources of available data follows.

(a) Students can apply knowledge of mathematics, science, and engineering

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Proficient in mathematics to a level of differential equations	IENG 216, IENG 311, IENG 362, IENG 441, IENG 471, IENG 486	Trend analysis	FE Exam	Annual	Kellogg	Department Assessment Retreat
2. Apply principles of statistics, operations research, and simulation to Industrial Engineering and Engineering Management applications	IENG 216, IENG 311, IENG 362, IENG 441, IENG 471, IENG 486	Concept inventory	IENG 486	Fall – 2012 & 2015	Matejcik	Department Assessment Retreat
		Embedded exam problems	IENG 362	Fall – 2012 & 2015	Kellogg	Department Assessment Retreat

1. Proficiency in mathematics, (mastery level high)

IEEM students are not required to complete the FE exam but are encouraged to do so. 86% of IEEM graduates that take the FE exam pass which is above the national average. FE exam scores in Mathematics is below the national average. FE exam scores in the engineering sciences is above the national average. Students typically score 90% of the national average in mathematics and modeling and computation but average 114% in all other areas. The department is offering new courses in Operations Research and process control tools to better address modeling. The campus has implemented a new mathematics program to help student proficiency in mathematics.

2. IEEM applications, (mastery level low to moderate)

Embedded exam problems in IENG 362 stochastic models indicate student conceptual understanding in probability and statistics is limited. Instructor evaluation in IENG 362 and IENG 486 of student's ability to translate statistical concepts from one context to another is also quite limited. End-of-year student focus group sessions indicate a similar concern on the part of the students. This year, the department implemented two new courses, one in Operations Research and one in Process Improvement tools to provide more hands on work and group problem solving as an aid to conceptual understanding.

(b) Students can design and conduct experiments, as well as to analyze and interpret data

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Designs experiments and collects appropriate experimental data	IENG 241L, IENG 311, IENG 321, IENG 475, IENG 486	Embedded Assessment	IENG 475	Spring – 2012 & 2015	Jensen, D	Department Assessment Retreat
2. Demonstrates ability to use basic types of analysis, including graphs, trend analysis, and statistical interpretation, to continually improve a system	IENG 241L, IENG 311, IENG 321, IENG 475, IENG 486	Embedded Assessment	IENG 486	Fall – 2011 & 2014	Matejcik	Department Assessment Retreat

1. Design experiments and collect data, (mastery level moderate)

IENG 475 final project results (as assessed by the production demonstration) show that student teams are able to identify problems that may be improved by experimentation, and they are able to design and conduct an experiment or series of experiments to test their theories and improve their processes to meet a goal. However, most of the experimentation is one-variable-at-a-time; and when there is multivariable experimentation, students often have difficulty in identifying interaction effects. Students rarely discuss their experiments using statistical terminology. Students also tend to be lax in immediately documenting their experimentation in their engineering notebooks. Formal exercises in experimentation and/or some required content in design of experiments may be required for improvement.

2. Ability to use basic types of analysis to interpret data, (mastery level moderate)
Exam results in IENG 486 Quality Control suggest students have difficulty understanding experimental data as it relates to experimental design and quality control. Results are correlated with concept inventory results. Scores are better following significant review but room for improvement remains.

(c) Students can 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

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Understands and incorporates system requirements in the design process, including recognizing and accounting for realistic constraints	IENG 311, IENG 321, IENG 355, IENG 366, IENG 425, IENG 475, IENG 465	Community Project Assessment (rubric)	IENG 321	Spring – 2011 & 2014	Piper	Department Assessment Retreat
2. Utilizes financial statements (income, balance, cash flow, proforma) for managerial control and the design of organizational systems	IENG 215, IENG 216, IENG 217, IENG 355	Project Assessment (rubric)	IENG 355	Spring – 2011 & 2014	Kellogg	Department Assessment Retreat

1. Incorporates system requirements in design (mastery level moderate to high)
IENG 321 projects were scored using a project rubric (5 point scale). Project scores in 2011 ranged from 3.90 – 4.85, with an average of 4.40, which is considered moderately proficient. In 2014, project scores ranged from 4.20 – 4.75, with an average of 4.55, which is considered to be moderately to highly proficient. In 2011, one project at Black Hills Works scored very high and received national recognition with a cash award for innovation for special worker populations. Another project at a local utility scored relatively poorly because they did not coordinate well with the host organization in evaluating their design recommendations. In 2014, all projects received above average scores or better. One project in particular demonstrated outstanding design for a specific individual's special needs given a number of difficult constraints. This project deliverable remains in use with significant quality-of-life improvement for that individual. Another project with lower scores was evaluated so because they failed to consider usability in their design of a smart device application.

2. Utilizes financial statements for managerial control (mastery level low to moderate)
While students understand basic financial statements, project rubric scores in IENG 355 indicate student have difficulties translating that information into budgets and pro-forma cash flow, income statements and balance sheets. Scores declined substantially upon modularization of the course but have been improving in recent years with the advent of a financial plan rubric.

(d) Students can function on multidisciplinary teams

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Incorporates effective team processing for assigning tasks and responsibilities to each member-specialist for a team project	IENG 241L, IENG 311, IENG 352, IENG 366, IENG 471, IENG 475, IENG 464, IENG 465	Project assessment (rubric)	IENG 465	Spring – 2012 & 2015	Jensen, D	Department Assessment Retreat
2. Completes assigned tasks and holds other team members responsible for completing assigned tasks	IENG 241L, IENG 311, IENG 352, IENG 366, IENG 471, IENG 475, IENG 464, IENG 465	Student Notebook Evaluation	IENG 471	Fall – 2011 & 2014	Jensen, D	Department Assessment Retreat
3. Understands and applies team tools for effective problem solving	IENG 241L, IENG 311, IENG 352, IENG 366, IENG 471, IENG 475, IENG 464, IENG 465	TeamKSA	IENG 462	Fall – 2011 & 2014	Karlin	Department Assessment Retreat

1. Assign tasks and responsibilities (mastery level moderate)

Project Rubric results in IENG 465 show that most students accomplished assigned tasks and responsibilities, although often these assignments are not explicitly documented in a clear fashion. Students were required to use engineering notebooks in the past but assigned tasks and completion thereof were not well documented. Two years ago the instructor placed greater weight on team processes in the overall scoring and has switched to use of the CATME like evaluation for team member feedback. The process has resulted in better team performance for most cases. Two team members were fired from their team this past year and consequently did not complete graduation requirements.

2. Completes tasks; hold team members responsible (mastery level moderate to high)

Student notebook evaluation in IENG 471: Review of the relevant page copies (from individual student engineering notebooks) and progress report memos required in the term project documentation shows that: (a.) the majority of student teams do delegate sub-tasks to their various members and most of those members do complete or resolve those delegated tasks in a responsible manner, (b.) for the most part, those team members that do not resolve those delegated tasks appropriately have been held responsible, even to the level of resigning from the team in extreme circumstances; and (c.) these delegations are not well documented in the individual student notebooks pages, but are more likely to be documented in the periodic progress reports.

3. Understands and applies team tools (mastery level high)

Students complete a Team KSA inventory in bookend course IENG 241 and take the same inventory a second time for a pre/post analysis in bookend course IENG 462. Team KSA results show indicate scores above the national average but do not show much growth from the sophomore to the senior year. The department is experimenting with the Comprehensive Assessment of Team Member Effectiveness (CATME) to see if it results in a better measure of team member effectiveness.

(e) Students can identify, formulate, and solve engineering problems

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Identifies and appropriately deals with systems having conflicting criteria from a variety of stakeholders	IENG 352, IENG 366, IENG 471, IENG 475, IENG 486	Project Poster Assessment (rubric)	IENG 352	Fall – 2012 & 2015	Kellogg	Department Assessment Retreat
2. Incorporates the critical role of humans in the design process	IENG 311, IENG 321, IENG 366, IENG 471, IENG 475	Project Assessment (rubric)	IENG 471	Fall – 2012 & 2015	Jensen	Department Assessment Retreat

1. Deal with conflicting criteria and multiple stakeholders (mastery level moderate)

Student teams complete an innovation project and present via a project poster. Posters are scored using a poster rubric. Posters were requested by the students because the department is project heavy with student teams working on service learning or industry sponsored projects in six different courses. However, analysis of posters indicated too many student teams contributed too little effort and failed to properly apply concepts learned in the NIST Innovation Engineering component. Two years ago, we switched back to project reports and are seeing better results. In addition, we found that using the iterative design method tied to whole brain thinking yielded designs that were not as well defined. Whole brain thinking is still introduced but we focus more strongly on the NIST Innovation Engineering components. IENG 366 incorporates case work and role playing exercises. Structured controversy seems to be most helpful in getting students to think about the value of alternative perspectives. Projects in IENG 471 and IENG 475 require small design projects that require students to formulate problem ideas, alternative solutions, and ultimately the design approach. IENG 486 requires students to be able to utilize statistical concepts for process improvement. Student conceptual understanding of probability and statistics requires substantial review of fundamental statistics. The department has introduced a new course in process control tools that will hopefully sharpen conceptual understanding.

2. Incorporate role of humans in design process (mastery level moderate)

Project assessment rubric in IENG 471: Results from applying the course project assessment rubric to the term-ending projects in IENG 471 show that the majority of project teams are able to integrate the human role in their designs moderately well to well in most cases (cf. Analysis, Recommendations, and Communications aspects in the course report). However, some students still struggle with problem definition, tending to agglomerate symptoms instead of identifying the root causes. The remaining aspects were addressed moderately well to well in their rubric assessments. Service learning projects are incorporated as a formal laboratory component for both IENG 311 and IENG 321. Project results indicate improved student understanding of the importance of the customer requirements when formulating design concepts.

(f) Students have an understanding of professional and ethical responsibility

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Understands and can apply ethics in engineering design and analysis	IENG 331, IENG 366, IENG 462, IENG 465	Trend Analysis	FE Exam	Annual	Kellogg	Department Assessment Retreat
		Course embedded	IENG 366	Spring – 2011 & 2014	Karlin	Department Assessment Retreat
2. Able to carry out responsibilities in a professional and ethical manner	IENG 241L, IENG 311, IENG 321, IENG 366, IENG 462, IENG 465	Defining Issues Test (DIT)	IENG 462	Spring – 2010 & 2013	Karlin	Department Assessment Retreat

1. Understands and can apply ethics in engineering design (mastery level moderate)

As part of their reflective practice, students analyze a case study in IENG 366 in which they discern effective solutions to a variety of ethically questionable organizational decisions. Just over 77% of the students adequately completed this case analysis. FE scores for problems related to engineering code of ethics correlate with the above.

2. Able to carry out responsibilities in a professional/ethical manner (mastery level moderate)

Student moral reasoning is first assessed in IENG 241 and is assessed a second time in IENG 462 using the Defining Issues Test. DIT results indicate moderate gains from the sophomore to the senior year. Average performance on the FE exam shows a performance index score of 14 compared to the 9.9 comparator average. DIT results correlate with FE results with IEEM students scoring above the national average.

(g) Students can communicate effectively

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Communicates effectively in written form through words, graphs, and tables	IENG 311, IENG 321, IENG 354, IENG 366, IENG 471, IENG 465	Project assessment (rubric)	IENG 321	Spring – 2013 & 2016	Piper	Department Assessment Retreat
2. Demonstrates knowledge of basic formats of technical and managerial communications including memos, technical reports, resumes, and technical presentation	IENG 311, IENG 321, IENG 354, IENG 366, IENG 471, IENG 465	Project assessment (rubric)	IENG 354	Fall – 2012 & 2015	Kellogg	Department Assessment Retreat
		Project assessment (rubric)	IENG 366	Spring – 2013 & 2016	Karlin	Department Assessment Retreat
3. Effectively communicates orally using a prepared technical presentation	IENG 311, IENG 321, IENG 366, IENG 471, IENG 465	Presentation assessment (rubric)	IENG 366	Spring – 2013 & 2016	Karlin	Department Assessment Retreat
		Presentation assessment (rubric)	IENG 465	Spring – 2013 & 2016	Jensen, D	Department Assessment Retreat

1. Communicate effectively in written form (mastery moderate)

Students complete a community based or service learning project as part of the course requirements for IENG 321 Human Factors. Using the project rubric, average communication scores for 2011 were 2.33 (slightly above apprentice level). Communication scores for 2016 are scoring at a Moderate/Apprentice level.

2. Demonstrates knowledge of basic formats of technical and managerial communications (mastery level moderate)

Student teams complete a formal marketing plan in IENG 354. Projects are scored using a project rubric. Scores indicate students write reasonably well but primarily at the novice or intermediate levels. Students complete managerial communication in multiple forms, including memos and technical presentations in IENG 366. Overall class results are approximately a 2 (on a scale of 0 to 3) for “clarity of argument” and approximately a 3 for “professional presentation”.

3. Can give an effective technical presentation (mastery level high)

Student teams give formal presentations in IENG 366 Engineering Management and in IENG 465. Presentations are scored via the campus presentation rubric. The student team case analysis presentations for IENG 366 were analyzed over the course of the semester and the overall class results are approximately: Account for environmental variables (1.5), Define problem (2), Gather evidence (2.5), Choose appropriate tools (N/A), Develop a chain of evidence (2), Make choices (2), Reasonable solutions (2), Clarity of argument (2), and Professional presentation (3). For IENG 465, presentation rubrics indicate that presentations are effective. However, details of the presentation are not often polished to a professional level.

(h) Students have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Considers broader context when evaluating impact of potential engineering solutions	IENG 215, IENG 241L, IENG 302, IENG 311, IENG 321, IENG 366, IENG 441, IENG 471, IENG 475, IENG 462, IENG 465	HBDI	IENG 241L	Spring – 2013 & 2016	Kellogg & Kerk	Department Assessment Retreat
		Reasoning with Current Issues (RCI)	IENG 462	Fall – 2012 & 2015	Karlin/Kellogg	Department Assessment Retreat
2. Develops major sections (marketing plan, financial) of an effective business plan for a new product or enterprise	IENG 215, IENG 216, IENG 217, IENG 302, IENG 354, IENG 355	Project Assessment (rubric)	IENG 354 & IENG 355	Fall – 2012 & 2015 Spring – 2013 & 2016	Kellogg	Department Assessment Retreat

1. Consider the broader context when evaluations solutions (mastery level moderate to high)

Students are introduced to whole brain thinking in the sophomore year as an introduction to multiple perspectives and multi-disciplinary teams. Herrmann Brain Dominance Inventory (HBDI) results show little if any change in average typology from the sophomore to the senior year. Intellectual growth is measured in the senior year using the Reflections on Current Issues (RCI). Students consistently perform one half step above the baseline, one half step above the national average, and one half step below that which is desired in industry.

2. Develops major sections of a business plan (mastery level low to moderate)

Student teams submit a marketing plan for IENG 354 and a finance plan for IENG 355. Projects are scored using the IEEM project rubric. Students can present a reasonable argument but have greater difficulty fully defining the problem, considering all the environmental factors, and developing a clear chain of evidence. For finance plans, students can generally complete a finance plan but struggle with completeness of details (critical elements may be missing) and few teams fully justify the rationale for numbers used in the plan. In the most recent offering, one student team provided a fairly complete plan for the costs of an athletic support center but completely failed to recognize the need for any revenue projections.

(i) Students have a recognition of the need for, and an ability to engage in life-long learning

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Demonstrates commitment to continuous learning through involvement in co-curricular activities	IENG 241L IENG 462	Course Embedded	IENG 241L	Spring – 2012 & 2015	Kellogg & Kerk	Department Assessment Retreat
2. Demonstrates increase in cognitive development	IENG 241L, IENG 311, IENG 352, IENG 366, IENG 425, IENG 471,IENG 462, IENG 465	RCI	IENG 462	Fall – 2011 & 2014	Karlin/Kellogg	Department Assessment Retreat

1. Demonstrates a commitment to continuous learning (mastery level low)

IENG 241 is a first required course introduced in the sophomore year. Students are first introduced to the importance of the co-curriculum, professional ethics, and continuous learning. IENG 462 provides a bookend course for IENG 241. Professional ethics, planned giving, and continuous learning are again emphasized in this course. The campus has a Mines Advantage program that addresses a number of a-k outcomes within the co-curriculum. While most students participate in co-curricular activities, mastery level is low because the documentation is low. Student Affairs has now more formally integrated the co-curriculum with the concept of added value. Additional information will be provided near the end of this section.

2. Demonstrates an increase in cognitive development (mastery level moderate to high)

Every three years, we require students to complete the Reflections on Current Issues (RCI) if they are within two semesters of graduation. Results are compared to national averages and to the baseline data obtained from national research. While we utilize the RCI to demonstrate gains in objective 4 (approved by out advisory board), we also use as good predictor for lifelong learning. Specifically, if we can move students from dualistic to relativistic thinking, we do not need to worry about their interest in continuing education; it will occur quite naturally. Research tells us that engineering graduates typically score around 3.8 which is well below that which desired both by graduate school and by industry. At the last offering in 2013, IEEM graduates scored 4.6, well above the national average. This score still is well below the theoretical optimum for this age group can still be made. However, this result is quite remarkable and is something we consider comparable to students fully engaged in undergraduate research. The difference is that this average is for all IEEM graduates, not the 2-3% of students engaged in undergraduate research across the campus.

(j) Students have a knowledge of contemporary issues

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Appreciates the importance of diversity to effective teams	IENG 241L, IENG 366, IENG 465, IENG 471	Course Embedded / HBDI	IENG 241L	Spring – 2012 & 2015	Kellogg & Kerk	Department Assessment Retreat
2. Understands current management techniques and their application in engineering management systems	IENG 366, IENG 425, IENG 486	Course Embedded	IENG 366	Spring – 2012 & 2015	Karlin	Department Assessment Retreat

1. Appreciate the importance of diversity (mastery level moderate to high)

Students are introduced to whole brain thinking in the sophomore year as an introduction to multiple perspectives and multi-disciplinary teams. Herrmann Brain Dominance Inventory (HBDI) results show little if any change in average typology from the sophomore to the senior year.

2. Understands and can apply current management techniques (mastery level moderate to high)

Students demonstrate their understanding of current management techniques and their ability to apply those techniques in engineering management systems through the variety of activities in this class. Assessment is rooted in the student case analysis memos. A sample of analysis memos from two different case studies were analyzed using a course rubric.

(k) Students can use the techniques, skills, and modern engineering tools necessary for engineering practice

Performance Criteria	Strategies	Assessment Method(s)	Source of Assessment	Time of data collection	Assessment Coordinator	Evaluation of Results
1. Demonstrates competence in modern Industrial Engineering tools and software for simulation, statistics, optimization, facilities, and ergonomics	IENG 241L, IENG 311, IENG 355, IENG 366, IENG 441, IENG 471, IENG 475, IENG 464, IENG 465	Course Embedded	IENG 441	Spring – 2011 & 2014	Matejcik	Department Assessment Retreat
		Course Embedded	IENG 475	Spring – 2011 & 2014	Jensen, D	Department Assessment Retreat
2. Demonstrates competence in modern Engineering Management tools and software for financial decision making, project management, organizational management, statistics, and optimization	IENG 241L, IENG 311, IENG 355, IENG 366, IENG 441, IENG 471, IENG 475, IENG 464, IENG 465	Course Embedded	IENG 311	Fall – 2010 & 2013	Piper	Department Assessment Retreat
		Course Embedded	IENG 464	Fall – 2010 & 2013	Jensen, D	Department Assessment Retreat

1. Demonstrates competence in modern engineering tools and software (mastery level moderate to high)

Students demonstrate competence in Simio (ARENA prior to 2012)simulation software in IENG 441. Course assessment results indicate proficiency. Students demonstrate an ability to develop models in SolidWorks, translate parts to CNC codes using MasterCam, and perform integrated functions in the computer controlled manufacturing class. Semester long projects demonstrate student proficiency in computer aided design, computer numerical controlled machining, and programmable logic control. With Simio students can model entity flows, interpret the default Simio outputs, prepare documents describing the results, use Tools to select appropriate distributions, and collect specialized statistics.

2. Demonstrates competence in engineering management tools (mastery level moderate)

Students must use statistics, project management software, Minitab (or R open statistics software), Simio, or optimization tools to design systems. Students complete a community based project or service learning project as part of the course requirement in IENG 311 Work Measurements. Course assessment demonstrates student proficiency. Furthermore, in the IENG 321 Project Rubric team report evaluations over the last two cycles show continued improvement in student project scores.

A project rubric is used not for grading but for scoring projects for program assessment and continuous improvement. The department conducted a calibration exercise prior to full implementation. Calibration exercise showed fairly consistent scoring between faculty members but warranted some clarification on terminology. In addition, not all elements of the rubric are used on all projects. The project rubric is included in the course notebooks but is also included here for completeness.

	3	2	1	0
Account for Environmental Variables	Can identify both engineering and other environmental variables apropos to issue	Can identify engineering related environmental variables apropos to the issue	Can identify environmental variables, but unsure which are related to the issue	Fails to identify environmental variables or see the need for these variables
Define Problem	Root cause(s) of problem determined	Root cause(s) looked for, but process ended too soon	Multiple symptoms aggregated as problem	First symptom seen "defined" as the problem
Gather Evidence	Wide range of appropriate evidence sources used	Some appropriate evidence sources used	Evidence sources used, but not entirely appropriate to issue	No or inappropriate evidence sources used
Choose Appropriate Tools	Both quantitative and qualitative tools used as appropriate	Uses quantitative tools as appropriate	Uses tools, but tools are not appropriate to issue	No tools or frameworks used
Develop a Chain of Evidence	Clear links – uses data in its context and connects data using appropriate tools	Links – uses data and connects using appropriate tools	Almost links – based on inadequate data or tools	No links – no chain of evidence
Make Choices	Recommendation links to chain of evidence and shows consideration of additional alternatives	Recommendation links to chain of evidence but comes from the "canned" set of alternatives	Recommendation does not link to chain of evidence	No recommendation made
Reasonable Solutions	Solution(s) considers implementation concerns, level of actual improvement, economic impact, social impact, and ethics	Solution(s) considers implementation concerns and economic impact	Solution(s) is technically feasible, but no additional concerns are considered	Solution(s) is not feasible
Clarity of Argument	Presentation of argument demonstrates problem definition, chain of evidence, analysis, and recommendation in easy to follow manner	Presentation of argument demonstrates problem definition, chain of evidence, analysis, and recommendation but not easy to follow	Presentation of argument demonstrates only parts of: problem definition, chain of evidence, analysis, and recommendation	Presentation of argument cannot be followed by reasonable audience member
Professional Presentation	Well organized, uses professional language and grammar, appropriate use of tables, figures, etc, aimed at audience	Somewhat organized, mostly uses professional language and grammar, appropriate use of tables, figures, etc, mostly aimed at audience	Somewhat organized, poor grammar, uses texting language, needed figures, tables, etc present and appropriate, not aimed at audience	No organization, poor grammar, uses texting language, needed figures, tables, etc not present, not aimed at audience

Figure 4.3 IEEM Project Rubric

Contribution from General Education:

Although performance criteria may not be consistent with department outcomes, ABET outcomes a-k are nevertheless addressed in the general education component. Outcomes and program assessments are defined and assessed by the general education committee. The general education assessment report will be posted to a separate notebook at the time of the site visit but can be made available earlier on request. Humanities and Social Science are particularly good at providing feedback summaries on changes made to aid student development in communications, Humanities, and Social Sciences. Most notable for improvements have been structuring classroom experiences that aid in deeper understanding and providing a contextual importance for engineering students who might otherwise be dismissive of these important courses. Again, reports from the general education committee can be available at the time of the visit.

Contribution From the Co-curriculum

Student Affairs has restructured a Students Emerging as Professionals (STEPS) program to more closely align components of the co-curriculum with professional practice. The Mines Advantage program focuses on a value added certificate programs in Communication, Career Preparation, Leadership and Teamwork, Community Involvement, and Personal Development. Industrial Engineering and Engineering Management are highly supportive of the co-curriculum and we encourage student involvement in a first course in the major (IENG 241). Further, service

learning components are required elements in three of our courses. One faculty member is a Co-PI on the newly founded EPICS program. Sixty two of IEEM majors participate in one or more of the Mines Advantage program.

B. Continuous Improvement

The department has an annual retreat each summer. The retreat has two primary purposes. A portion of the retreat is primarily focused on strategic planning. During this session, the faculty meets to discuss feedback from constituents and current initiatives at the campus or state level. Comments from the department advisory board and the student focus group session along with results, along with assessment results are used adapt old strategies or implement new ones. Assessment results are generally reserved for the assessment retreat but may be reviewed if pertinent to strategic initiatives. If necessary, a SWOT or force field analysis may be conducted during deliberations of a proposed initiative. Past initiatives resulting from this process include the occupational safety minor and the certificate programs. The proposed innovation center was a direct result of Advisory Board input, South Dakota economic development initiatives, and a desire to respond to attributes of the Engineer of 2020.

The second focus of the retreat is on program assessment and curriculum development. Program assessments and pertinent course assessments are reviewed along with components of the alumni and employer surveys if applicable. Faculty members discuss areas of strength, areas for improvement, and strategies for curricular thrusts. Because of persistent student concerns and assessment data showing little or no improvement in modeling or conceptual understanding in probability and statistics, the department introduced two new courses this past year. ENGM 631 is a graduate course in linear programming. It is considered a professional development course and offers more focus on modeling. IEEM majors were allowed to take this course in the Fall 2015 and will again available in Fall 2016. We will be proposing a new 400/500 level course that will provide for better use of limited resources and will hopefully improve student modeling in operations. Students may take this in lieu of Math 353. The second course is process control tools where we focus on applications of hypothesis testing, regression, and experimental design. IENG 492 is an experimental course and will be offered again in the Spring. We then have to re-evaluate both available resources and improved conceptual understanding to probability and statistics to determine of a new course is warranted.

Actions to Improve the Program

The department is highly progressive and has a particularly strong focus on undergraduate education and scholarly teaching. The department is currently involved in (10) active NSF/NIOSH grants related to STEM education and Human Engineering. Department faculty routinely publish scholarly works in education, and is active in ASEE and FIE leadership in addition to development within the discipline. Consequently, the department has incorporated a number of new initiatives since that last ABET visit and works on curriculum on an almost ongoing basis. Summary of program improvements listed above follow.

- Redesign of the capstone sequence to include better reporting and separation of tasks. Program uses a new project and team rubric to better delineate task assignments and accountability.
- Introduction of a semester long project in IENG 475 computer controlled manufacturing.

- New CNC mill and the introduction of 3D printers, laser engraver, CNC routers, and injection molding to enhance manufacturing capacity.
- New technology support modules for probability and statistics.
- New course in process control tools to promote better conceptual understanding in probability and statistics.
- New course in Operations Research with more focus on modeling.
- Redesign of IENG 311 Work Measurements and IENG 321Human Factors to better integrate laboratory components with service learning.
- Introduction of a semester design project in IENG 471 Facilities Planning.
- Redesign of IENG 241 to include data collection and analysis.
- Introduction of IENG 248 Engineering Graphics and Computer Modeling with a semester project.
- Move to classroom inversion components in IENG 215, 216, 217 Cost Estimating, and 441 Simulation.

C. Additional Information

Evidence of achievement levels for each program outcome may be found in the outcome notebooks for the industrial engineering and engineering management program at the time of the site visit. Each outcome notebook will contain the outcome matrix and assessment data that supports the level of achievement. Assessment data can be correlated back to course notebooks that contain samples of student work; e.g., home work, exams, laboratory reports, posters, and/or project reports. Where available, outcome notebooks will also include complementary information and assessment from outside the department; e.g; general education courses and student affairs STEPS program.

Course notebooks will also be available in the resources room at the time of the visit. Each course notebook includes the syllabus in ABET format showing how course learning outcomes map to program outcomes, a regular syllabus, a course report, and samples of student work. The course report is the primary document used by department faculty to review the overall curriculum, determine how well program outcomes are met, and where curricular changes should be made. Each course report includes a map of course outcomes to program outcomes, strategies associated with the course to meet various outcomes, assessment data collected, and a summary of recommendations for improvement.

As part of the departmental presentation for budget requests, the campus has placed incentives for treatment of special topics. For the BY 2016 budget, the “special topics” were retention and the first year experience, enrollment planning, and fundraising. By framing budget requests in terms of special concern to the institution, departments were asked early in the year to focus on retention and first year advising. While the Industrial Engineering and Engineering Management program has a 95% three year retention rate, these numbers do not show up in any system data reporting mechanism. Cohort groups tend to penalize a department like Industrial Engineering when a first year cohort might only be a dozen students. Nevertheless, we now track student cohort groups. In addition, we support advising efforts, student engagement, and overall retention. These do not fit in the framework of outcomes assessment but are considered important and a special report on these topics may be found in the departmental notebook.