

**ABET**

**Self-Study Report**

for the

**Mechanical Engineering Technology Program**

at

**Colorado Mesa University**

**Grand Junction, Colorado**

**July 1, 2016**

**CONFIDENTIAL**

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## **List of Acronyms**

AEC	Archuleta Engineering Center
CI	Concept Inventory
CMU	Colorado Mesa University
FE	Fundamentals of Engineering Exam
IAC	Industry Advisory Council
ME	Mechanical Engineering
MET	Mechanical Engineering Technology
METAC	Mechanical Engineering Technology Assessment Committee
PC	Program Criteria
PEO	Program Educational Objective
PES	Physical & Environmental Sciences
SO	Student Outcome
UCB	University of Colorado Boulder

## **BACKGROUND INFORMATION**

### **A. Contact Information**

The primary visit contact for the ABET evaluation is the Director of the Engineering Programs, Tim Brower. Dr. Brower's contact information is

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### **B. Program History**

The University of Colorado Boulder (UCB) and Colorado Mesa University (CMU, formerly Mesa State College), entered into a partnership in February 2008 to deliver a Mechanical Engineering (ME) program in its entirety in Grand Junction, Colorado, the home of CMU. The UCB/CMU ME Partnership Program enables students to earn a Bachelor of Science in Mechanical Engineering (BSME) degree while in residence on the CMU campus in Grand Junction. The first two years of classes, including seven lower-level engineering courses, are offered by CMU and taught by CMU faculty. Students pay CMU tuition for these courses. Upper-level ME classes are offered by UCB at the CMU campus and are taught by UCB faculty who are in residence in Grand Junction. Students pay UCB tuition for this part of the program. Supplemental upper-division elective courses are offered by CMU to Partnership students during the UCB portion of the program. Students completing all requirements are awarded the BSME degree by UCB. The UCB/CMU ME Partnership Program received accreditation through the Engineering Accreditation Commission of ABET in August 2013.

In order to provide an alternative pathway to becoming an engineer and to better serve the vast array of students entering the engineering program at CMU, a Mechanical Engineering Technology (MET) program was initiated solely by CMU in January 2010. The first two years of both the ME and MET programs are essentially identical. That is, the outcomes (and pre-requisites) of the seven lower-level engineering courses that are required for both curricula are the same, allowing for both sets of students to sit in these classes. Then, as students enter the latter portion of their sophomore year, the programs diverge into a more theoretical ME program and a more applied MET program. The primary difference is most engineering classes in the ME junior year require Differential Equations, a class not required for the MET program. Students are encouraged to not commit to a program until well into their second year, thus allowing them time for a thorough comparison of both paths leading to an engineering career.

In order to take advantage of ABET's offer to have a program with the name "Applied Mechanical Engineering" rather than "Mechanical Engineering Technology," and seek accreditation through ETAC, the name of the MET Program was changed to the Applied

Mechanical Engineering Program in Fall 2014. However, after a Request for Evaluation (RFE) was submitted, ABET withdrew their offer to honor a name other than Mechanical Engineering Technology. The program changed the name back to MET effective late November 2015 and submitted an RFE for MET in January 2016.

Serving the citizenry of Colorado by enrolling a student population from diverse geographic areas within Colorado is a goal of the engineering programs on the CMU campus. The MET and ME Partnership Programs enable collaboration between two institutions to serve the western portion of Colorado, an area that did not previously offer any Bachelor of Science Degrees in Mechanical Engineering.

The first cohort of MET students, a graduating class of one, finished their senior year of classes in May 2013. In May of 2014 there were three MET graduates. An additional student graduated in December 2014. There were five MET graduates in May of 2015. The most recent class of six MET students graduated in May 2016.

The current request for accreditation through the Engineering Technology Accreditation Commission of ABET for the MET Program is a first-time request.

### **C. Options**

There are no formal options, tracks, or concentrations, etc. included in the MET Program. However, twelve credits of electives are grouped into “Manufacturing” and “Energy and Power” categories. Students are currently allowed to mix and match electives to total 12 credits since the program’s small class sizes do not warrant offering the full contingent of classes in these two categories.

### **D. Program Delivery Modes**

The MET Program is delivered using a traditional, lab/lecture methodology, with a daytime schedule, aimed at residential students. The program is experimenting with online delivery of the course ENGR 261 Statics. There were 6 students enrolled in the summer 2015 online offering of ENGR 261. Nine students took this class online in spring 2016 and the program will deliver this course online again in summer 2016 with 6 students registered.

### **E. Program Locations**

The Program is offered on both the CMU main campus and at the CMU Archuleta Engineering Center (AEC), approximately 3 miles from the main campus in Grand Junction. Typically, lower-level classes that do not require a laboratory are offered on the main campus. Laboratory classes and most upper-level engineering classes are only offered at the AEC. The address of each location is:

Colorado Mesa University  
1100 North Avenue  
Grand Junction, CO 81501

Archuleta Engineering Center  
2510 Foresight Circle  
Grand Junction, CO 81505

**F. Public Disclosure**

The Program Educational Objective (PEO), Student Outcomes (SOs), annual student enrollment and graduation data is made accessible to the public at the following location:

<http://www.coloradomesa.edu/engineering/degrees/mechanical-engineering-technology-bachelor.html>

**G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them**

N/A. This is the initial accreditation of this program.

# GENERAL CRITERIA

## CRITERION 1. STUDENTS

### A. Student Admissions

First-year students who are admitted to CMU’s four-year division must meet a minimum index score of 92. Baccalaureate seeking students with an index of 80-91 may be offered provisional admission provided they follow a curriculum designed in conjunction with an Academic Success Coach. Once the student completes 24 college-level credit hours, to include a grade of C or higher in SUPP 100, SUPP 101, ENGL 111, and MATH 105, 110, or 113 with an overall 2.5 GPA or higher, the student then may transition to a baccalaureate program.

A student accepted into the baccalaureate program and considering an engineering degree choice is classified as a pre-engineering student. A pre-engineering student does not have to declare the MET or ME degree path until midway through their sophomore year. However, a student may declare their intent to pursue an MET degree at any time after they successfully complete ENGR 101 Introduction to Engineering, a course that describes the differences between the MET and the ME degrees.

### B. Evaluating Student Performance

Evaluation of performance begins at the individual class level. Student evaluation is based on required course components. Evaluation tools used within a course include some or all of the following: individual homework assignments, in-class “clicker” (an in-classroom response system) questions, quizzes, examinations, individual lab reports, group projects, peer evaluation of contribution to team projects, computer assignments and project reports.

Under rare circumstances, a student who does not meet a course pre-requisite may take a class out of sequence. The procedure is for the student to meet with the faculty teaching the course. The faculty in turn would discuss the situation with the Engineering Program Director and then generate a document explaining why the student would be successful in the course without the pre-requisite and insert the document into the student advising folder.

Students are considered to be making “satisfactory progress” toward a degree if they attain a cumulative GPA consistent with the table listed below.

Cumulative Credit Hours	Cumulative GPA
0 – 15	1.70
16 – 30	1.80
31 – 45	1.90
46 and above	2.00

Students failing to achieve the minimum GPAs listed above will be placed on academic probation. The student will remain on probation until the minimum GPA is achieved, providing the student earns a minimum semester GPA of 2.00. If a student already on academic probation fails to earn a semester GPA of 2.00, the student will be placed on academic suspension. The student will be prohibited from further attendance at CMU for a minimum of one semester.

A student must achieve a cumulative grade point average of 2.00 or higher to graduate at the baccalaureate level.

Grades at CMU are as follows:

- A = Excellent to superior;
- B = Good to excellent;
- C = Satisfactory;
- D = Passing but not satisfactory;
- F = Fail;
- I = Incomplete;
- IP = In progress;
- W = Withdraw;
- NC = No credit;
- P = Pass.

Incomplete (“I”) grades are temporary grades given to a student only in an emergency case and at the discretion of the instructor. At the end of the semester following the one in which an “I” is given, the “I” becomes the grade that is submitted by the instructor to the Registrar’s Office. If the instructor does not submit a grade by the deadline for that semester, the grade becomes an “F.” A grade of “I” given spring semester must be addressed by the end of the following fall term.

### **C. Transfer Students and Transfer Courses**

The MET Program seeks to admit external candidates (students outside of CMU) with a high probability of successfully completing their undergraduate engineering technology degree. It is the policy of CMU to accept academic credits from:

1. All public colleges and universities in the State of Colorado provided they are currently regionally accredited. This applies regardless of the institution’s accreditation status at the time the credit was earned.
2. Private and out-of-state colleges and universities, provided the institution is currently regionally accredited and was accredited or was a candidate for accreditation at the time the credit was earned.
3. Regionally accredited two-year community or junior colleges.
4. Regionally accredited institutions that award “S” or “P” grades, if the granting institution states that such grade is equal to a grade of “C” or better.  
Regional accrediting bodies are:
  - Middle States Association of Colleges and Schools
  - New England Association of Schools and Colleges
  - Northwestern Association of Schools and Colleges
  - North Central Association of Schools and Colleges
  - Southern Association of Schools and Colleges
  - Western Association of Schools and Colleges
5. gtPathways-Colorado guaranteed general education transfer courses (see Catalog section on General Education Overview/Colorado Department of Higher Education Statewide Guaranteed Transfer Courses)
6. Colleges and universities outside of the United States provided the institution maintains the equivalent of a regional accreditation and individual transcripts have been evaluated by World Education Services or another NACES-approved member.

Only courses with a grade of “C” or better are eligible to be applied toward a degree.

CMU reserves the right to evaluate, on a course-by-course basis, any credits earned 15 years or more prior to enrollment. Initially, only courses used to fulfill general education requirements will be accepted in transfer. Other courses will be transferred upon acceptance by the Engineering Program Director. Additional transfer policies are available at <http://www.coloradomesa.edu/registrar/transfer.html>.

Advanced Placement and International Baccalaureate Credits: Advanced Placement (AP) or International Baccalaureate (IB) transfer credit may be obtained by students who have successfully completed AP or IB courses and tests while in high school. Information about specific AP and IB courses and credits can be found <http://www.coloradomesa.edu/registrar/transfer.html>.

#### **D. Advising and Career Guidance**

The MET Program is committed to providing all students with a high quality academic and career advising service. All faculty participate in regular faculty meetings where they share best practices and identify ways in which they can support and improve advising. Advising in the program is a shared responsibility among all faculty. Students are assigned faculty advisors upon entrance into CMU. Faculty advisors provide career advice and guide students towards particular electives depending upon their interests and future plans. Students are assigned to a faculty member for advising loosely based on the first letter of the student’s last name (reality mandates equalizing the advising load for faculty regardless of last name). Current allocations are:

Brower all UCB matriculated students (junior and senior years)  
McNeill A-E  
Bevill F-I  
Kessler J-N  
Lanci O-S  
Castro T-Z

#### **E. Work in Lieu of Courses**

CMU policy on awarding college credit for work in lieu of courses is summarized here: <http://www.coloradomesa.edu/registrar/transfer.html>. This includes:

- Advanced Placement (AP) and International Baccalaureate (IB) Examinations
- College-Level Examination Program (CLEP)
- Military Credit
- Credit by Examination

## **F. Graduation Requirements**

To be eligible for the BS Degree in MET from CMU, a student must meet all of the following minimum requirements:

- 1) 126 semester hours total (Students must complete a minimum of 30 of the last 60 hours of credit at CMU, with at least 15 semester hours in major discipline courses numbered 300 or higher).
- 2) 40 upper division credits (A minimum of 15 taken within the major at CMU)
- 3) 2.00 cumulative GPA or higher in all CMU coursework
- 4) 2.00 cumulative GPA or higher in coursework toward the major content area
- 5) Pre-collegiate courses (usually numbered below 100) cannot be used for graduation.
- 6) When filling out the program sheet a course can be used only once.
- 7) A student must follow the CMU graduation requirements either from 1) the program sheet for the major in effect at the time the student officially declares a major; or 2) a program sheet for the major for a year subsequent to the year during which the student officially declares the major which is approved for the student by the Program Director. Because a program may have requirements specific to the degree, the student should check with the faculty advisor for additional criteria. It is the student's responsibility to be aware of, and follow, all requirements for the degree being pursued. Any exceptions or substitutions must be approved by the student's faculty advisor, Program Director and PES Department Head.
- 8) A student must receive a "C" or higher in any class that is a pre-requisite for a subsequent class.
- 9) See the "Undergraduate Graduation Requirements" in the CMU catalog for additional graduation information.  
([https://www.coloradomesa.edu/catalog/documents/CMU\\_Catalog\\_1516.pdf](https://www.coloradomesa.edu/catalog/documents/CMU_Catalog_1516.pdf))

Individual student records are reviewed and audited to confirm that baccalaureate degree requirements have been met. The Program Sheet that the student is graduating under is the "contract" between the student and CMU. The Program Sheet is reviewed by the advisor, the Program Director, the PES Department Chair and ultimately the Registrar.

## **G. Transcripts of Recent Graduates**

Ten random transcripts for the most recent three graduating classes will be provided and described in a separate document. The program is using the fall 2015 program structure in the Self-Study documentation. Any subsequent changes to the curriculum will be provided along with the transcripts.

## **CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVE**

### **A. Mission Statement**

#### *CMU Institutional Mission Statement:*

“Committed to a personal approach, Colorado Mesa University is a dynamic learning environment that offers abundant opportunities for students and the larger community to grow intellectually, professionally, and personally. By celebrating exceptional teaching, academic excellence, scholarly and creative activities, and by encouraging diversity, critical thinking, and social responsibility, CMU advances the common good of Colorado and beyond.”

#### *Statutory Role and Mission:*

The role and mission of the institution was reenacted in 2010 by the Colorado General Assembly (Colorado Revised Statutes 23-53-101) and amended in 2011 when Mesa State College was renamed Colorado Mesa University:

“There is hereby established a university at Grand Junction, to be known as Colorado Mesa University, which shall be a general baccalaureate and graduate institution with selective admission standards. Colorado Mesa University shall offer liberal arts and sciences, professional and technical degree programs and a limited number of graduate programs. Colorado Mesa University shall also maintain a community college role and mission, including career and technical education programs. Colorado Mesa University shall receive resident credit for two-year course offerings in its commission-approved service area. Colorado Mesa University shall also serve as a regional education provider.”

### **B. Program Educational Objective (PEO)**

The mechanical engineering field is a broad engineering discipline that incorporates skills and expertise in the areas of design, manufacturing, materials, mechanics, thermal sciences, and energy that are essential to most sectors of industry. Students engage in a wide range of careers in industry, academia, government and nonprofit organizations, and the PEO is correspondingly broad:

“The Program Educational Objective of the Colorado Mesa University Mechanical Engineering Technology Program is to prepare graduates with mechanical technical knowledge, problem solving skills, and implementation skills so that, within three years of graduation, they will have successfully established themselves in a professional career in design, installation, operations, technical sales, or service functions in industry.”

The MET PEO can be found at: <http://www.coloradomesa.edu/engineering/degrees/mechanical-engineering-technology-bachelor.html>.

### **C. Consistency of the PEO with the Mission of the Institution**

The objective of the MET Program is congruent with the College's mission. The objective is also consistent with the accreditation criteria, which call for broad statements that describe the career and professional accomplishments which the MET Program is preparing graduates to attain.

### **D. Program Constituencies**

The constituents of the MET Program include:

- Faculty
- Students
- Alumni
- Industry Advisory Council

The faculty is committed to producing high quality graduates who are able to serve a broad range of industries and society at large. The faculty has high expectations, expressed in the PEO as preparing graduates with "...mechanical technical knowledge, problem solving skills, and implementation skills."

The undergraduate students' need for a broad, professional foundation that will prepare them for a wide choice of "professional careers in design, installation, operations, technical sales, or service functions in industry" is well served by the PEO. The alumni who have established themselves in professional careers "within three years of graduation" are also well served by the PEO.

External constituents are represented by the Industry Advisory Council (IAC) which meets at least once per semester. The IAC comprises members from industry, government, and the service sector from the Western Slope of Colorado. These members represent companies of significance in Western Colorado who are major employers of our students in the role of interns, or entry level engineers. These companies need qualified mechanical engineers ready to enter the workforce and make immediate contributions. In this capacity, the IAC reviewed and approved the PEO. Additional external constituents played a role in developing the MET Program via a survey given to local industry. The results of that survey indicated that electives in the MET Program should focus on manufacturing and energy. Specific survey results are attached to the IAC minutes of May 2013.

### **E. Process for Revision of the Program Educational Objectives**

The basic process for review and revision of the PEO is shown in Fig. 2-1. The wording of the PEO is reviewed with each set of program constituents. It is anticipated that the PEO will be reviewed on a 2-year cycle.

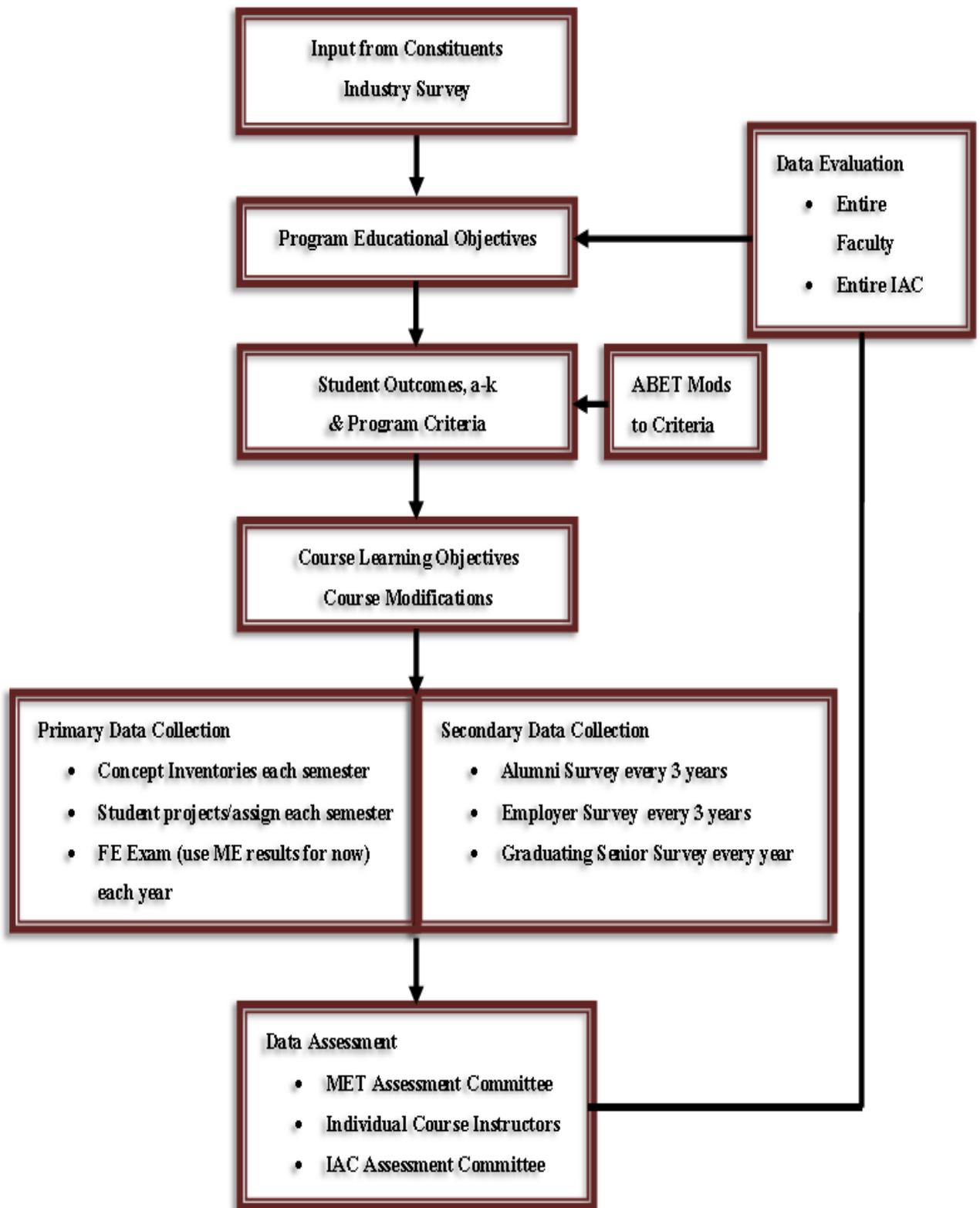


Figure 2-1. Process for Revision of the PEOs & Student Outcomes.

### **CRITERION 3. STUDENT OUTCOMES**

#### **A. Process for Establishment and Revision of Student Outcomes (SOs)**

The MET Program constituents periodically review the PEO and SOs. Various discussions concerning the PEO between the IAC and Program faculty are documented in the respective minutes of each group. Students participate in these discussions primarily in classes taught by the faculty.

#### **B. Student Outcomes**

The list of SOs for the program align directly with the ABET ETAC Student Outcomes (a) through (k). These outcomes describe what students are expected to know and be able to do by the time of graduation:

- (a) an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities;
- (b) an ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;
- (c) an ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes;
- (d) an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives;
- (e) an ability to function effectively as a member or leader on a technical team;
- (f) an ability to identify, analyze, and solve broadly-defined engineering technology problems;
- (g) an ability to apply written, oral, and graphical communication in both technical and non- technical environments; and an ability to identify and use appropriate technical literature;
- (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) a knowledge of the impact of engineering technology solutions in a societal and global context; and
- (k) a commitment to quality, timeliness, and continuous improvement.

Along with the SOs given above, specific skills uniquely related to mechanical engineering technology have been developed to satisfy the MET Program Criteria. Hence, the Mechanical Engineering Technology Program requires that its graduates demonstrate knowledge and competency in:

- PC-a: Geometric dimensioning and tolerancing and computer aided drafting and design,
- PC-b: The selection, set-up and calibration of instrumentation and sensors used in mechanical design and equipment operation,
- PC-c: Industry codes, specs and standards,
- PC-d: Manufacturing processes,
- PC-e: Material science and selection,
- PC-f: Solid mechanics,
- PC-g: Thermal sciences, and
- PC-h: Electrical circuits and controls.

The SOs, Program Criteria and the PEO are documented on the engineering website: <http://www.coloradomesa.edu/engineering/degrees/mechanical-engineering-technology-bachelor.html>.

### **C. Mapping of SOs to Criterion 3 Learned Capabilities and PC Outcomes**

In turn, the MET undergraduate curriculum is derived from the SOs (a) through (k) and MET specific Program Criteria as shown in Table 3-2. The courses in the MET curriculum are thus designed to achieve the PEO. The SOs and Program Criteria are woven throughout the entire curriculum as will be demonstrated herein.

It should be noted that SOs (a) through (k) and the Program Criteria are components of more courses than those indicated in Table 3-2. However, in order to keep the assessment process manageable, a subset of classes is used to illustrate strategies for achieving SOs. In the continuous improvement process, other specific courses might be identified to focus efforts to improve student preparation to meet SOs.

As shown in Appendix F, the Student Outcomes (SOs) are further refined into specific Learning Objectives (a-1, a-2, b-1, etc.) that are derived from each Student Outcome. *Learning Objectives* are the elements of competency that the students will demonstrate by their graduation from the MET Program. *Performance Criteria* (a-1-a, a-1-b, b-1-a, etc.) are measurable statements and indicate the specific characteristics students should exhibit in order to demonstrate the desired attainment of the Student Outcome. In most cases, Performance Criteria language is included in the rubrics used to assess student work.

### **D. Relationship of Student Outcomes to Program Educational Objective**

The curriculum provides broad preparation in engineering and science fundamentals, as well as focused technical electives that prepare students to succeed in professional careers in engineering and related fields. Extensive design experience is offered through the Integration I and II courses taken in the junior year and additionally in the full-year capstone design course taken during the senior year. The capstone course includes projects offered by industrial partners and prepares students to successfully pursue and “*establish themselves in professional careers*” in engineering. All student outcomes are vital for students to be successful in their positions in

industry. Finally, while the MET curriculum is focused on preparation for careers in this field, successful completion of the curriculum also supports success in other professional fields by providing extensive experience in the problem solving, critical thinking and design skills that are valuable in many other professions.

As reflected by the general nature of the PEO, students in the MET Program learn the general skills and abilities appropriate to the wide range of achievements the MET Program expects of students in a diverse range of industry sectors. In addition, they learn the specific skills required for careers in mechanically related engineering disciplines.

The relationship of PEO to SOs (a) through (k) and the specific MET Program Criteria is outlined in Table 3-1.

**Table 3-1. Matrix of Program Educational Objective to Student Outcomes**

Program Educational Objective	Student Outcomes											Program Criteria
	a	b	c	d	e	f	g	h	i	j	k	
Prepare graduates with technical knowledge and skills	X	X	X	X		X						X
Prepare graduates to establish themselves in professional careers				X	X		X	X	X	X	X	X

Table 3-2. Matrix of how Student Outcomes and Program Criteria are aligned with Program Curriculum.

Student Outcomes – What students are expected to know and be able to do by graduation:	Lower-Level Courses											Upper-Level Courses																				
	MAMT 102 Machine Shop	MAMT 105 Print Reading & Sketching	MAMT 106 GD & T	ENGR 101 Intro to Engr	ENGR 125 CAD & Fab	ENGR 140 1st Year Projects	CSCI 130 Intro Engr Comp	ENGR 224 Material Sci	ENGR 225 Intro Manuf	ENGR 261 Statics & Str.	ENGR 263 Mech of Solids	SOCI 120 Tech & Society	ENGR 305 Engr Econ & Ethics	ENGR 312 Thermo	ENGR 317 Circuits & Elec	ENGR 321 Fluid Mech	STAT 305 Statistics & Quality Contr for ENGR	ENGR 325 Compt Design	ENGR 343 Dynamics	ENGR 345 Engr. Integration I	ENGR 385 Engr. Integration II	ENGR 401 Professionalism Seminar	ENGL 425 Scientific Writing	ENGR 427 Measurements Lab	ENGR 435 Industrial Controls	ENGR 445 Sr Proj I	ENGR 446 Writing for Senior Projects	ENGR 485 Sr Proj II				
a) an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities – SolidWorks (SW) and LabView (LV)					X <sub>sw</sub>				X <sub>sw</sub>						○ <sub>lv</sub>					X <sub>sw</sub>	○ <sub>sw</sub>				X <sub>lv</sub>						X <sub>sw</sub>	
b) an ability to select and apply knowledge of mathematics, science, engineering, and technology to ET problems that require the application of principles and applied procedures or methodologies								Δ		Δ	Δ			Δ		Δ				Δ												
c) an ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes									X						○		X								X							
d) an ability to design systems, components, or processes for broadly-defined ET problems appropriate to PEOs																X		X		X											○	X
e) an ability to function effectively as a member or leader on a technical team						X										X											X			○		
f) an ability to identify, analyze, and solve broadly-defined engineering technology problems								Δ		Δ	Δ			Δ		Δ				Δ												
g) an ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature					X	X		X															X			X		○	○			
h) an understanding of the need for and an ability to engage in self-directed continuing professional development				X														X				○										
i) an understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity				X									○																			
j) a knowledge of the impact of engineering technology solutions in a societal and global context																																
k) a commitment to quality, timeliness, and continuous improve't						X								X													X			○		
<b>Program Criteria-Demon Knowledge &amp; competency in:</b>																																
a) GD&T			X		X				○																							
b) Instrumentation & Sensors															X										X		○					
c) Industry Codes, Specs & Standards								X											○													
d) Manufacturing Processes	X	X	X						○																							
e) Material Science & Selection								X	○																							
f) Solid Mechanics										X	X								○	X												
g) Thermal Sciences														○		○																
h) Electrical Circuits & Controls															○												○					

X indicates where an outcome is addressed (a formative assessment); Δ indicates where concept inventories are used for assessment; ○ indicates where a summative assessment occurs

## CRITERION 4. CONTINUOUS IMPROVEMENT

A plan for curricular assessment and improvement is in place and is shown in Figure 2-1. This figure illustrates the implementation plan for continuous improvement of curricular content and assessment of progress towards program goals and objectives.

A consistent program philosophy is to use various strategies throughout the curricula to introduce the Student Outcomes. For example, as indicated in Table 3-2 for SO (g) “an ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature,” the strategies begin in the freshman year in ENGR 125 CAD and ENGR 140 1<sup>st</sup> Year Engineering Projects. It is touched on in a sophomore level course, ENGR 224 Material Science and the junior/senior level course ENGL 425 Scientific Writing. In the senior year, students are heavily involved in written, oral, and graphical communication in the capstone courses ENGR 445 and 485. Finally in the spring semester of their senior year students are assessed in their ability to communicate effectively in ENGR 446, a course that is taken concurrently with the last semester of their senior project, ENGR 485.

### A. Student Outcomes

First, a verbiage note, primary and secondary assessments are currently suggested at ABET for summative assessments. In the past, these two terms were designated direct and indirect assessments, respectively. Herein, the MET program is using the primary and secondary terms. A primary demonstration of the attainment of Student Outcomes occurs via:

- Concept Inventories in certain courses (a definition and example of Concept Inventories may be found in Appendix E),
- targeted course projects, presentations, assignments, and exams, and
- FE Exam results given to ME students. Note that completion of the FE Exam will be a requirement for graduation from the MET Program. However, in the state of Colorado, a student is not able to sit for the FE unless they are graduating from an ABET accredited program. Since the MET Program is not ABET accredited yet, this assessment tool is not utilized at this time. However, limited information from the UCB Partnership ME students (for whom taking the FE is a requirement) will be shown herein.

Secondary means of demonstrating attainment of Student Outcomes include the use of Senior Exit Surveys and Employer Surveys.

Table 4-1 shows the **typical template format** used for the assessment activity of an individual Student Outcome. The column headings are defined as follows:

*Learning Objectives* - to assist in the assessment process, the Program has broken the ABET Student Outcomes into elements of competency, i.e., Learning Objectives. Each Learning Objective has related Performance Criteria, which are measurable statements against which students are directly assessed. These Performance Criteria, not shown in the table but listed in the various rubrics used for the actual assessment of an outcome, indicate the specific

characteristics students should exhibit in order to demonstrate the desired attainment of the Learning Objective. The language used in the rubrics is given in Appendix F.

*Strategies* (or formative assessments) are the courses or activities that are designed to provide opportunities for the students to learn, practice, demonstrate and/or get feedback on their performance on the Learning Objectives. Strategies identify how the curriculum is aligned with each Student Outcome.

*Assessment Method* is the type of assessment instrument that is used to assess student learning and involves the Senior Exit Survey, CI, course projects, assignments, or exams. For all SOs, at least one of the courses listed as a strategy is used to assess the outcome.

*Time Data was Collected* identifies when the assessment data were collected.

*Evaluation of Results* is the person(s)/group(s) responsible for conducting the assessment (e.g., marking of rubrics or comparing average percentages, etc.). This evaluation is given to the Program Director who, in consultation with the MET Assessment Committee (METAC) determines the meaning of the assessment results and makes recommendations for action to remedy any shortcomings.

The “results” and “actions” for a particular student outcome are listed below each table.

**Table 4-1.**  
**Student Outcome x: An ability to .....**

Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results

**Results:** Includes the sample size of students, rubric outcomes, observations on the assessment techniques.

**Actions:** Includes changes to the strategies, assessment methods or other actions that address the results noted above.

The specification of Learning Objectives for each Student Outcome is essential for adequate assessment. Rubrics associated with each Learning Objective are provided as a sub-folder in the course folder of the jump drive given with the Self-Study.

**Assessment Summary of Student Outcome Results**

For each Student Outcome, all the raw data that goes into populating Tables 4-2a through 4-2k and Tables 4-3a through 4-3h will be provided on the jump drive containing the July 1<sup>st</sup> Self-Study.

Please note that the averaging of averages is never used herein.

The **expected level of attainment** for each of the different types of instruments used to assess Student Outcomes is described as follows:

- *When a rubric is used: a minimum of 80% of the students must receive > 70% average on the scoring rubric (i.e., 3.5 out of 5 or 2.8 out of 4).*
- *When course Concept Inventories (CI) are used: % Gain = [(Post-test student average %) – (Pre-test average %)] ≥ 20%. For certain courses the program has data from UCB student results. In these cases, the UCB ME student average is used as an expected level of attainment.*
- *When the rubric from SOCI 120 is used: the mean intermediate score of >5.0 is used as a target. The assumption is that the*
- *When the Senior Exit/Employer Survey is used: the mean intermediate score of >3.0 is used as a target of the student's perceived ability or of the employer's perception of that particular SO or PC. A 3.0 is defined as moderately well.*
- *When the IAC evaluated the senior projects, the following rubric was used. Each team must score > 70% of the max score of 5 or a score of 3.5. It is important to note that MET and ME students are intentionally integrated on the same team to better represent an industrial setting.*

The expected level of attainment of 70% chosen for many of the outcomes reflects the program passing grade of C. As the MET Program matures, it is expected that a higher expectation for program graduates will evolve.

Take note that the CMU MET Program Criteria have been newly updated to reflect the current ABET ETAC criteria documents. The decision to update the MET Program Criteria was to add specificity to the attributes that an MET student exhibit at graduation. The program embraces the ABET ETAC Program Criteria change, however, due to the newness of the requirement, some of the assessments of PC a-h are only being accomplished for the first time in the 2015-16 academic year.

## **B. Continuous Improvement**

Tables 4.2a - 4.2k and Tables 4.3a - 4.3h provide summaries of the results and actions associated with each Student Outcome (a) through (k) and the MET Program Criteria (a) through (h), respectively.

**Table 4-2a.**  
**Student Outcome a:**  
**An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities**

Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Eval of Results
Students will be able to demonstrate the ability to:				
a-1. Proficiently use LABVIEW to solve engineering problems	ENGR 317 ENGR 427	-Sr Exit Survey -Employer Surv -Assign in ENGR 317	-Sp 2015, 16 -Sp 2016 -Sp 2015, 16	Instructor METAC
a-2. Proficiently use Solid Modeling to solve engineering problems	ENGR 125 ENGR 225 ENGR 345 ENGR 385	-Sr Exit Survey - Employer Surv - Assign in ENGR 385	-Sp 2015, 16 -Sp 2016 -Sp 2016	Instructor METAC

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
An ability to select and apply the knowledge, techniques, skills, and modern ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
An ability to select and apply knowledge of STEM to ET problems ...	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
An ability to conduct standard tests and measurements...	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4
An ability to design systems, components, or processes for ET problems ...																				
An ability to function effectively as a member or leader on a technical team																				
An ability to identify, analyze, and solve broadly-defined ET problems																				
An ability to apply written, oral, and graphical communication in ...																				
An understanding of the need for and ability to engage in self-directed continuing PD																				
An understanding of /commitment to address prof & ethical responsibilities...																				
A knowledge of the impact of ET solutions in a societal and global context																				
A commitment to quality, timeliness, and continuous improvement																				
Knowledge of GD&T and computer aided drafting and design																				
Hands-on skills in the selection, set-up and calibration of instr & sensors used ...																				
Knowledge of industry codes, specs and standards																				
Knowledge and hands-on skills in manufacturing processes																				
Knowledge and problem solving ability in material science and selection																				
Problem solving ability in solid mechanics																				
Problem solving ability in thermal sciences																				
Problem solving ability in electrical circuits and controls																				

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

*Assignment in ENGR 317 (n=15 in 2015 & n=18 in 2016):*

Spring 2015	Bagnard, Natalie	Bear, Brant	Buck, Christopher	Burdi, Shane	Carlton, John	Dana, Brett	Gillespie, Logan	Hawley, Nathan	Jenkins, Jeremy	Kawano, Ryan	Lara, Leandro	Marin Garacia, Jose	Nielson, Thomas	Rucker, Taylor	Asland, Thomas
<b>Category/Score</b>															
<b>LabVIEW Basics</b>	3.0	2.5	2.5	2.5	2.5	2.0	1.3	3.0	2.0	3.0	2.5	2.5	2.0	3.0	2.0
<b>Using LabVIEW VIs</b>	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.2	3.7	2.7	3.7	3.7	3.7	3.7
<b>Creating VIs</b>	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3.0	2.5	2.5	2.5	2.5	2.5	3.0	2.5
<b>Using LabVIEW Vis for Data Acquisition/Generation</b>	3.0	3.0	2.5	2.5	2.5	2.5	2.5	3.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5
<b>Averages</b>	<b>3.1</b>	<b>2.9</b>	<b>2.8</b>	<b>2.8</b>	<b>2.8</b>	<b>2.7</b>	<b>2.5</b>	<b>3.2</b>	<b>2.6</b>	<b>2.9</b>	<b>2.6</b>	<b>2.8</b>	<b>2.7</b>	<b>3.1</b>	<b>2.7</b>

**Rubric max was 5.0, target of 70% is 3.5: 0% of students scored > 70% on Rubric**

Spring 2016	Ahmed, James	Benson, Ryan	Burdi, Shane	DeFeo, Anthony	Dulaney, Dane	Gilliam, Jeremy	Hamer, Dalton	Hegge, Daniel	Ibarra, Carlos	Jenkins, Jeremy	Kawano, Ryan	Koos, Jaden	Matosky, Lance	Patton, Morgan	Prescott, James	Salazar, Daniel	Ward, Peter	Wolfe, Mathew
<b>Category/Score</b>																		
<b>LabVIEW Basics</b>	1.3	1.0	2.0	1.3	2.0	1.5	1.3	1.0	2.5	2.5	2.5	2.5	2.5	2.0	2.5	1.0	2.0	0.8
<b>Using LabVIEW VIs</b>	2.0	1.0	2.5	2.0	2.0	2.5	2.0	1.5	3.0	2.5	2.5	2.5	2.5	2.5	3.0	1.0	2.5	1.3
<b>Creating VIs</b>	1.0	1.0	1.3	1.0	1.3	1.3	1.0	1.0	1.3	2.0	2.0	1.3	1.3	1.3	1.3	1.0	1.3	0.8
<b>Using LabVIEW Vis for Data Acquisition/Generation</b>	1.0	1.0	2.0	1.3	1.3	1.3	1.3	1.0	1.3	2.5	2.5	2.0	2.0	2.0	1.8	1.0	2.0	0.8
<b>Averages</b>	<b>1.3</b>	<b>1.0</b>	<b>2.0</b>	<b>1.4</b>	<b>1.7</b>	<b>1.7</b>	<b>1.4</b>	<b>1.1</b>	<b>2.0</b>	<b>2.4</b>	<b>2.4</b>	<b>2.1</b>	<b>2.1</b>	<b>2.0</b>	<b>2.2</b>	<b>1.0</b>	<b>2.0</b>	<b>0.9</b>

**Rubric max was 5.0, target of 70% is 3.5: 0% of students scored > 70% on Rubric**

*Assignment in ENGR 385 (n=4) in spring 2016:*

	Ryan Benson	Dane Dulaney	Alexandra Fieber	Carlos Ibarra
a-2-a. Solid models are created for components using appropriate modeling techniques	5.0	5.0	5.0	5.0
a-2-b. Parts drawings for machined components are fully dimensioned with appropriate tolerances and fabrication notes where appropriate	N/A	N/A	N/A	N/A
a-2-c. Solid model assembly files are complete; component mates provide appropriate degrees of freedom and accurately represent component interactions; exploded view(s) are utilized to clarify component positions	3.5	3.0	3.0	3.5
a-2-d. Appropriate clearances, interferences, and tolerances used in solid model	4.5	4.0	4.0	4.5
a-2-e. Complete Bill of Materials accompanies solid model assembly file (including vendor/catalog #'s where appropriate; appropriate part naming; part quantities are listed)	4.0	3.5	3.5	4.0
<b>AVERAGE:</b>	<b>4.3</b>	<b>3.9</b>	<b>3.9</b>	<b>4.3</b>

**Rubric max was 5.0: 100% of students scored > 70% on Rubric**

**Results Summary for Student Outcome a: An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	3.5/5.0	>3.0	No
	2016	3.8/5.0	>3.0	No
Employer Survey	2016	3.8/5.0	>3.0	No
LabView Assign in ENGR 317	2015	0%	>70%	Yes
	2016	0%	>70%	Yes
SolidWorks Assign in ENGR 385	2016	100%	>70%	No

**Actions:** By not meeting the expected level of attainment for use of the software LabView, the program must act. The METAC concluded that the six 20-min LabView exercises conducted in ENGR 317 did not allow enough time to adequately prepare students to show proficiency in the rubric. In the future this outcome will be assessed in the new senior-level course ENGR 427 Measurements. ENGR 317 is a pre-req for ENGR 427.

**Table 4-2b.**

**Student Outcome b:**

**An ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies**

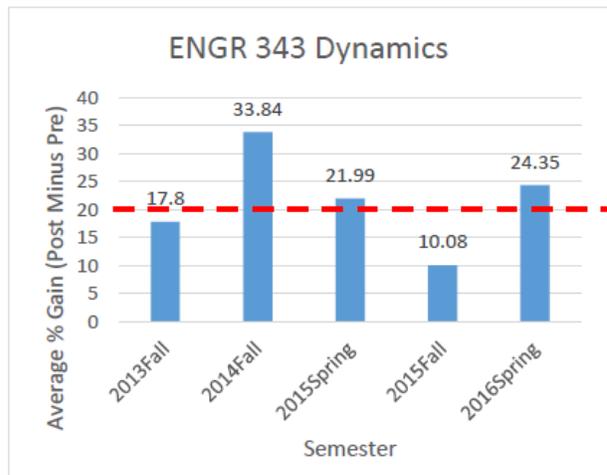
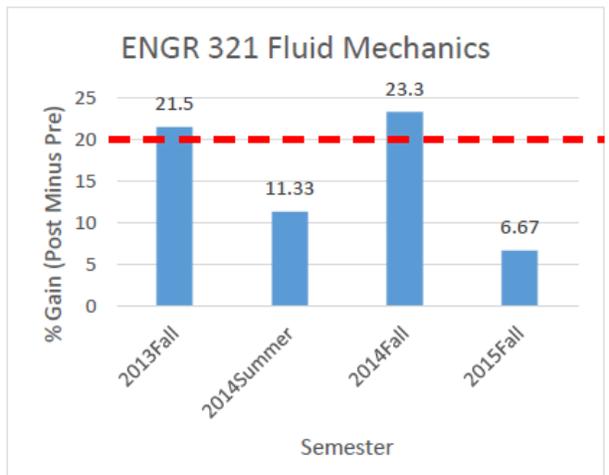
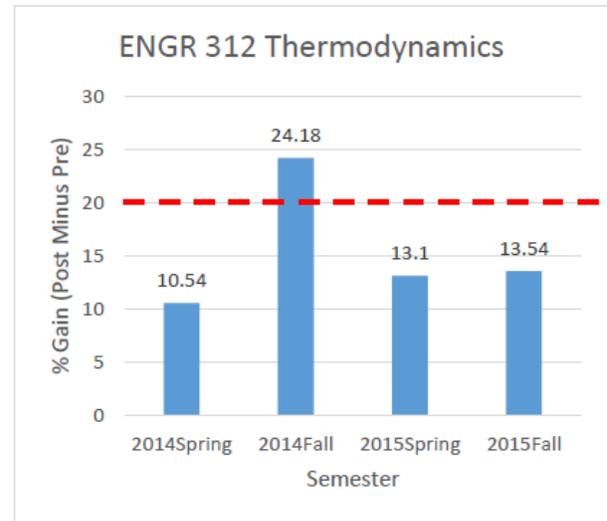
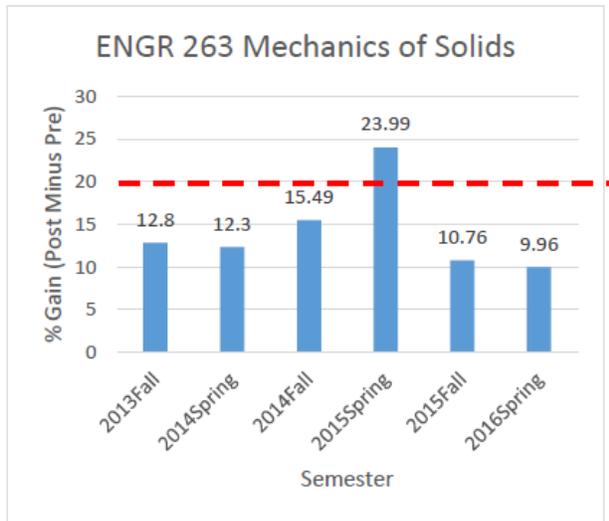
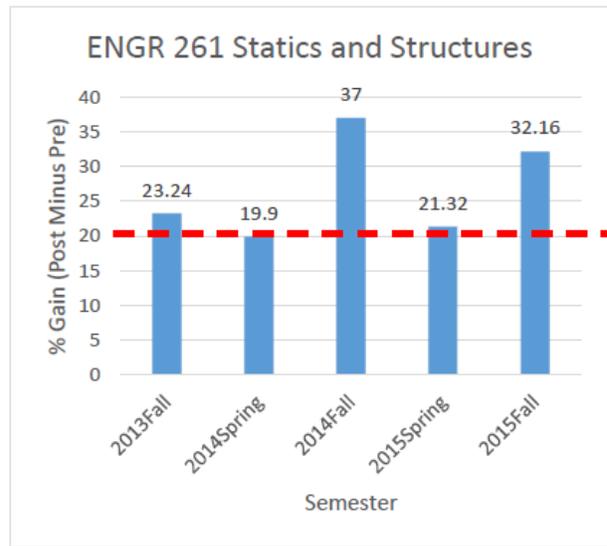
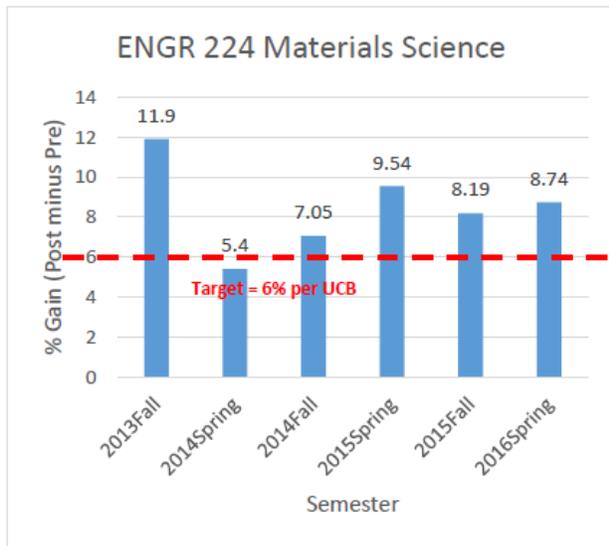
Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
b-1. Apply knowledge of math to the level required for fluency in the tech of anal and syn that are relevant to the broad field of engr	ENGR 224, 261, 263, 312, 321, 343	-Sr Exit Survey -Employer Surv -CI's in 6 classes	-Sp 2015, 16 -Sp 2016 -each time the course is taught	METAC
b-2. Apply knowledge of the physical sciences, life sciences, and information sciences to the broad field of engineering	ENGR 224, 261, 263, 312, 321, 343	-Sr Exit Survey -Employer Surv -CI's in 6 classes	-Sp 2015, 16 -Sp 2016 -each time the course is taught	METAC
b-3. Apply knowledge of engineering & technology to real problems	ENGR 224, 261, 263, 312, 321, 343	-Sr Exit Survey -Employer Surv -CI's in 6 classes	-Sp 2015, 16 -Sp 2016 -each time the course is taught	METAC

**Results:** *Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
An ability to select and apply the knowledge, techniques, skills, and modern ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
An ability to select and apply knowledge of STEM to ET problems ...		3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
An ability to conduct standard tests and measurements...		4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4
An ability to design systems, components, or processes for ET problems ...																				
An ability to function effectively as a member or leader on a technical team																				
An ability to identify, analyze, and solve broadly-defined ET problems																				
An ability to apply written, oral, and graphical communication in ...																				
An understanding of the need for and ability to engage in self-directed continuing PD																				
An understanding of /commitment to address prof & ethical responsibilities...																				
A knowledge of the impact of ET solutions in a societal and global context																				
A commitment to quality, timeliness, and continuous improvement																				
Knowledge of GD&T and computer aided drafting and design																				
Hands-on skills in the selection, set-up and calibration of instr & sensors used ...																				
Knowledge of industry codes, specs and standards																				
Knowledge and hands-on skills in manufacturing processes																				
Knowledge and problem solving ability in material science and selection																				
Problem solving ability in solid mechanics																				
Problem solving ability in thermal sciences																				
Problem solving ability in electrical circuits and controls																				

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Concept Inventory (n=various, 2013 through 2016) results are:



**Results Summary for Student Outcome b: An ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	3.5/5.0	>3.0	No
	2016	3.7/5.0	>3.0	No
Employer Survey	2016	4.4/5.0	>3.0	No
Concept Inventories ENGR 224 Materials	2013- 2016	>6%	>6%	No
Concept Inventories ENGR 261 Statics	2013- 2016	>20%	>20%	No
Concept Inventories ENGR 263 Solid Mechanics	2013- 2016	<20%	>20%	Yes
Concept Inventories ENGR 312 Thermodynamics	2013- 2016	<20%	>20%	Yes
Concept Inventories ENGR 321 Fluids	2013- 2016	Variable	>20%	No
Concept Inventories ENGR 343 Dynamics	2013- 2016	Variable Mostly>20%	>20%	No

**Actions:** By not meeting the expected level of attainment specified as an increase in CI score of  $\geq 20\%$  for two of the six classes, i.e., ENGR 263 Solid Mechanics and ENGR 312 Thermodynamics, action must be taken. The METAC discussed having inconsistency in the instruction of ENGR 312 Thermodynamics over the past several years. Recommended immediate actions will be to:

1. Hire a new full-time faculty member that will be responsible for teaching the thermofluids sequence of MET courses. As of today, an offer is on the table to a potential candidate to fill this role.
2. Professors Scott Bevill and Scott Kessler will retool the concept inventory used for ENGR 263 Solid Mechanics. It is felt that the CI does not reflect what is being taught in the class.
3. Along the lines of “2” we will investigate using a different CI in the future.

**Table 4-2c.**

**Student Outcome c:**

**An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes**

Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
c-1. Follow the design of experiment plan	ENGR 224 ENGR 317 STAT 305 ENGR 427	-Sr Exit Survey -Employer Surv -Assign in ENGR 317	Sp 2015, 16 Sp 2016 Sp 2016	Instructor METAC
c-2. Acquire data on appropriate experimental variables	ENGR 224 ENGR 317 STAT 305 ENGR 427	-Sr Exit Survey -Employer Surv -Assign in ENGR 317	Sp 2015, 16 Sp 2016 Sp 2016	Instructor METAC
c-3. Compare experimental data and results to appropriate theoretical models	ENGR 224 ENGR 317 STAT 305 ENGR 427	-Sr Exit Survey -Employer Surv -Assign in ENGR 317	Sp 2015, 16 Sp 2016 Sp 2016	Instructor METAC

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
(a) An ability to select and apply the knowledge, techniques, skills, and modern ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
(b) An ability to select and apply knowledge of STEM to ET problems ...	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
(c) An ability to conduct standard tests and measurements...	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4
(d) An ability to design systems, components, or processes for ET problems ...																				
(e) An ability to function effectively as a member or leader on a technical team																				
(f) An ability to identify, analyze, and solve broadly-defined ET problems																				
(g) An ability to apply written, oral, and graphical communication in ...																				
(h) An understanding of the need for and ability to engage in self-directed continuing PD																				
(i) An understanding of /commitment to address prof & ethical responsibilities...																				
(j) A knowledge of the impact of ET solutions in a societal and global context																				
(k) A commitment to quality, timeliness, and continuous improvement																				
(a) Knowledge of GD&T and computer aided drafting and design																				
(b) Hands-on skills in the selection, set-up and calibration of instr & sensors used ...																				
(c) Knowledge of industry codes, specs and standards																				
(d) Knowledge and hands-on skills in manufacturing processes																				
(e) Knowledge and problem solving ability in material science and selection																				
(f) Problem solving ability in solid mechanics																				
(g) Problem solving ability in thermal sciences																				
(h) Problem solving ability in electrical circuits and controls																				

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Assignment in ENGR 317 (n=15 in 2015 & n=18 in 2016):

Spring 2015	Bagnard, Natalie	Bear, Brant	Buck, Christopher	Burdj, Shane	Carlton, John	Dana, Brett	Gillespie, Logan	Hawley, Nathan	Jenkins, Jeremy	Kawano, Ryan	Lara, Leandro	Marin Garacia, Jose	Nielson, Thomas	Rucker, Taylor	Asland, Thomas
<b>Category/Score</b>															
<b>Understanding and use of Dual Power Supply</b>	3.0	3.0	3.0	2.0	2.5	2.5	1.3	3.0	2.0	2.0	2.0	2.5	3.0	3.0	2.0
<b>Understanding and use of DMM</b>	3.0	3.0	3.0	2.0	2.5	2.5	1.3	3.0	2.0	2.0	2.0	2.5	3.0	3.0	2.0
<b>Understanding and use of Arbitrary Waveform Generator</b>	3.0	2.5	3.0	2.0	2.5	2.5	2.0	3.0	2.0	2.0	2.0	3.0	2.0	3.0	2.0
<b>Understanding and use of Digital Sampling Oscilloscope</b>	3.0	3.0	2.5	2.0	2.5	2.5	2.0	3.0	2.0	2.0	2.0	3.0	2.5	3.0	2.0
<b>Averages</b>	<b>3.0</b>	<b>2.9</b>	<b>2.9</b>	<b>2.0</b>	<b>2.5</b>	<b>2.5</b>	<b>1.7</b>	<b>3.0</b>	<b>2.0</b>	<b>2.0</b>	<b>2.0</b>	<b>2.8</b>	<b>2.6</b>	<b>3.0</b>	<b>2.0</b>

**Rubric max was 5.0, target of 70% is 3.5: 0% of students scored > 70% on Rubric**

Spring 2016	Ahmed, James	Benson, Ryan	Burdj, Shane	DeFeo, Anthony	Dulaney, Dane	Gilliam, Jeremy	Hamer, Dalton	Hegge, Daniel	Ibarra, Carlos	Jenkins, Jeremy	Kawano, Ryan	Koos, Jaden	Matosky, Lance	Patton, Morgan	Prescott, James	Salazar, Daniel	Ward, Peter	Wolfe, Mathew
<b>Category/Score</b>																		
<b>Understanding and use of Dual Power Supply</b>	1.0	2.0	1.5	1.5	1.8	1.5	0.5	0.5	1.8	2.0	2.0	2.0	1.5	2.5	2.0	0.5	2.0	0.5
<b>Understanding and use of DMM</b>	1.0	2.0	2.0	1.5	1.8	1.5	1.0	0.5	1.8	2.0	1.8	2.0	1.3	2.0	1.5	0.5	1.5	0.5
<b>Understanding and use of Arbitrary Waveform Generator</b>	0.5	1.5	1.5	1.5	2.0	1.5	2.0	0.5	2.0	2.0	2.0	2.0	1.3	2.0	1.5	0.3	2.0	0.3
<b>Understanding and use of Digital Sampling Oscilloscope</b>	0.5	2.0	2.0	1.5	2.0	1.5	1.5	0.5	1.8	2.0	2.0	2.0	2.0	2.0	1.5	0.3	2.0	0.3
<b>Averages</b>	<b>0.8</b>	<b>1.9</b>	<b>1.8</b>	<b>1.5</b>	<b>1.9</b>	<b>1.5</b>	<b>1.3</b>	<b>0.5</b>	<b>1.9</b>	<b>2.0</b>	<b>2.0</b>	<b>2.0</b>	<b>1.5</b>	<b>2.1</b>	<b>1.6</b>	<b>0.4</b>	<b>1.9</b>	<b>0.4</b>

**Rubric max was 5.0, target of 70% is 3.5: 0% of students scored > 70% on Rubric**

**Results Summary for Student Outcome c: An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	3.75/5.0	>3.0	No
	2016	3.5/5.0	>3.0	No
Employer Survey	2016	4.0/5.0	>3.0	No
Assign in ENGR 317	2015	0%	>70%	Yes
	2016	0%	>70%	Yes

**Actions:** The program does not meet the expected level of attainment for SO (c). Discussions with the METAC concluded that this outcome is not appropriate to be assessed in ENGR 317. The language suggested for the assessment rubric of:

c-1. Follow the design of experiment plan
c-2. Acquire data on appropriate experimental variables
c-3. Compare experimental data and results to appropriate theoretical models

is better suited to be in a more mechanical related rather than electrical course. The decision is for this outcome to be assessed in ENGR 343 Dynamics in the future.

The program will also check with the STAT 305 instructor to make sure this information is being covered since STAT 305 is a strategy for this outcome.

**Table 4-2d.**

**Student Outcome d:**

**An ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives**

Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
d-1. Use engineering skills to design systems, components, and processes	ENGR 321 ENGR 325 ENGR 345 ENGR 485	-Sr Exit Survey -Employer Surv -presentation to IAC in ENGR 485	-Sp 2015, 16 -Sp 2016 -Sp 2013, 14, 15, 16	Instructor METAC

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), &*

*Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
An ability to select and apply the knowledge, techniques, skills, and modern ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
An ability to function effectively as a member or leader on a technical team	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
An ability to identify, analyze, and solve broadly-defined ET problems	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

*IAC Evaluation of Senior Projects in ENGR 485:*

The evaluation of this outcome was performed by dividing it into three different aspects:

- d-1. Use engineering skills to design systems, components, or processes
  - d-1-a. Specifications and functions are clearly defined by the problem statement
  - d-1-b. Use of engineering judgment in the design process is demonstrated
  - d-1-c. Realization of the design that meets all specifications and functions

Figure 4.3d.1 shows the question used to evaluate this aspect. The initial questions from academic year 2013, shown Fig. 4.3d.1 (a), were modified to the ones shown in (b). The average of the scores provided by all IAC members to the teams that included at least one MET student, are shown in Fig. 4.3d.2 (a, b, and c). The number of MET students in each team ranged from 1 to 3. Teams typically consisted of 3 students each.

**Figure 4.3d.1**

Scale					
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable
1	2	3	4	5	NA
#	Question	A	B	C	D
2	Project goals and specifications were clearly stated				
5	The team presents a clear strategy/plan to find a solution				
11	After carefully comparing the stated goals to the conclusions, The team did meet its design project goals.				

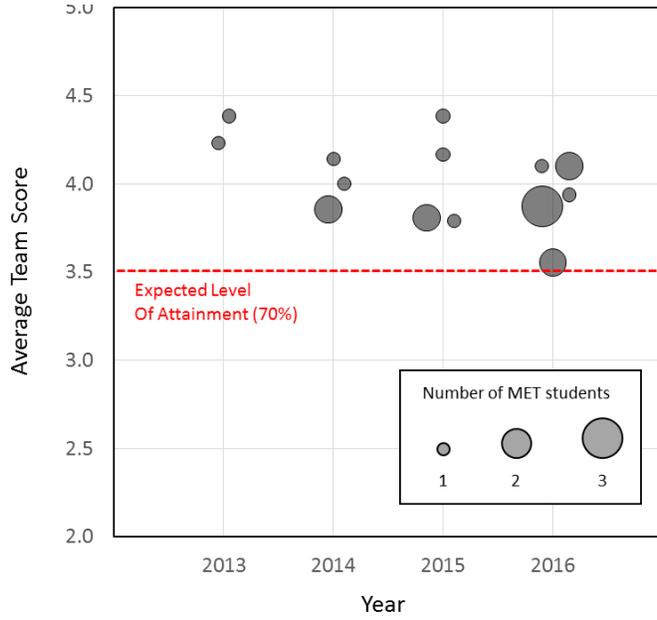
(a) Questions from 2013 addressing d-1-a, d-1-b, and d-1-c.

Please fill the boxes on the right with a number included in the interval [0-5]. In case you have comments, please use the back of this form.

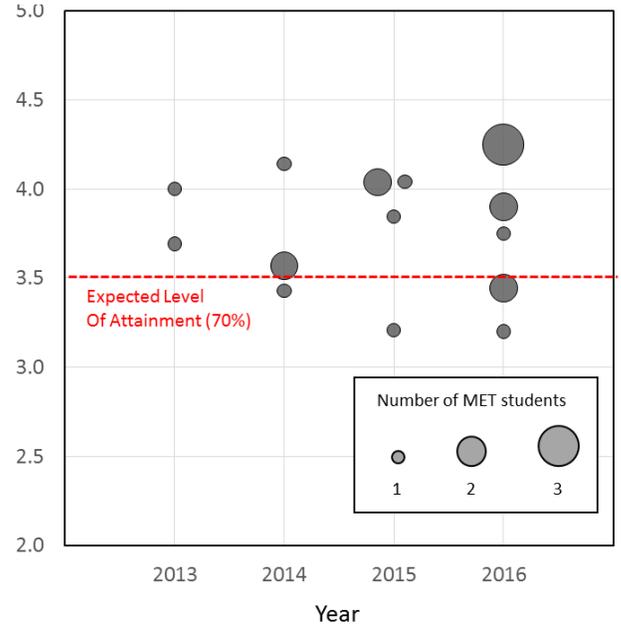
Topic	Unacceptable (0)	Marginal (1-2)	Acceptable (3)	Exceptional (4-5)	A	B	C	D
<b>Project Goals</b>	Design goals are poorly presented and team has difficulty articulating the general aim of the project.	Design goals are poorly presented but, team can articulate the general aim of the project.	Goals are presented in an acceptable way.	Goals are clearly presented.				
<b>Supporting Data</b>	No supporting evidence that design goals were achieved (empirical or analytical data)	Minimal or unconvincing evidence (empirical or analytical data) to indicate that design is adequate.	Team provides some empirical or analytical data to prove that design goals have been met.	Team provides significant empirical or analytical data to prove that design goals have been met.				
<b>Product Functionality</b>	Project or product is rarely functional with frequent bugs, glitches or performance issues that limit functionality. Parts appear unfinished.	Product or project is sporadically functional with bugs, glitches or performance issues that take significant time to address. Parts appear to be patched together at the last minute.	Product or project is functional with infrequent bugs, glitches or performance issues that can be solved quickly. Design appears mostly completed and the prototype is functional.	Product or project is fully functional. No bugs, glitches or performance issues. Team set an ambitious solution and delivered a superior product. Prototype was fully tested.				

(b) Modification of questions for Years 2014 through 2016 addressing d-1-a, d-1-b, and d-1-c.

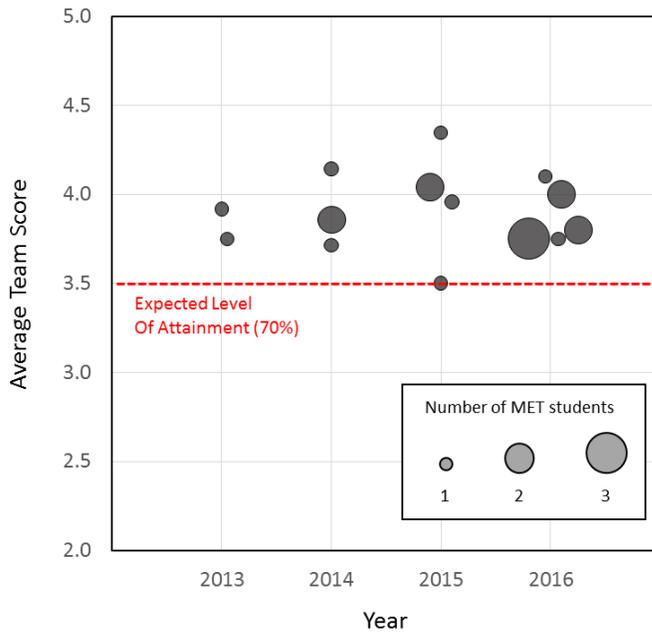
**Figure 4.3d.2 (a). Evaluation results for SO-d-1-a**



**Figure 4.3d.2 (b). Evaluation results for SO-d-1-b**



**Figure 4.3d.2 (c). Evaluation results for SO-d-1-c**



**Results Summary for Student Outcome d: An ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	3.0/5.0	>3.0	Yes
	2016	3.7/5.0	>3.0	No
Employer Survey	2016	3.75/5.0	>3.0	No
IAC Evaluation of Senior Projects for SO-d-1-a	2013	100%	>70%	No
	2014	100%	>70%	No
	2015	100%	>70%	No
	2016	100%	>70%	No
IAC Evaluation of Senior Projects for SO-d-1-b	2013	100%	>70%	No
	2014	66%	>70%	Yes
	2015	75%	>70%	No
	2016	60%	>70%	Yes
IAC Evaluation of Senior Projects for SO-d-1-c	2013	100%	>70%	No
	2014	100%	>70%	No
	2015	100%	>70%	No
	2016	100%	>70%	No

**Actions:** Action is warranted due to results given by Senior Exit Survey and IAC evaluation for SO-d-1-b, “the use of engineering judgement in the design process.” The METAC discussed this and concluded that the IAC would have a hard time evaluating how engineering judgement played a role in the design process from the brief exposure they had with each team during the judging event. For the most part, the program is doing well in achieving this outcome. For SO-d-1-b, the suggestion was made to clarify or reword the rubric to include words “engineering judgement.” Clearer instructions to the IAC and student teams will also be useful.

**Table 4-2e.**  
**Student Outcome e:**

**An ability to function effectively as a member or leader on a technical team**

Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
e-1. Use professional skills to effectively function as a member of a technical team	ENGR 140 ENGR 321 ENGR 445 ENGR 485	-Sr Exit Survey -Employer Surv -Presentation to IAC in ENGR 485	-Sp 2015, 16 -Sp 2016 -Sp 2013, 14, 15, 16	METAC IAC

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), &*

*Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
An ability to select and apply the knowledge, techniques, skills, and modern ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	Knowledge of GD&T and computer aided drafting and design	3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
An ability to select and apply knowledge of STEM to ET problems ...												Hands-on skills in the selection, set-up and calibration of instr. & sensors used ...								
An ability to conduct standard tests and measurements...												Knowledge of industry codes, specs and standards								
An ability to design systems, components, or processes for ET problems ...												Knowledge and hands-on skills in manufacturing processes								
<b>An ability to function effectively as a member or leader on a technical team</b>												Knowledge and problem solving ability in material science and selection								
An ability to identify, analyze, and solve broadly-defined ET problems												Problem solving ability in solid mechanics								
An ability to apply written, oral, and graphical communication in ...												Problem solving ability in thermal sciences								
An understanding of the need for and ability to engage in self-directed continuing PD												Problem solving ability in electrical circuits and controls								
An understanding of /commitment to address prof & ethical responsibilities...																				
A knowledge of the impact of ET solutions in a societal and global context																				
A commitment to quality, timeliness, and continuous improvement																				
Student's Perceived Ability (2015)	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
Student's Perceived Ability (2016)	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
Employer (2016)	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

*IAC Evaluation of Senior Projects in ENGR 485:*

The evaluation of this outcome was performed by using a single question:

- e-1. Use professional skills to effectively function as a member of a technical team

Figure 4.3e.1 shows the question used to evaluate this outcome. The initial question from academic year 2013, shown Fig. 4.3e.1 (a), were modified to the ones shown in (b) for years 2014 and 2015 and modified again in 2016, as shown in (c). The average of the scores provided by all IAC members to the teams that included at least one MET student, are shown in Fig. 4.3d.2 (a, b, and c). The number of MET students in each team ranged from 1 to 3. Teams typically consisted of 3 students each.

**Figure 4.3e.1**

Scale					
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable
1	2	3	4	5	NA

#	Question	A	B	C	D
4	The team demonstrates knowledge of the importance of diversity ideas, discussion and team work.				

(a) Questions from 2013 addressing SO e)

Please fill the boxes on the right with a number included in the interval [0-5]. In case you have comments, please use the back of this form.

Topic	Unacceptable (0)	Marginal (1-2)	Acceptable (3)	Exceptional (4-5)	A	B	C	D
Technical Knowledge	Team demonstrates a fundamental lack of understanding of engineering or scientific principles related to the project. Only 1 team member is knowledgeable about project details.	One or two members demonstrate understanding of engineering or scientific principles related to the project. Several members have obvious misconceptions. Limited grasp of the design process	Several members demonstrate understanding of engineering or scientific principles related to the project with minimum misconceptions.	All team members demonstrate complete understanding of engineering or scientific principles related to the project				

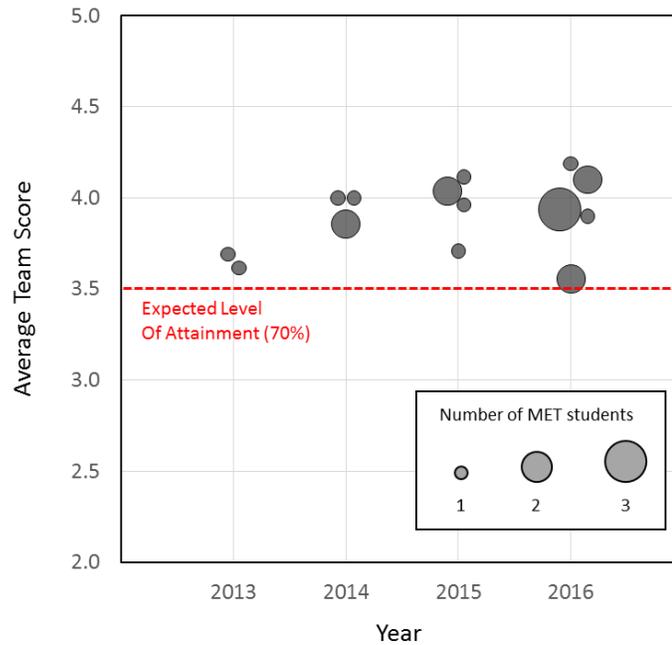
(b) Modification of questions for Years 2014 and 2015 addressing SO e).

Please fill the boxes on the right with a number included in the interval [0-5]. In case you have comments, please use the back of this form.

Topic	Unacceptable (0)	Marginal (1-2)	Acceptable (3)	Exceptional (4-5)	A	B	C	D
Team Work	No cooperation between team members is noticeable. Members did not work as a team	Minimum coordination is observed. Two members may have collaborated.	Some teamwork interaction is observed among all members.	Great teamwork skills are observed. All members seem to understand the value of teamwork.				

(c) Modification of questions for Year 2016 addressing SO e).

**Figure 4.3e.2. Evaluation Rubrics for SO e.**



**Results Summary for Student Outcome e: An ability to function effectively as a member or leader on a technical team**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	4.25/5.0	>3.0	No
	2016	4.3/5.0	>3.0	No
Employer Survey	2016	4.4/5.0	>3.0	No
IAC Evaluation of Senior Projects	2013	100%	>70%	No
	2014	100%	>70%	No
	2015	100%	>70%	No
	2016	100%	>70%	No

**Actions:** Expected level of attainment is met in all categories. No action needed at this time.

**Table 4-2f.**  
**Student Outcome f:**

**An ability to identify, analyze, and solve broadly-defined engineering technology problems**

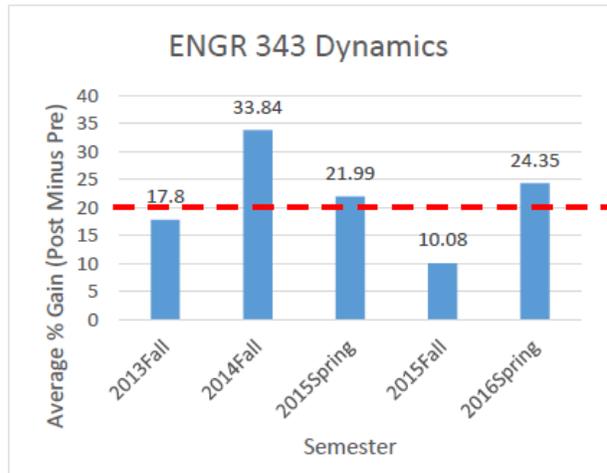
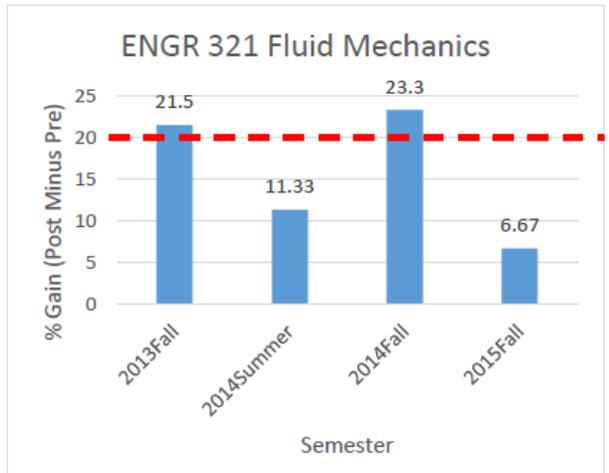
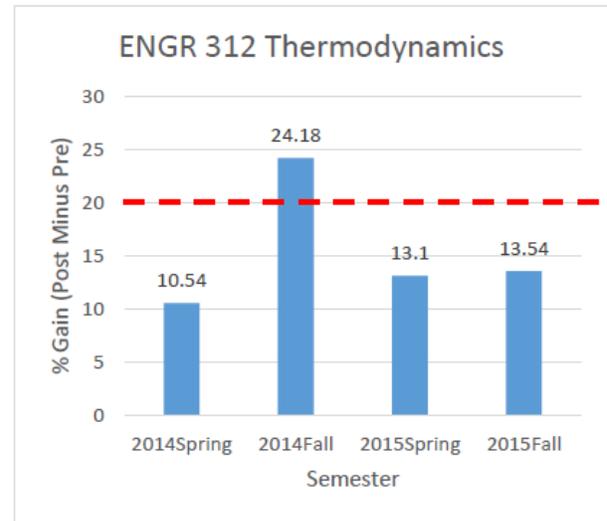
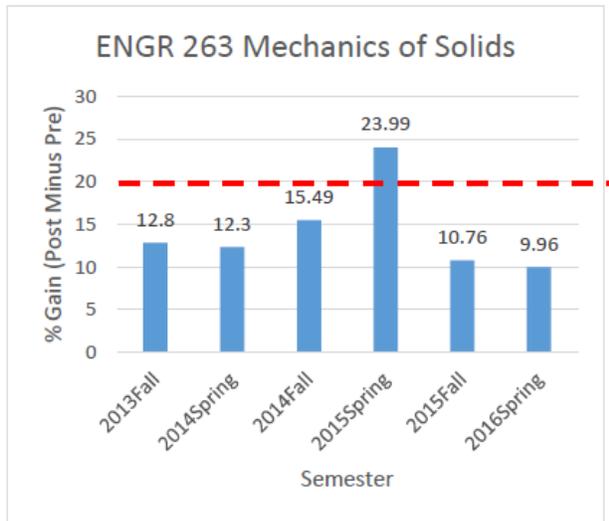
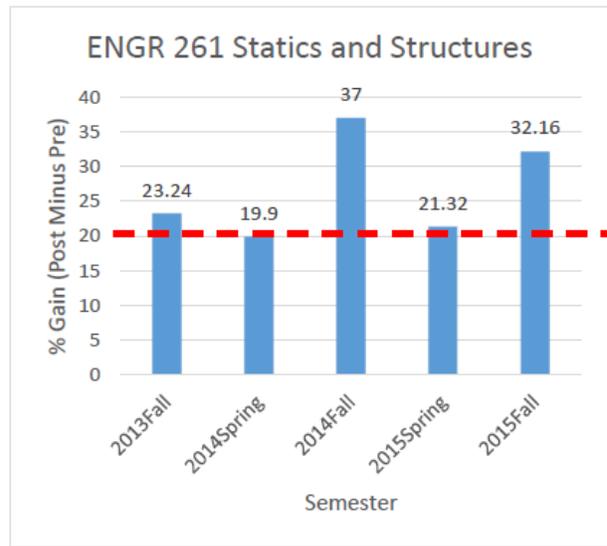
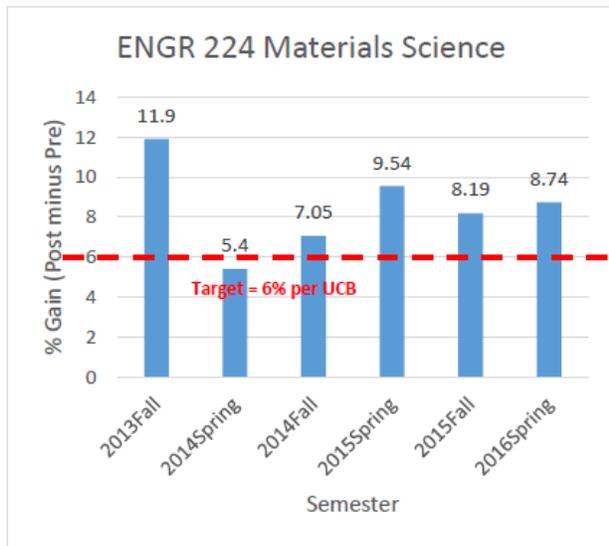
Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
f-1. Identify engineering problems	ENGR 224, 261, 263, 312, 321, 343	-Sr Exit Survey -Employer Surv -CI's in 6 classes	-Sp 2015, 16 -Sp 2016 -each time the course is taught	METAC
f-2. Formulate engineering problems	ENGR 224, 261, 263, 312, 321, 343	-Sr Exit Survey -Employer Surv -CI's in 6 classes	-Sp 2015, 16 -Sp 2016 -each time the course is taught	METAC
f-3. Solve engineering problems	ENGR 224, 261, 263, 312, 321, 343	-Sr Exit Survey -Employer Surv -CI's in 6 classes	-Sp 2015, 16 -Sp 2016 -each time the course is taught	METAC

**Results:** *Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

Student Outcomes	Program Criteria												
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
(a) An ability to select and apply the knowledge, techniques, skills, and modern ... to ET problems ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.75	3.25	4.25	3	3.5	2.5
(b) An ability to select and apply knowledge of STEM to ET problems ...	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2	3.7	3.8
(c) An ability to conduct standard tests and measurements...	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4	3.5	3.75
(d) An ability to design systems, components, or processes for ET problems ...													
(e) An ability to function effectively as a member or leader on a technical team													
(f) An ability to identify, analyze, and solve broadly-defined ET problems													
(g) An ability to apply written, oral, and graphical communication in ...													
(h) An understanding of the need for and ability to engage in self-directed continuing PD													
(i) An understanding of /commitment to address prof & ethical responsibilities...													
(j) A knowledge of the impact of ET solutions in a societal and global context													
(k) A commitment to quality, timeliness, and continuous improvement													
(a) Knowledge of GD&T and computer aided drafting and design													
(b) Hands-on skills in the selection, set-up and calibration of instr & sensors used ...													
(c) Knowledge of industry codes, specs and standards													
(d) Knowledge and hands-on skills in manufacturing processes													
(e) Knowledge and problem solving ability in material science and selection													
(f) Problem solving ability in solid mechanics													
(g) Problem solving ability in thermal sciences													
(h) Problem solving ability in electrical circuits and controls													

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Concept Inventory (n=various, 2013 through 2016) results are:



**Results Summary for Student Outcome f: An ability to identify, analyze, and solve broadly-defined engineering technology problems**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	3.25/5.0	>3.0	No
	2016	3.5/5.0	>3.0	No
Employer Survey	2016	4.0/5.0	>3.0	No
Concept Inventories ENGR 224 Materials	2013- 2016	>6%	>6%	No
Concept Inventories ENGR 261 Statics	2013- 2016	>20%	>20%	No
Concept Inventories ENGR 263 Solid Mechanics	2013- 2016	<20%	>20%	Yes
Concept Inventories ENGR 312 Thermodynamics	2013- 2016	<20%	>20%	Yes
Concept Inventories ENGR 321 Fluids	2013- 2016	Variable	>20%	No
Concept Inventories ENGR 343 Dynamics	2013- 2016	Variable Most>20%	>20%	No

**Actions:** By not meeting the expected level of attainment specified as an increase in CI score of  $\geq 20\%$  for two of the six classes, i.e., ENGR 263 Solid Mechanics and ENGR 312 Thermodynamics, action must be taken. The METAC discussed having inconsistency in the instruction of ENGR 312 Thermodynamics over the past several years. Recommended immediate actions will be to:

1. Hire a new full-time faculty member that will be responsible for teaching the thermofluids sequence of MET courses. As of today, an offer is on the table to a potential candidate who may fill this role.
2. Professors Scott Bevill and Scott Kessler will retool the concept inventory used for ENGR 263 Solid Mechanics. It is felt that the CI does not reflect what is being taught in the class.
3. Along the lines of “2” we will investigate using a different CI in the future.

**Table 4-2g.  
Student Outcome g:**

**An ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature**

Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
g-1. Use written communication tools	ENGR 125 ENGR 140 ENGR 224 ENGL 425 ENGR 445/446/485	-Sr Exit Survey -Employer Surv -Sr Proj Final Report in ENGR 426/485	Sp 2015, 16 Sp 2016 Sp 2013, 14, 15, 16	Instructor METAC IAC
g-2. Use oral communication techniques	ENGR 140 ENGR 224 ENGL 425 ENGR 445/446/485	-Sr Exit Survey -Employer Surv -Sr Proj Final Presentations in ENGR 426/485	Sp 2015, 16 Sp 2016 Sp 2013, 14, 15, 16	Instructor METAC IAC
g-3. Use graphical communication tools	ENGR 125 ENGR 140 ENGR 445/446/485	-Sr Exit Survey -Employer Surv -Sr Proj Final Report in ENGR 426/485	Sp 2015, 16 Sp 2016 Sp 2013, 14, 15, 16	Instructor METAC IAC

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

	<b>Student Outcomes</b>													<b>Program Criteria</b>						
	(a) An ability to select and apply the knowledge, techniques, skills, and modern ...	(b) An ability to select and apply knowledge of STEM to ET problems ...	(c) An ability to conduct standard tests and measurements...	(d) An ability to design systems, components, or processes for ET problems ...	(e) An ability to function effectively as a member or leader on a technical team	(f) An ability to identify, analyze, and solve broadly-defined ET problems	(g) An ability to apply written, oral, and graphical communication in ...	(h) An understanding of the need for and ability to engage in self-directed continuing PD	(i) An understanding of /commitment to address prof & ethical responsibilities...	(j) A knowledge of the impact of ET solutions in a societal and global context	(k) A commitment to quality, timeliness, and continuous improvement		(a) Knowledge of GD&T and computer aided drafting and design	(b) Hands-on skills in the selection, set-up and calibration of instr & sensors used ...	(c) Knowledge of industry codes, specs and standards	(d) Knowledge and hands-on skills in manufacturing processes	(e) Knowledge and problem solving ability in material science and selection	(f) Problem solving ability in solid mechanics	(g) Problem solving ability in thermal sciences	(h) Problem solving ability in electrical circuits and controls
Student's Perceived Ability (2015)	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
Student's Perceived Ability (2016)	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
Employer (2016)	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

*Assignment in ENGR 446 (n=5) in 2015 results are:*

<b>Assessed during Spring 2015 - ENGR 446: Topics - Writing for Senior Design</b>						
Description: This student outcome was assessed with two different assignments. A final written report was used for SO-g-1 and SO-g-3 and oral presentations for sponsor updates and poster presentations for the student showcase/design expo were used for SO-g-2.						
	Learning Objectives	Bartels	Matthews	Rowley	Rowsam	Zemezouak
SO-g-1	Demonstrate an ability to use written communication tools	3	4.5	3	3	4.5
SO-g-2	Demonstrate an ability to use oral communication techniques	3	4	3	3	4
SO-g-3	Demonstrate an ability to use graphical communication tools	3.5	4	3.5	3.5	4
	Average:	3.2	4.2	3.2	3.2	4.2

**Rubric max was 5.0, target of 70% is 3.5: 40% of students scored > 70% on Rubric**

Assignment in ENGR 446 (n=9) in 2016 results are:

<b>Assessed during Spring 2016 - ENGR 446: Writing for Senior Design</b>										
Description: This student outcome was assessed with two different assignments. A final written report was used for SO-g-1 and SO-g-3 and oral presentations for sponsor updates and poster presentations for the student showcase/design expo were used for SO-g-2.										
Learning Objectives		Bag nar d	Buc k	Gon calve s	Hilke n	Kaw ano	Klein	Lara	Niels on	Rucker
SO-g-1	Demonstrate an ability to use written communication tools	2.5	4.5	3.5	3	3.5	3.5	3.5	3.5	4.5
SO-g-2	Demonstrate an ability to use oral communication techniques	3	5	3	3	3	3	3	3	5
SO-g-3	Demonstrate an ability to use graphical communication tools	3.5	4.5	3.5	3.5	3.5	3.5	3.5	3.5	4.5
Average:		3.0	4.7	3.3	3.2	3.3	3.3	3.3	3.3	4.7

**Rubric max was 5.0, target of 70% is 3.5: 22% of students scored > 70% on Rubric**

*IAC Evaluation of Senior Projects in ENGR 485:*

The evaluation of this outcome was performed by dividing it into three different aspects:

- g-1. Use of written communication tools (use ENGR 446),
- g-2. Use of oral communication techniques (use ENGR 485), and
- g-3. Use of graphical communication tools (use ENGR 485).

Figure 4.3g.1 shows the question used to evaluate this outcome. The initial question from academic year 2013, shown Fig. 4.3g.1 (a), was modified to the one shown in (b) for years 2014 through 2016. The average of the scores provided by all IAC members to the teams that included at least one MET student, are shown in Fig. 4.3g.2 (b, and c). The number of MET students in each team ranged from 1 to 3. Teams typically consisted of 3 students each.

**Figure 4.3g.1**

Scale					
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable
1	2	3	4	5	NA

#	Question	A	B	C	D
16	The presentation/poster demonstrates:				
a.	Good oral/visual communications skills				
16	The presentation/poster demonstrates:				
c.	Effective use of drawings and sketches				

(a) Year 2013

Please fill the boxes on the right with a number included in the interval [0-5]. In case you have comments, please use the back of this form.

Topic	Unacceptable (0)	Marginal (1-2)	Acceptable (3)	Exceptional (4-5)	A	B	C	D
<b>Oral Communications</b>	Team presents a confusing overview of project with possibly a few salient details. One team member may speak clearly but others cannot be understood.	Team presents a mostly understandable overview of project with possibly a few confusing details. Several team members may speak clearly.	Team presents a professional and understandable overview. Most of team members speak clearly.	Team presents a professional, cohesive, interesting and understandable overview of the project. All team members speak loudly and clearly.				
<b>Poster</b>	Poster contains inadequate information, with too much text, or with superfluous graphics. Poster have many errors (6+)	Poster contains adequate information, but with too much text, or with graphics that do not support presentation. Poster has 4 or fewer errors.	Poster is professional in appearance, contains appropriate information presented in a logical and understandable way. Presentations has 2 or fewer errors	Poster is attractive and professional in appearance, contains appropriate information presented in a logical, efficient and understandable way. Poster is error-free.				

(b) Years 2014 through 2016

Figure 4.3g.2. Evaluation Rubrics for SO g-2.

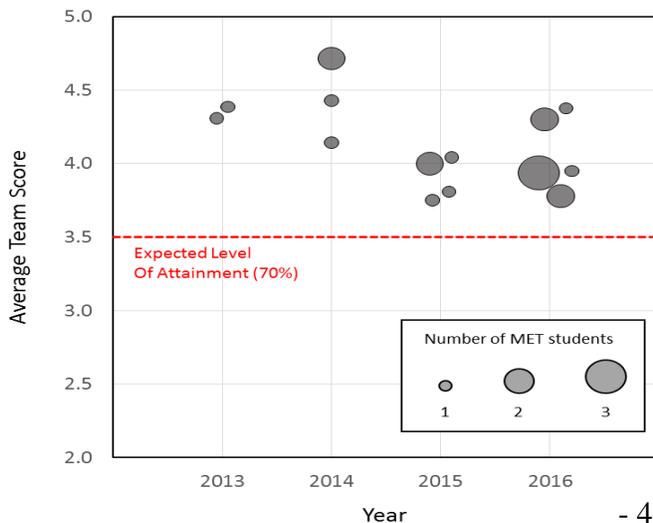
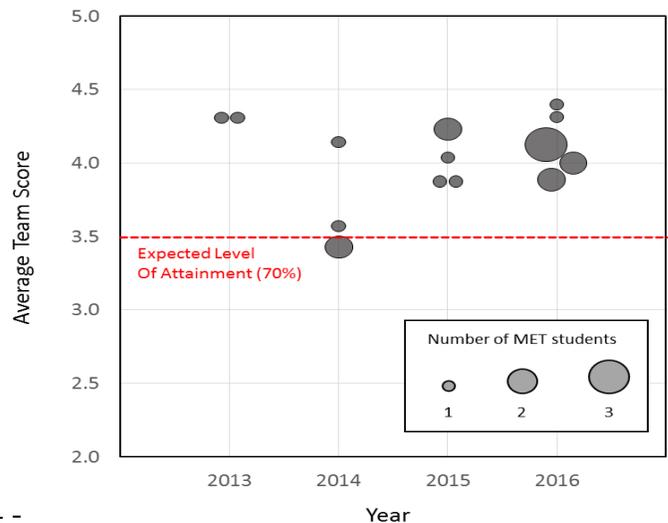


Figure 4.3g.2. Evaluation Rubrics for SO g-3.



**Results Summary for Student Outcome g: An ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	3.25/5.0	>3.0	No
	2016	3.8/5.0	>3.0	No
Employer Survey-written/oral/visual	2016	4.6/4.2/4.0/5.0	>3.0	No
Assign in ENGR 446	2015	40%	>70%	Yes
SO-g-1, SO-g-2, SO-g-3	2016	22%	>70%	Yes
IAC Evaluation of	2013	100%	>70%	No
Senior Projects	2014	100%	>70%	No
SO-g-2	2015	100%	>70%	No
	2016	100%	>70%	No
IAC Evaluation of	2013	100%	>70%	No
Senior Projects	2014	67%	>70%	Yes
SO-g-3	2015	100%	>70%	No
	2016	100%	>70%	No

**Actions:** The expected level of attainment is not achieved for this outcome. Results for the Senior Exit Survey and assignment in ENGR 446 indicate a need for action. Writing in engineering is a fundamental problem throughout engineering disciplines. The METAC decided to form a subcommittee to investigate what might be done to help in this issue. This committee will report back to the faculty at the first faculty meeting in the fall.

**Table 4-2h.**  
**Student Outcome h:**  
**An understanding of the need for and an ability to engage in self-directed continuing professional development**

Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
h-1. Apply knowledge of professional development in an engineering discipline	ENGR 101 ENGR 325 ENGR 401	-Sr Exit Survey -Employer Surv -assign in ENGR 401	-Sp 2015, 16 -Sp 2016 -F 2014, 15	METAC

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), &*

*Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
An ability to select and apply the knowledge, techniques, skills, and modern ... An ability to select and apply knowledge of STEM to ET problems ... An ability to conduct standard tests and measurements... An ability to design systems, components, or processes for ET problems ... An ability to function effectively as a member or leader on a technical team An ability to identify, analyze, and solve broadly-defined ET problems An ability to apply written, oral, and graphical communication in ... An understanding of the need for and ability to engage in self-directed continuing PD An understanding of /commitment to address prof & ethical responsibilities... A knowledge of the impact of ET solutions in a societal and global context A commitment to quality, timeliness, and continuous improvement	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
Employer (2016)	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Assignment in ENGR 401 (n=3 in 2014 & n=9 in 2015)

F 2014	Score out of 10. Scores based on individual essays written as part of the final assignment
LAST	
Matthews	8.5
Rowsom	7.0
Zemezouak	7.5

**Rubric max was 10, target of 70% is 7.0: 100% of students scored > 70% on Rubric**

F 2015	Score out of 10. Scores based on individual essays written as part of the final assignment
LAST	
Jacobson	8.5
Buck	6.5
Marin Garcia	6.5
Lara	7
Bagnard	7
Kawano	7
Benson	7
Rucker	8
Nielson	7.5

**Rubric max was 10, target of 70% is 7.0: 78% of students scored > 70% on Rubric**

**Results Summary for Student Outcome h: An understanding of the need for and an ability to engage in self-directed continuing professional development**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	3.25/5.0	>3.0	No
	2016	4.0/5.0	>3.0	No
Employer Survey	2016	4.2/5.0	>3.0	No
Assign in ENGR 401	2014	100%	>70%	No
	2015	78%	>70%	Yes

**Actions:** No action is warranted. Note, fall 2014 was the first time ENGR 401 Professionalism Seminar was taught. Even though in 2015 the program missed its mark of 80% of students achieving >70% on the rubric, it is not considered enough to warrant a change in direction. The program will watch the results over time.

**Table 4-2i.**  
**Student Outcome i:**  
**An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity**

Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
i-1. Demonstrate knowledge of professional engineering code of ethics	ENGR 101 ENGR 305	-Sr Exit Survey -Employer Surv - Assign in ENGR 305	Sp 2015, 16 Sp 2016 F 2015	METAC Instructor
i-2. Evaluate the ethical dimensions of an engineering problem in the discipline	ENGR 101 ENGR 305	-Sr Exit Survey -Employer Surv - Assign in ENGR 305	Sp 2015, 16 Sp 2016 F 2015	METAC Instructor

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
An ability to select and apply the knowledge, techniques, skills, and modern ... ET problems ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
An ability to select and apply knowledge of STEM to ET problems ...	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
An ability to conduct standard tests and measurements...	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4
An ability to design systems, components, or processes for ET problems ...																				
An ability to function effectively as a member or leader on a technical team																				
An ability to identify, analyze, and solve broadly-defined ET problems																				
An ability to apply written, oral, and graphical communication in ...																				
An understanding of the need for and ability to engage in self-directed continuing PD																				
An understanding of /commitment to address prof & ethical responsibilities..																				
A knowledge of the impact of ET solutions in a societal and global context																				
A commitment to quality, timeliness, and continuous improvement																				
Knowledge of GD&T and computer aided drafting and design																				
Hands-on skills in the selection, set-up and calibration of instr & sensors used ...																				
Knowledge of industry codes, specs and standards																				
Knowledge and hands-on skills in manufacturing processes																				
Knowledge and problem solving ability in material science and selection																				
Problem solving ability in solid mechanics																				
Problem solving ability in thermal sciences																				
Problem solving ability in electrical circuits and controls																				

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

*Assignment in ENGR 305 (n = 10)*

<b>Assessed during Fall 2015 - ENGR 305: Engineering Economics and Ethics</b>											
Description: This program criteria was assessed with two different assignments. An exam was used for SO-i-1 (students were given a reference sheet referencing the NCEES Rules of Professional Conduct to use during the exam). A final project was used to assess SO-i-2 (students were tasked with starting a company and analyzing the economics and ethics of several available options).											
Learning Objectives		Benson	Burton	Dana	Dulaney	Fieber	Ibarra	Kawano	Marin Garcia	Patton	Rankin
SO-i-1-a	Demonstrate knowledge of a professional engineering code of ethics	3	3.5	3	3	3	3	3	4.5	4	4.5
SO-i-2-a	Demonstrate identification/recognition of an ethical dilemma	3	3	3	3.5	2.5	3	3	3.5	3	3
SO-i-2-b	Evaluate the ethical dimensions of an engineering problem in the discipline	2.5	2.5	2.5	3	2	3	2.5	3	2	2
<b>Average:</b>		<b>2.8</b>	<b>3.0</b>	<b>2.8</b>	<b>3.2</b>	<b>2.5</b>	<b>3.0</b>	<b>2.8</b>	<b>3.7</b>	<b>3.0</b>	<b>3.2</b>

**Rubric max was 5.0, target of 70% is 3.5: 10% of students scored > 70% on Rubric**

**Results Summary for Student Outcome i: An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	3.75/5.0	>3.0	No
	2016	4.0/5	>3.0	No
Employer Survey	2016	4.4/5	>3.0	No
Assign in ENGR 305	F 2015	10%	>70%	Yes

**Actions:** The expected level of attainment is not achieved. Assignment in ENGR 305 Engineering Economics and Ethics shows a concern. The first time this class was taught was fall 2015. Since this is a new course, the METAC decided not to make any changes but to look at the progress over time.

**Table 4-2j.**  
**Student Outcome j:**  
**A knowledge of the impact of engineering technology solutions in a societal and global context**

Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
j-1. Describe and analyze the impact of engineering technology solutions	SOCI 120	-Sr Exit Survey -Employer Surv -Assign in SOCI 120	-Sp 2015, 16 -Sp 2016 -Each time class is taught	Instructor METAC

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
An ability to select and apply the knowledge, techniques, skills, and modern ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
An ability to select and apply knowledge of STEM to ET problems ...	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
An ability to conduct standard tests and measurements...	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4
An ability to design systems, components, or processes for ET problems ...																				
An ability to function effectively as a member or leader on a technical team																				
An ability to identify, analyze, and solve broadly-defined ET problems																				
An ability to apply written, oral, and graphical communication in ...																				
An understanding of the need for and ability to engage in self-directed continuing PD																				
An understanding of /commitment to address prof & ethical responsibilities...																				
A knowledge of the impact of ET solutions in a societal and global context																				
A commitment to quality, timeliness, and continuous improvement																				
Knowledge of GD&T and computer aided drafting and design																				
Hands-on skills in the selection, set-up and calibration of instr & sensors used ...																				
Knowledge of industry codes, specs and standards																				
Knowledge and hands-on skills in manufacturing processes																				
Knowledge and problem solving ability in material science and selection																				
Problem solving ability in solid mechanics																				
Problem solving ability in thermal sciences																				
Problem solving ability in electrical circuits and controls																				

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

*Assignment in SOCI 120:*

Using the data provided by the instructor (shown on the USB drive) the target was the average or mid-point of the intermediate score resulting in a score > 5.0. On average it is believed to be the averaging the scores on social, environmental, global and unintended. Assessment data was taken in both an in-class section of this class and an online section. The results indicate:

*(n=35 for in-class, n=27 for online) in Fall 2014:*

	In-Class	Online
Social	92% > 5.0	100% > 5.0
Environmental	31% > 5.0	34% > 5.0
Global	43% > 5.0	30% > 5.0
Unintended	35% > 5.0	60% > 5.0
<b>Overall</b>	<b>77% &gt; 5.0</b>	<b>89% &gt; 5.0</b>

*(n=32 for in-class in Fall 2015, & n=28 for online in Spring 2016):*

	In-Class	Online
Social	97% > 5.0	100% > 5.0
Environmental	40% > 5.0	53% > 5.0
Global	25% > 5.0	29% > 5.0
Unintended	51% > 5.0	65% > 5.0
<b>Overall</b>	<b>81% &gt; 5.0</b>	<b>96% &gt; 5.0</b>

**Results Summary for Student Outcome j: A knowledge of the impact of engineering technology solutions in a societal and global context**

Assessment Method	Year	Result	Target	Action Required?	
Senior Exit Survey	2015	3.25/5.0	>3.0	No	
	2016	3.8/5	>3.0	No	
Employer Survey	2016	3.25/5	>3.0	No	
Assign in SOCI 120 "overall"	In-class	F2014	77%	>5.0	No
	On-line	F2014	89%	>5.0	No
	In-class	F2015	81%	>5.0	No
	On-line	Sp2016	96%	>5.0	No

**Actions:** The expected level of attainment is met for this SO, however, the senior exit survey in 2015, the employer survey in 2016 both are relatively low. The program needs to understand better what the instructor means by "overall" versus the individual categories. The METAC decided to have the instructor attend an engineering faculty meeting early in fall to discuss these findings. Engineering faculty might need to tie content given in SOCI 120 into existing ENGR courses more, specifically ENGR 312 for fall 2016.

**Table 4-2k.  
Student Outcome k:**

**A commitment to quality, timeliness, and continuous improvement**

Learning Objectives	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
k-1. Show proficiency in following guidelines, meeting deadlines, and improving assigned tasks	ENGR 140 ENGR 312 ENGR 445 ENGR 485	-Sr Exit Exam -Employer Surv -IAC Eval of Senior Project	Sp 2015, 16 Sp 2016 Sp 2013, 14, 15, 16	METAC Instructor

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), &*

*Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
An ability to select and apply the knowledge, techniques, skills, and modern ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	Knowledge of GD&T and computer aided drafting and design	3	3.5	2.5	2.75	3.25	3.5	2.25	3.25	
An ability to select and apply knowledge of STEM to ET problems ...	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2	Hands-on skills in the selection, set-up and calibration of instr & sensors used ...	3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5	
An ability to conduct standard tests and measurements...	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4	Knowledge of industry codes, specs and standards	3.5	3.75	3.5	4	4.25	4.25	4	4	
An ability to design systems, components, or processes for ET problems ...												Knowledge and hands-on skills in manufacturing processes									
An ability to function effectively as a member or leader on a technical team												Knowledge and problem solving ability in material science and selection									
An ability to identify, analyze, and solve broadly-defined ET problems												Problem solving ability in solid mechanics									
An ability to apply written, oral, and graphical communication in ...												Problem solving ability in thermal sciences									
An understanding of the need for and ability to engage in self-directed continuing PD												Problem solving ability in electrical circuits and controls									
An understanding of /commitment to address prof & ethical responsibilities...																					
A knowledge of the impact of ET solutions in a societal and global context																					
A commitment to quality, timeliness, and continuous improvement																					

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

*IAC Evaluation of Senior Projects in ENGR 485:*

The evaluation of this outcome was performed by dividing it into three different aspects:

- k-1. Show proficiency in following guidelines, meeting deadlines, and improving assigned tasks
  - k-1-a. Quality engineering work is demonstrated
  - k-1-b. A commitment to timeliness is demonstrated
  - k-1-c. A commitment to continuous improvement is demonstrated

Figure 4.3k.1 shows the questions used to evaluate this aspect. The initial questions from academic year 2013, as shown in Fig. 4.3k.1 (a), were modified to the ones shown in (b) for academic years 2014 through 2016. The average of the scores provided by all IAC members to the teams that included at least one MET student, are shown in Fig. 4.3k.2 (a, b, and c). The number of MET students in each team ranged from 1 to 3. Teams typically consisted of 3 students each.

**Figure 4.3k.1**

		Scale					
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable
		1	2	3	4	5	NA

#	Question	A	B	C	D
15	Poster quality represents the work by an entry level engineer.				
6	The team understands the design loop (e.g., need, concept, evaluate, build, test, repeat, etc)?				
14	The team engages in a technical conversation in a professional manner (e.g. does not use casual language, slang)				

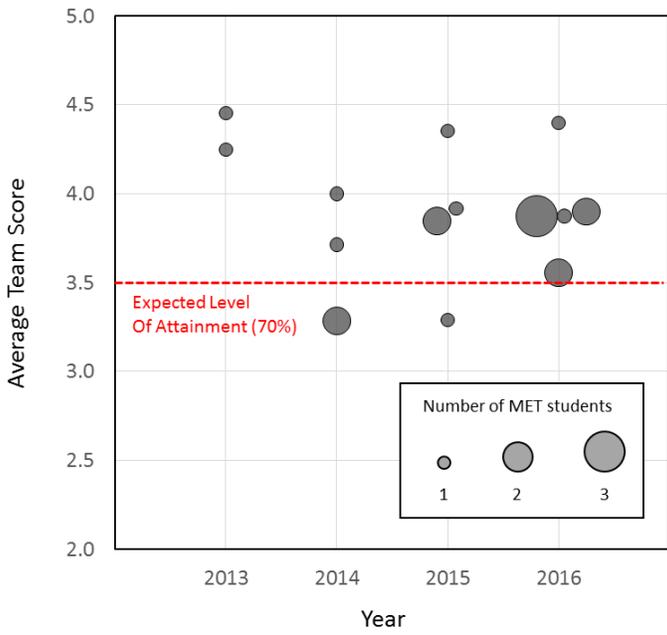
(a) Year 2013

Please fill the boxes on the right with a number included in the interval [0-5]. In case you have comments, please use the back of this form.

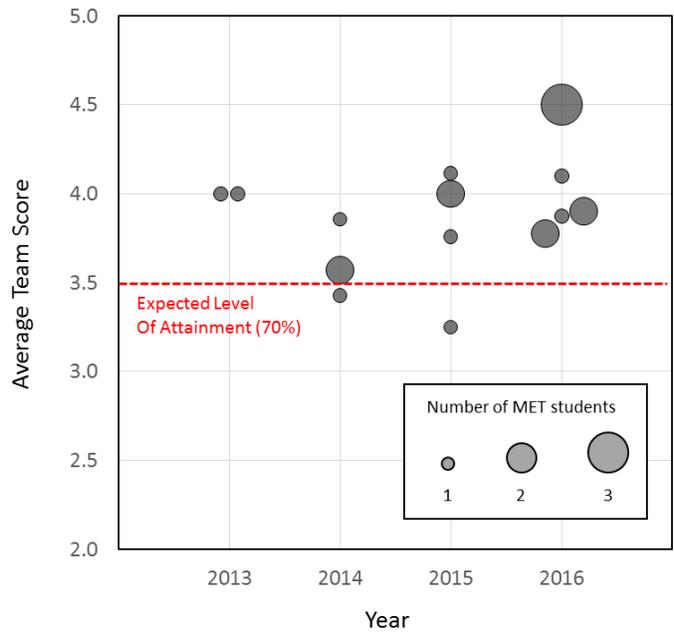
Topic	Unacceptable (0)	Marginal (1-2)	Acceptable (3)	Exceptional (4-5)	A	B	C	D
<b>Fabrication</b>	Final product/prototype is at the level of a first-year engineering college student or below (duct tape, etc.). Fabrication is below industry standards.	Final product/prototype is not up to the level expected of a graduating engineer. Minimal fabrication is completed and below industry standards.	Final product/prototype is nearly the quality used in industry. Most fabrication is completed to industry standard.	Final product/prototype is equivalent to the quality from an entry-level engineer. All fabrication is completed to industry standard.				
<b>Testing</b>	Designs clearly not tested properly. Testing plan is poorly developed and testing data is not provided.	Design testing is marginal. Testing plan developed, but not implemented properly. Parts of the design appear to be tested at the last minute.	Design testing acceptable for industry standards. Testing plan developed and implemented. Testing data is provided.	Design testing exceptional by industry standards. Testing plan developed and implemented with needed corrections iterated in the design.				
<b>Professionalism</b>	Team members are unprofessional/inappropriate in appearance and demeanor. Communications are filled with slang (e.g., "man", "thing", "like"). Body language very unprofessional (slouching, no eye contact).	Team members are somewhat unprofessional/inappropriate in appearance and demeanor. Communications somewhat professional but could still use some polish. Body language marginally professional.	Team members are appropriate in appearance and demeanor. Communications are more professional and delivered in language appropriate for industry. Body language communicates professional interest with proper posture, appropriate eye contact and use of hand gestures.	Team members go the "extra mile" in professional appearance and demeanor as if they were preparing for an interview with the company. Communications are sharp and polished. Body language is professional in terms of posture, eye contact and hand gestures.				

(b) Years 2014 through 2016

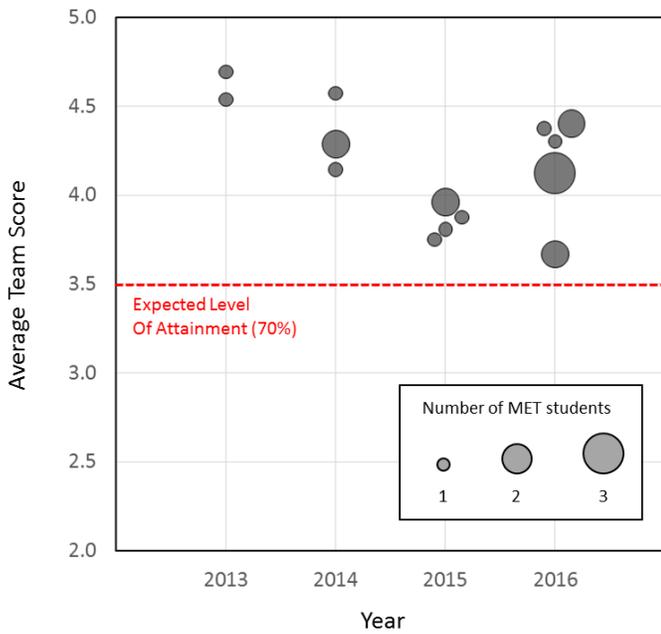
**Figure 4.3k.2 (a). Evaluation Rubrics for SO k-1.**



**Figure 4.3k.2 (b). Evaluation Rubrics for SO k-2.**



**Figure 4.3k.2 (c). Evaluation Rubrics for SO k-3.**



**Results Summary for Student Outcome k: A commitment to quality, timeliness, and continuous improvement**

<b>Assessment Method</b>	<b>Year</b>	<b>Result</b>	<b>Target</b>	<b>Action Required?</b>
Senior Exit Survey	2015	4.25/5.0	>3.0	No
	2016	4.2/5.0	>3.0	No
Employer Survey	2016	4.4/5.0	>3.0	No
IAC Evaluation of	2013	100%	>70%	No
Senior Projects	2014	66%	>70%	Yes
SO k-1, k-2, k-3	2015	75%	>70%	No
	2016	100%	>70%	No

**Actions:**

No action is warranted. Only a single team in four years did not meet the expected level of attainment for this outcome.

**Table 4-3a. Program Criteria:  
PC-a: Demonstration of knowledge and competency in geometric dimensioning and tolerancing and computer aided drafting and design**

Performance Indicator	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
PC-a-1. Ability to interpret GD&T correctly	MAMT 106 ENGR 125 ENGR 225	-Sr Exit Survey -Employer Surv -Assign in ENGR 225	-Sp 2015,16 -Sp 2016 -F 2015	METAC
PC-a-2. Ability to apply GD&T in CAD and design	MAMT 106 ENGR 125 ENGR 225	-Sr Exit Survey -Employer Surv -Assign in ENGR 225	-Sp 2015,16 -Sp 2016 -F 2015	METAC

**Results:** Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), &

Employer Survey spring 2016 (n=5):

	Student Outcomes													Program Criteria					
	(a) An ability to select and apply the knowledge, techniques, skills, and modern ...	(b) An ability to select and apply knowledge of STEM to ET problems ...	(c) An ability to conduct standard tests and measurements...	(d) An ability to design systems, components, or processes for ET problems ...	(e) An ability to function effectively as a member or leader on a technical team	(f) An ability to identify, analyze, and solve broadly-defined ET problems	(g) An ability to apply written, oral, and graphical communication in ...	(h) An understanding of the need for and ability to engage in self-directed continuing PD	(i) An understanding of /commitment to address prof & ethical responsibilities...	(j) A knowledge of the impact of ET solutions in a societal and global context	(k) A commitment to quality, timeliness, and continuous improvement	(a) Knowledge of GD&T and computer aided drafting and design	(b) Hands-on skills in the selection, set-up and calibration of instr & sensors used ...	(c) Knowledge of industry codes, specs and standards	(d) Knowledge and hands-on skills in manufacturing processes	(e) Knowledge and problem solving ability in material science and selection	(f) Problem solving ability in solid mechanics	(g) Problem solving ability in thermal sciences	(h) Problem solving ability in electrical circuits and controls
Student's Perceived Ability (2015)	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	3.0	3.5	2.5	2.75	3.25	3.5	2.25	3.25
Student's Perceived Ability (2016)	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2	3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
Employer (2016)	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4	3.5	3.75	3.5	4	4.25	4.25	4	4

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Assignment in ENGR 225 (n=7) spring 2015:

Assessed during Spring 2016 - ENGR 425: Advanced Manufacturing						
Description: The assignment was first given in ENGR 425 in the spring of 2016 but will be given in ENGR 225/426 starting in the fall of 2016. This was a laboratory assignment that required students to solid model a simple pin and block assembly (two blocks and three pins) and produce two sets of drawings from the assembly - a set of drawings dimensioned with coordinate tolerancing and a set dimensioned with GD&T. Students were encouraged to use the ASME Y14.5 and ISO 1101 standards as references to complete the drawings and their comparative write-up of the two dimensioning systems.						
Learning Objectives		Dana	Ibarra	Lara	Nielson	Patton
PC-a-1-a	Demonstrate an ability to interpret GD&T correctly by comparing GD&T and coordinate tolerancing systems	3.5	4.5	3.5	3.5	1
PC-a-1-b	Demonstrate awareness of ASME Y14.5 and/or ISO 1101	3.5	3.5	3.5	3.5	1
PC-a-2-a	Demonstrate basic knowledge and use of CAD software	4.5	4.5	4.5	4.5	1
PC-a-2-b	Demonstrate an ability to apply GD&T in CAD and design	3.5	4.5	3.5	3.5	1
Average:		3.8	4.3	3.8	3.8	1.0

**Rubric max was 5.0, target of 70% is 3.5: 80% of students scored > 70% on Rubric**

**Results Summary for PC-a: Demonstration of knowledge and competency in geometric dimensioning and tolerancing and computer aided drafting and design**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	3.0/5.0	>3.0	Yes
	2016	3.7/5.0	>3.0	No
Employer Survey	2016	3.5/5.0	>3.0	No
Assign in ENGR 225 (assignment was given in ENGR 425, one time only)	2016	80%	>70%	No

**Actions:** No action is warranted. Students that had graduated in 2015 were not exposed to the new 2-credit GD&T class. The METAC decided to wait until the implementation of the new GD&T class had time to take effect.

**Table 4-3b. Program Criteria:**

**PC-b: Demonstration of knowledge and competency in the selection, set-up and calibration of instrumentation and sensors used in mechanical design and equipment operation**

Performance Indicator	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
PC-b-1. Proficiently select, set-up and utilize a power supply, oscilloscope, multimeter, universal counter, function/waveform generator	ENGR 317 ENGR 427 ENGR 435	-Sr Exit Survey -Employer Surv -Assign in ENGR 435	-Sp 2015, 16 -Sp 2016 -Sp 2015, 16	METAC Instructor
PC-b-2. Proficiently select, set-up, calibrate and utilize sensors used in mechanical design and equipment operation	ENGR 317 ENGR 427 ENGR 435	-Sr Exit Survey -Employer Surv -Assign in ENGR 435	-Sp 2015, 16 -Sp 2016 -Sp 2015, 16	METAC Instructor

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), &*

*Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
An ability to select and apply the knowledge, techniques, skills, and modern ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	Knowledge of GD&T and computer aided drafting and design	3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
An ability to select and apply knowledge of STEM to ET problems ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	Hands-on skills in the selection, set-up and calibration of instr & sensors used ...	3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
An ability to conduct standard tests and measurements...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	Knowledge of industry codes, specs and standards	3.5	3.75	3.5	4	4.25	4.25	4	4
An ability to design systems, components, or processes for ET problems ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	Knowledge and hands-on skills in manufacturing processes	3.5	3.75	3.5	4	4.25	4.25	4	4
An ability to function effectively as a member or leader on a technical team	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	Knowledge and problem solving ability in material science and selection	3.5	3.75	3.5	4	4.25	4.25	4	4
An ability to identify, analyze, and solve broadly-defined ET problems	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	Problem solving ability in solid mechanics	3.5	3.75	3.5	4	4.25	4.25	4	4
An ability to apply written, oral, and graphical communication in ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	Problem solving ability in thermal sciences	3.5	3.75	3.5	4	4.25	4.25	4	4
An understanding of the need for and ability to engage in self-directed continuing PD	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	Problem solving ability in electrical circuits and controls	3.5	3.75	3.5	4	4.25	4.25	4	4
An understanding of /commitment to address prof & ethical responsibilities...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25									
A knowledge of the impact of ET solutions in a societal and global context	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25									
A commitment to quality, timeliness, and continuous improvement	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25									

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Assignment in ENGR 435 (n=8) spring 2016:

Category/Student	Bagnard	Bear	Buck	Carlton	Dana	Lara	Nielson	Rucker
PC-b Instrumentation & Sensors	63.3%	9.1%	81.8%	63.6%	72.7%	54.5%	63.6%	81.8%

*Rubric max was 100%, target is 70%: 38% of students scored >70% on Rubric*

**Results Summary for PC-b: Demonstration of knowledge and competency in the selection, set-up and calibration of instrumentation and sensors used in mechanical design and equipment operation**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	3.5/5.0	>3.0	No
	2016	3.8/5.0	>3.0	No
Employer Survey	2016	3.75/5.0	>3.0	No
Assign in ENGR 435	2016	38%	>70%	Yes

**Actions:** The program did not achieve the expected level of attainment for this SO from its assessment in ENGR 435 Industrial Controls. Discussion with the METAC indicated that only 2 of the 8 students assessed in this class had taken the pre-req ENGR 427 Instrumentation. This was due to ENGR 427 not being offered previous to fall 2015. The program will monitor the progress of students as the curriculum matures. An additional remedy was to assess the students later in ENGR 435 rather than midway through the course.

**Table 4-3c. Program Criteria:  
PC-c: Demonstration of knowledge and competency in industry codes, specs and standards**

Performance Indicator	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
PC-c-1. Application of industry codes, specs and standards that are relevant to the broad field of engineering	ENGR 224 ENGR 325	-Sr Exit Survey -Employer Surv -Assign in ENGR 325	-Sp 2015, 16 -Sp 2016 -Sp 2016	METAC Instructor

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

	<b>Student Outcomes</b>											<b>Program Criteria</b>							
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Student's Perceived Ability (2015)	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
Student's Perceived Ability (2016)	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2	3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
Employer (2016)	3.8	4.4	4	3.75	4.4	4	4.6 Written 4.2 oral 4 visual	4.2	4.4	3.25	4.4	3.5	3.75	3.5	4	4.25	4.25	4	4

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Assignment in ENGR 325 (n=12) spring 2016:

Category/Student	Bear, Brant M.	Burdi, Shane T.	Dana, Brett T.	Dulaney, Dane O.	Gillespie, Logan W.	Gilliam, Jeremy C.	Ibarra, Carlos O.	Jenkins, Jeremy P.	Marin Garcia, Jose M.	Patton, Morgan B.	Wood, Alexander S.
<b>PC-c Industry Codes &amp; Standards</b>											
Citation of Applicable Standard, Code, Specification	1.0	2.0	2.0	2.0	2.0	2.0	3.0	1.0	2.0	1.0	0.0
Application of Standards, Codes, Specifications	1.0	1.0	1.0	1.0	1.0	2.0	2.0	1.0	2.0	1.0	0.0
<b>Averages for PC-c</b>	<b>1.0</b>	<b>1.5</b>	<b>1.5</b>	<b>1.5</b>	<b>1.5</b>	<b>2.0</b>	<b>2.5</b>	<b>1.0</b>	<b>2.0</b>	<b>1.0</b>	<b>0.0</b>

**Rubric max was 4, target is 2.8: 0% of students scored >70% on Rubric**

**Results Summary for PC-c: Demonstration of knowledge and competency in industry codes, specs and standards**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	2.5/5.0	>3.0	Yes
	2016	3.2/5.0	>3.0	No
Employer Survey	2016	3.5/5.0	>3.0	No
Assign in ENGR 325	2016	0%	>70%	Yes

**Actions:** The program did not reach the expected level of attainment for this SO. The instructor for ENGR 224 (a formative assessment of this PC) and ENGR 325 (the class that ultimately assesses this PC) will emphasize codes and standards to a larger degree. The METAC decided to monitor the results of this outcome before changing anything else since it only became an actual program criteria recently due to the change in the ABET Program Criteria for MET.

**Table 4-3d. Program Criteria:**  
**PC-d: Demonstration of knowledge and competency in manufacturing processes**

Performance Indicator	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
PC-d-1. Apply knowledge of the equations used in manufacturing economics	MAMT 102 MAMT 105 MAMT 106 ENGR 225	-Sr Exit Survey -Employer Surv -Assign in ENGR 225	-Sp 2015, 16 -Sp 2016 -F 2014, 15	METAC Instructor
PC-d-2. Apply knowledge of manufacturing techniques	MAMT 102 MAMT 105 MAMT 106 ENGR 225	-Sr Exit Survey -Employer Surv -Assign in ENGR 225	-Sp 2015, 16 -Sp 2016 -F 2014, 15	METAC Instructor
PC-d-3. Apply hands-on skills to manufacturing processes	MAMT 102 MAMT 105 MAMT 106 ENGR 225	-Sr Exit Survey -Employer Surv -Assign in ENGR 225	-Sp 2015, 16 -Sp 2016 -F 2014, 15	METAC Instructor

**Results:** *Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
An ability to select and apply the knowledge, techniques, skills, and modern ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
An ability to select and apply knowledge of STEM to ET problems ...	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
An ability to conduct standard tests and measurements...	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4
An ability to design systems, components, or processes for ET problems ...																				
An ability to function effectively as a member or leader on a technical team																				
An ability to identify, analyze, and solve broadly-defined ET problems																				
An ability to apply written, oral, and graphical communication in ...																				
An understanding of the need for and ability to engage in self-directed continuing PD																				
An understanding of /commitment to address prof & ethical responsibilities...																				
A knowledge of the impact of ET solutions in a societal and global context																				
A commitment to quality, timeliness, and continuous improvement																				
Knowledge of GD&T and computer aided drafting and design																				
Hands-on skills in the selection, set-up and calibration of instr & sensors used ...																				
Knowledge of industry codes, specs and standards																				
Knowledge and hands-on skills in manufacturing processes																				
Knowledge and problem solving ability in material science and selection																				
Problem solving ability in solid mechanics																				
Problem solving ability in thermal sciences																				
Problem solving ability in electrical circuits and controls																				

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Assignment in ENGR 225 (n=7):

<b>Assessed during Fall 2014 - ENGR 225: Introduction to Manufacturing</b>								
Description: This program criteria was assess with two different assignments. A homework assignment related to manufacturing economics (HW6) was used for PC-d-1 (students applied equations to a series of questions) and a laboratory assignment on welding was used for PC-d-2 and PC-d-3 (students had to physically weld their own samples for a bend test and tension test after considering design constraints related to loads and weld joints).								
Learning Objectives		Bartels	Bauer	Harbert	Klein	Rowley	Rucker	Zemezouak
PC-d-1	Demonstrate an ability to apply knowledge of the equations used in manufacturing economics	2	2.5	2.5	3	3	4	4
PC-d-2	Demonstrate an ability to apply knowledge of manufacturing techniques	3.5	1	1	3.5	3.5	3.5	3
PC-d-3	Demonstrate an ability to apply hands-on skills to manufacturing processes	4	1	1	3.5	4.5	3.5	3.5
Average:		3.2	1.5	1.5	3.3	3.7	3.7	3.5

**Rubric max was 5.0, target of 70% is 3.5: 43% of students scored > 70% on Rubric**

<b>Assessed during Fall 2015 - ENGR 225: Introduction to Manufacturing</b>																
Description: This program criteria was assessed with two different assignments. A homework assignment related to manufacturing economics (HW6) was used for PC-d-1 (students applied equations to a series of questions) and a laboratory assignment on welding was used for PC-d-2 and PC-d-3 (students had to physically weld their own samples for a bend test and tension test after considering design constraints related to loads and weld joints).																
Learning Objectives		Cooper	Dana	Fleber	Ibarra	Bagnard	Burdi	Gilliam	Hawley	Hilken	Jenkins	Kawano	Lara	Nielson	Patton	Wood
PC-d-1	Demonstrate an ability to apply knowledge of the equations used in manufacturing economics	4.5	4	3.5	3.5	4	3	3	3.5	3	3	3.5	3.5	3	3.5	4
PC-d-2	Demonstrate an ability to apply knowledge of manufacturing techniques	4	4	3	4	3.5	3.5	3.5	4	3.5	3.5	3.5	3.5	3.5	3.5	2.5
PC-d-3	Demonstrate an ability to apply hands-on skills to manufacturing processes	4	3.5	3	3.5	4	4.5	4.5	3.5	3.5	4	3	3	3	3	4.5
Average:		4.2	3.8	3.2	3.7	3.8	3.7	3.7	3.7	3.3	3.5	3.3	3.3	3.2	3.3	3.7

**Rubric max was 5.0, target of 70% is 3.5: 60% of students scored > 70% on Rubric**

**Results Summary for PC-d: Demonstration of knowledge and competency in manufacturing processes**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	2.75/5.0	>3.0	Yes
	2016	3.8/5.0	>3.0	No
Employer Survey	2016	4.0/5.0	>3.0	No
Assign in ENGR 225	2014	43%	>70%	Yes
	2015	60%	>70%	Yes

**Actions:** The program did not reach the expected level of attainment for this SO. However, significant improvement occurred from 2014 to 2015 in both the student perception and the class assessment. The METAC decided no changes were necessary only to keep an eye on this outcome with expected improvement again in 2016. Again a wait and see attitude is taken due to the fact that the ABET Program Criteria for MET recently added specificity to manufacturing processes.

**Table 4-3e. Program Criteria:**

**PC-e: Demonstration of knowledge and competency in material science and selection**

Performance Indicator	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
PC-e-1. Apply knowledge and problem solving ability to the selection of material in engineering design	ENGR 224 ENGR 225	-Sr Exit Survey -Employer Surv -Assign in ENGR 225	-Sp 2015, 16 -Sp 2016 -F 2015, 16	METAC Instructor

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
An ability to select and apply the knowledge, techniques, skills, and modern ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
An ability to select and apply knowledge of STEM to ET problems ...																				
An ability to conduct standard tests and measurements...																				
An ability to design systems, components, or processes for ET problems ...																				
An ability to function effectively as a member or leader on a technical team																				
An ability to identify, analyze, and solve broadly-defined ET problems																				
An ability to apply written, oral, and graphical communication in ...																				
An understanding of the need for and ability to engage in self-directed continuing PD																				
An understanding of /commitment to address prof & ethical responsibilities...																				
A knowledge of the impact of ET solutions in a societal and global context																				
A commitment to quality, timeliness, and continuous improvement																				
Knowledge of GD&T and computer aided drafting and design																				
Hands-on skills in the selection, set-up and calibration of instr & sensors used ...																				
Knowledge of industry codes, specs and standards																				
Knowledge and hands-on skills in manufacturing processes																				
Knowledge and problem solving ability in material science and selection																				
Problem solving ability in solid mechanics																				
Problem solving ability in thermal sciences																				
Problem solving ability in electrical circuits and controls																				
Student's Perceived Ability (2015)	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
Student's Perceived Ability (2016)	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
Employer (2016)	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Assignment in ENGR 225 (n=7 in 2014 & n=15 in 2015):

Assessed during Fall 2014 - ENGR 225: Introduction to Manufacturing								
Description: This program criterion was assessed with a laboratory assignment on design (students had to select a product and review the impact of design changes on materials and manufacturing processes or review the impact of material/process changes on the design).								
Learning Objectives		Bartels	Bauer	Harbert	Klein	Rowley	Rucker	Zemezouak
PC-e-1	Demonstrate an application of knowledge and problem solving ability to the selection of material in engineering design	4	2	3.5	3	3	4	4
Average:		4.0	2.0	3.5	3.0	3.0	4.0	4.0

**Rubric max was 5.0, target of 70% is 3.5: 57% of students scored >70% on Rubric**

Assessed during Fall 2015 - ENGR 225: Introduction to Manufacturing																
Description: This program criterion was assessed with a laboratory assignment on design (students had to select a product and review the impact of design changes on materials and manufacturing processes or review the impact of material/process changes on the design).																
Learning Objectives	Cooper	Dana	Fieber	Ibarra	Bagnard	Burdi	Gilliam	Hawley	Hilken	Jenkins	Kawano	Lara	Nielson	Patton	Wood	
PC-e-1	Demonstrate an application of knowledge and problem solving ability to the selection of material in engineering design	4.5	4.5	3.5	4.5	2	3.5	3	4	4	4	4	4	4	4	3.5
Average:		4.5	4.5	3.5	4.5	2.0	3.5	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.5

**Rubric max was 5.0, target of 70% is 3.5: 87% of students scored > 70% on Rubric**

**Results Summary for PC-e: Demonstration of knowledge and competency in material science and selection**

<b>Assessment Method</b>	<b>Year</b>	<b>Result</b>	<b>Target</b>	<b>Action Required?</b>
Senior Exit Survey	2015	3.25/5.0	>3.0	No
	2016	3.3/5.0	>3.0	No
Employer Survey	2016	4.25/5.0	>3.0	No
Assign in ENGR 225	2015	57%	>70%	Yes
	2016	87%	>70%	No

**Actions:** The program did not reach the expected level of attainment for this SO. However, since the scores are improving from 2015 to 2016 it was decided that no major action needed to occur. Keep in mind that in 2016 was the second time the instructor for this class taught the class. She was hired specifically to teach manufacturing related courses. In the past it was combined with the MET students taking MCEN 4026, a senior level class with the same outcomes. The METAC decided to give the content more time to develop.

**Table 4-3f. Program Criteria:  
PC-f: Demonstration of knowledge and competency in solid mechanics**

Performance Indicator	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
PC-f-1. Apply problem solving skills and principles to a broad range of engineering design problems	ENGR 261 ENGR 263 ENGR 325 ENGR 343	-Sr Exit Survey -Employer Surv -Assign in ENGR 325	-Sp 2015, 16 -Sp 2016 -Sp 2015	METAC Instructor

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

Student Outcomes	Student Outcomes											Program Criteria							
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Student's Perceived Ability (2015)	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25	3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
Student's Perceived Ability (2016)	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2	3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
Employer (2016)	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4	3.5	3.75	3.5	4	4.25	4.25	4	4

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Assignment in ENGR 325 (n=11) spring 2016:

<i>Category/Student</i>	Bear, Brant M.	Burdi, Shane T.	Dana, Brett T.	Dulaney, Dane O.	Gillespie, Logan W.	Gilliam, Jeremy C.	Ibarra, Carlos O.	Jenkins, Jeremy P.	Marin Garcia, Jose M.	Patton, Morgan B.	Wood, Alexander S.
<b>PC-f Solid Mechanics</b>											
Draw & Label Free-Body Diagram	1.0	3.0	4.0	3.0	1.0	4.0	4.0	4.0	3.0	4.0	2.0
Quantify Stress & Identify Critical Stress Locations	1.0	4.0	4.0	4.0	1.0	4.0	4.0	4.0	4.0	3.0	2.0
Determine Deformation (strain, elongation, angle of twist)	2.0	4.0	4.0	3.0	1.0	4.0	4.0	3.0	4.0	3.0	2.0
Specify Components for Prescribed Loading or Deformation Conditions	1.0	3.0	4.0	3.0	1.0	4.0	4.0	3.0	3.0	4.0	2.0
<b>Averages for PC-f</b>	<b>1.3</b>	<b>3.5</b>	<b>4.0</b>	<b>3.3</b>	<b>1.0</b>	<b>4.0</b>	<b>4.0</b>	<b>3.5</b>	<b>3.5</b>	<b>3.5</b>	<b>2.0</b>

*Rubric max was 4.0, target of 70% is 2.8: 73% of students scored >70% on Rubric*

**Results Summary for PC-f: Demonstration of knowledge and competency in solid mechanics**

<b>Assessment Method</b>	<b>Year</b>	<b>Result</b>	<b>Target</b>	<b>Action Required?</b>
Senior Exit Survey	2015	3.5/5.0	>3.0	No
	2016	3.5/5.0	>3.0	No
Employer Survey	2016	4.25/5.0	>3.0	No
Assign in ENGR 325	2016	73%	>70%	No

**Actions:** No action is required for this outcome.

**Table 4-3g. Program Criteria:  
PC-g: Demonstration of knowledge and competency in the thermal sciences**

Performance Indicator	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
PC-g-1. Apply problem solving skills and principles to thermodynamic engineering design problems	ENGR 312	-Sr Exit Survey -Employer Surv -Assign in ENGR 312	-Sp 2015, 16 -Sp 2016 -Sp 2015, F 2015, Sp 2016	METAC Instructor
PC-g-2. Apply problem solving skills and principles to fluid mechanics engineering design problems	ENGR 321	-Sr Exit Survey -Employer Surv -Assign in ENGR 321	-Sp 2015, 16 -Sp 2016 -F 2014	METAC Instructor

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
An ability to select and apply the knowledge, techniques, skills, and modern ... ET problems ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
An ability to conduct standard tests and measurements...																				
An ability to design systems, components, or processes for ET problems ...																				
An ability to function effectively as a member or leader on a technical team																				
An ability to identify, analyze, and solve broadly-defined ET problems																				
An ability to apply written, oral, and graphical communication in ...																				
An understanding of the need for and ability to engage in self-directed continuing PD																				
An understanding of /commitment to address prof & ethical responsibilities...																				
A knowledge of the impact of ET solutions in a societal and global context																				
A commitment to quality, timeliness, and continuous improvement																				
Knowledge of GD&T and computer aided drafting and design																				
Hands-on skills in the selection, set-up and calibration of instr & sensors used ...																				
Knowledge of industry codes, specs and standards																				
Knowledge and hands-on skills in manufacturing processes																				
Knowledge and problem solving ability in material science and selection																				
Problem solving ability in solid mechanics																				
Problem solving ability in thermal sciences																				
Problem solving ability in electrical circuits and controls																				
Student's Perceived Ability (2015)	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25
Student's Perceived Ability (2016)	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5
Employer (2016)	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Assignment in ENGR 312:

<b>Spring 2015 - ENGR 312: Engineering Thermodynamics, n=7</b>										
<b>Description:</b> The assignment was a project related to an actual reheat steam power plant consisted of three turbines where the students had to analyze the cycle and determine the net work output, the cycle thermal efficiency, and draw the cycle processes on an actual T-s diagram.										
		Bagnard	Buck	Burton	Carlton	Jenkins	Kawano	Klein		
PC-g-1-a	The system, its boundary, and processes are correctly identified	4	4.5	0	3.5	5	4	4.5		
PC-g-1-b	State of the substance is determined and its thermodynamic properties is correctly evaluated	4	5	0	4.5	4	5	4		
PC-g-1-c	Equations for the first and second law (if applicable) are correctly applied and simplified	4.5	5	0	4	3	3.5	3		
PC-g-1-d	Heat/work transfer and/or system efficiency (if applicable) are determined	4	3.5	0	4.5	4.5	5	3		
	Average	4.13	4.50	0.00	4.13	4.13	4.38	3.63		

**Rubric max was 4.0, target of 70% is 2.8: 86% of students scored >70% on Rubric**

<b>Fall 2015 - ENGR 312: Engineering Thermodynamics, n=11</b>												
		Ahmed	Benson	Burdi	DeFeo	Gilliam	Hamer	Hawley	Ibarra	Matosky	Mayerle	Peltier
PC-g-1-a	The system, its boundary, and processes are correctly identified	2	2.0	4	2.0	4	2	4.0	4	3.5	3	3.5
PC-g-1-b	State of the substance is determined and its thermodynamic properties is correctly evaluated	1.5	2	3	2	3	2	4	4	3	2.5	3
PC-g-1-c	Equations for the first and second law (if applicable) are correctly applied and simplified	1.5	2	3.5	2	3.5	2	4	4	3	3	3
PC-g-1-d	Heat/work transfer and/or system efficiency (if applicable) are determined	2	2	3	2	3.5	2	4	4	3	3	3
	Average	1.75	2.00	3.25	2.00	3.38	2.00	4.00	4.00	3.13	2.88	3.13

**Rubric max was 4.0, target of 70% is 2.8: 64% of students scored >70% on Rubric**

<b>Spring 2016 - ENGR 312: Engineering Thermodynamics, n=6</b>										
		Ahmed	Dulaney	Gillespie	Hegge	Wolfe	Wood			
PC-g-1-a	The system, its boundary, and processes are correctly identified	3	3	3	3	1	3			
PC-g-1-b	State of the substance is determined and its thermodynamic properties is correctly evaluated	3	3	3	3	1	3			
PC-g-1-c	Equations for the first and second law (if applicable) are correctly applied and simplified	3	3	3	3	3	3			
PC-g-1-d	Heat/work transfer and/or system efficiency (if applicable) are determined	3	3	3	3	1	3			
	Average	3.00	3.00	3.00	3.00	1.50	3.00			

**Rubric max was 4.0, target of 70% is 2.8: 80% of students scored >70% on Rubric**

Assignment in ENGR 321 (n=5) fall 2014:

Fall 2014 - ENGR 321: Fluid Mechanics						
<b>Description:</b> The assignment was a project related to an actual piping system, where the students had to determine pressure at different points in the system, all minor and major losses in the piping system, the flow rate, the power required to run the system, and a had to choose a proper pump						
		Klein	Patton	Buck	Dana	Hawley
PC-g-2-a	System components and their characteristics are identified and fluid properties are determined	4	4.5	5	4.5	5
PC-g-2-b	Proper form of the energy eqn is written between different points in the piping system	5	4	5	5	5
PC-g-2-c	Both major and minor losses are correctly calculated, using appropriate assumptions	4.5	4	4.5	5	5
PC-g-2-d	Power requirements for the pump is determined and an appropriate pump is selected	5	3.5	5	4.5	5
Average		4.63	4.00	4.88	4.75	5.00

Rubric max was 5.0, target of 70% is 3.5: 100% of students scored >70% on Rubric

**Results Summary for PC-g: Demonstration of knowledge and competency in the thermal sciences**

Assessment Method	Year	Result	Target	Action Required?
Senior Exit Survey	2015	2.25/5.0	>3.0	Yes
	2016	3.3/5.0	>3.0	No
Employer Survey	2016	4.0/5.0	>3.0	No
Assign in ENGR 312	Sp2015	86%	>70%	No
	F2015	64%	>70%	Yes
	Sp2016	80%	>70%	No
Assign in ENGR 321	2014	100%	>70%	No

**Actions:** Program has had multiple instructors for the thermal/fluids sequence since inception. A new engineering faculty hire is expected to bring stability to these classes and will be expected to bring in dedicated labs in both ENGR 312 Thermodynamics and ENGR 321 Fluids. With this addition, it is expected that students will feel more adept in these courses and assessment scores will increase.

**Table 4-3h. Program Criteria:**

**PC-h: Demonstration of knowledge and competency in electrical circuits and controls**

Performance Indicator	Strategies	Assessment Method(s)	Time Data was Collected	Evaluation of Results
Students will be able to demonstrate the ability to:				
PC-h-1. Solve & create solutions to electrical circuit problems	ENGR 317	-Sr Exit Survey -Employer Surv -Assign in ENGR 317	-Sp 2015, 16 -Sp 2016 -Sp 2016	METAC Instructor
PC-h-2. Solve & create solutions to controls problems	ENGR 435	-Sr Exit Survey -Employer Surv -Assign in ENGR 435	-Sp 2015, 16 -Sp 2016 -Sp 2016	METAC Instructor

**Results:**

*Survey Results: Senior Exit Survey spring 2015 (n=4) & spring 2016 (n=6), & Employer Survey spring 2016 (n=5):*

Student Outcomes	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	Program Criteria	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
An ability to select and apply the knowledge, techniques, skills, and modern ... ET problems ...	3.5	3.5	3.75	3	4.25	3.25	3.25	3.25	3.75	3.25	4.25		3	3.5	2.5	2.75	3.25	3.5	2.25	3.25	
An ability to select and apply knowledge of STEM to ET problems ...	3.8	3.7	3.5	3.7	4.3	3.5	3.8	4	4	3.8	4.2		3.7	3.8	3.2	3.8	3.3	3.5	3.3	3.5	
An ability to conduct standard tests and measurements...	3.8	4.4	4	3.75	4.4	4	4.6 written 4.2 oral 4 visual	4.2	4.4	3.25	4.4		3.5	3.75	3.5	4	4.25	4.25	4	4	
An ability to design systems, components, or processes for ET problems ...																					
An ability to function effectively as a member or leader on a technical team																					
An ability to identify, analyze, and solve broadly-defined ET problems																					
An ability to apply written, oral, and graphical communication in ...																					
An understanding of the need for and ability to engage in self-directed continuing PD																					
An understanding of /commitment to address prof & ethical responsibilities...																					
A knowledge of the impact of ET solutions in a societal and global context																					
A commitment to quality, timeliness, and continuous improvement																					
Knowledge of GD&T and computer aided drafting and design																					
Hands-on skills in the selection, set-up and calibration of instr & sensors used ...																					
Knowledge of industry codes, specs and standards																					
Knowledge and hands-on skills in manufacturing processes																					
Knowledge and problem solving ability in material science and selection																					
Problem solving ability in solid mechanics																					
Problem solving ability in thermal sciences																					
Problem solving ability in electrical circuits and controls																				3.25	
																					3.5
																					4

Importance/Ability Scale: 1-Not at all, 2-Not very well, 3-Moderately well, 4-Very well, 5-Extremely well

Assignment in ENGR 317 (n=15) in spring 2015 and (n=18) in spring 2016:

Learning Objectives, Sp 2015		Bagnard, Natalie	Bear, Brant	Buck, Christopher	Burdj, Shane	Carlton, John	Dana, Brett	Gillespie, Logan	Hawley, Nathan	Jenkins, Jeremy	Kawano, Ryan	Lara, Leandro	Marin Garacia, Jose	Nielson, Thomas	Rucker, Taylor	Asland, Thomas
PC-h-1	Ability to diagnose and repair and electrical circuit problem	3.5	2.5	3.0	2.5	2.5	3.0	1.5	3.5	2.5	3.0	1.5	3.0	2.5	3.5	1.5
PC-h-2	Demonstrate ability to solve an electrical circuit problem	3.5	2.0	2.5	2.0	2.0	2.5	1.0	3.5	2.0	2.5	1.0	2.5	2.0	3.5	1.0
Averages		3.5	2.3	2.8	2.3	2.3	2.8	1.3	3.5	2.3	2.8	1.3	2.8	2.3	3.5	1.3

**Rubric max was 4.0, 70% of 4.0 is a target 2.8: 47% of students scored >70% on Rubric**

Learning Objectives, Sp 2016		Ahmed, James	Benson, Ryan	Burdj, Shane	DeFeo, Anthony	Dulaney, Dane	Gilliam, Jeremy	Hamer, Dalton	Hegge, Daniel	Ibarra, Carlos	Jenkins, Jeremy	Kawano, Ryan	Koos, Jaden	Matosky, Lance	Patton, Morgan	Prescott, James	Salazar, Daniel	Ward, Peter	Wolfe, Mathew
PC-h-1-a	Diagnose and repair and electrical circuit problem	1.0	3.0	2.0	2.0	1.5	1.5	1.0	0.5	3.0	2.0	2.0	2.5	1.5	2.5	2.0	1.0	1.5	0.5
PC-h-1-b	Solve an electrical circuit problem	1.0	3.0	2.0	2.0	1.5	1.5	1.0	0.5	2.5	1.5	1.5	2.5	1.0	2.0	2.0	1.0	1.0	0.5
Averages		1.0	3.0	2.0	2.0	1.5	1.5	1.0	0.5	2.8	1.8	1.8	2.5	1.3	2.3	2.0	1.0	1.3	0.5

**Rubric max was 4.0, 70% of 4.0 is a target 2.8: 11% of students scored >70% on Rubric**

Assignment in ENGR 435 (n=8) spring 2016:

Category/Student	Bear	Buck	Carlton	Dana	Lara	Rucker
PC-h Controls	97%	91%	89.6%	94%	86.6%	95.5%

**Rubric max was 100%, target is 70%: 100% of students scored >70% on Rubric**

**Results Summary for PC-h: Demonstration of knowledge and competency in electrical circuits and controls**

<b>Assessment Method</b>	<b>Year</b>	<b>Result</b>	<b>Target</b>	<b>Action Required?</b>
Senior Exit Survey	2015	3.25/5.0	>3.0	No
	2016	3.5/5.0	>3.0	No
Employer Survey	2016	4.0/5.0	>3.0	No
Assign in ENGR 317	2015	47%	>70%	Yes
Assign in ENGR 317	2016	11%	>70%	Yes
Assign in ENGR 435	2016	100%	>70%	No

**Actions:** The program did not reach the expected level of attainment for this SO as assessed in ENGR 317. ENGR 317 has a significant lab portion where students work in 2-person teams to build, diagnose, and solve electric circuit problems. The instructor agreed that he was too helpful when students experienced problems and that it would be more beneficial to the students to let them struggle more. The METAC agreed to let this go for another assessment iteration and see where these percentages go.

## B. Continuous Improvement

Although every Student Outcome was assessed within the past two years, the frequency with which these assessments will be carried out in the future is spaced out according to the schedule shown in Table 4-5. The assessment of Student Outcomes will be on a two-to-three year cycle. However, certain materials will be collected each year as indicated by the “strategies” given in Tables 4-3 and 4-4. For example, CIs will be collected and analyzed each time the courses utilizing CIs are taught and FE Exam results will be analyzed in the spring of each year (beginning after a successful accreditation effort). Data collected during evaluation by our IAC will be collected every year.

**Table 4-5: Assessment frequency for Student Outcomes (a)-(k) and Program Criteria**

Student Outcome	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
a) an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities	X	X		X		X		X
b) an ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies	X	X	X	X	X	X	X	X
c) an ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes;	X	X			X		X	
d) an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives	X	X	X	X	X	X	X	X
e) an ability to function effectively as a member or leader on a technical team	X	X	X	X	X	X	X	X
f) an ability to identify, analyze, and solve broadly-defined engineering technology problems	X	X	X	X	X	X	X	X
g) an ability to apply written, oral, and graphical communication in both technical and non- technical environments; and an ability to identify and use appropriate technical literature	X	X			X		X	
h) an understanding of the need for and an ability to engage in self-directed continuing professional development	X	X		X		X		X
i) an understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity	X	X			X		X	
j) a knowledge of the impact of engineering technology solutions in a societal and global context	X	X		X		X		X
k) a commitment to quality, timeliness, and continuous improvement	X	X	X	X	X		X	
Program Criteria	X	X		X		X		X

Note that the MET Program launched at CMU in Jan. 2010. Low numbers of students have been involved in the program with graduating classes of 1, 3, 6, and 6 in 2013, 2014, 2015, and 2016, respectively. Assessment and continuous improvement have been pursued largely through the efforts taken with the UCB ME Partnership program. In fall 2014, a major MET Program reorganization was undertaken to assure that the MET (actually the AME Program at the time) would be accredited successfully. Some of the first primary assessments directly aimed at the MET Program were completed over the past two years. However, Table 5.0 shows the significant changes from the program inception to the present time. Many of these improvements were initiated on the basis of the UCB ME Partnership student FE results (e.g., the implementation of the class ENGR 305 Engineering Economics and Ethics), the ASME 2030 Survey Paper (introducing a 2-credit GD&T class along with incorporating

industry codes and standards more thoroughly throughout the curriculum) and the 2015 upgrade in the MET Program Criteria (incorporation of Program Criteria a through h is a direct result of this upgrade). Hence, continuous improvement has been occurring within the MET Program every year since its inception.

A summary of the continuous improvement efforts that were identified and the plan of the program to remedy the problems is shown in Table 4.6.

### **C. Additional Information**

Copies of the assessment strategies including assignments, rubrics, and raw data results for each Student Outcome and Program Criteria will be available for review and given to the evaluators July 1st in the form of a jump drive. Information will be sorted into Student Outcome specific folders. The folders will be organized as follows:

1. First section will describe the particular outcome including the Program's interpretation of the outcome, importance of the outcome to students, how the outcome will be assessed, and the rubrics used for assessment.
2. Second section will provide evidence used to assess the outcome including raw data and student work used in the assessment.
3. Third section will provide the strategies used in the assessment, e.g., examples of student work from other courses, that are aligned with the outcome.

In order to supplement the Self-Study, the following additional information will be provided on USB Flash Drives:

- 1) Electronic Self-Study document
- 2) Chronologically organized minutes from the Industry Advisory Council, and faculty meetings.
- 3) Senior Survey results
- 4) Employer Survey results
- 5) Course notebooks
- 6) Material specific to Student Outcomes and Program Criteria located in folders under the specific class that that outcome was assessed
  - a. Rubrics
  - b. Assessment assignment
  - c. Raw assessment results
- 7) Videos of students giving presentations

**Table 4-6. Summary of Program improvement plans.**

Student Outcome	Program Improvement	Expected Implementation Date	Responsibility
a) An ability to select and apply the knowledge, techniques, skills, and modern tools (LabView) ....	1. assess in ENGR 427 next year	Fall 2016	S. Bevill
b) An ability to select and apply knowledge of mathematics, science, engineering, and technology ....	1. New hire will give stability to ENGR 312 2. Retool CI for ENGR 263 3. Investigate other CI options	Fall 2016	New MET Hire S. Bevill S. Kessler
c) An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments .....	1. Should be assessed in a more “mechanical-oriented” class. 2. Assess in ENGR 343 next year 3. check with instructor of STAT 305 to assure content is consistent	Fall 2016	S. Bevill
d) An ability to design systems, components, or processes for ....	1. Update language on rubric so it will be more clear to IAC	Sp 2017	F. Castro
e) An ability to function effectively as a member or leader on a technical ...	None Required	n/a	n/a
f) An ability to identify, analyze, and solve broadly-defined engineering technology problems.	4. New hire will give stability to ENGR 312 5. Retool CI for ENGR 263 6. Investigate other CI options	Fall 2016	New MET Hire S. Bevill S. Kessler
g) An ability to apply written, oral, and graphical communication in both ...	1. form committee to investigate	Fall 2016	S. Lanci, chair
h) An understanding of the need for and an ability to engage in self-directed continuing pro ...	None Required	n/a	n/a
i) An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity	1. monitor future assessments	Fall 2016	S. Lanci
j) A knowledge of the impact of engineering technology solutions in a societal and global context	1. Invite professor of SOCI 120 engr faculty meeting 2. Tie content into existing ENGR courses, particularly ENGR 312	Fall 2016	T. Casey, Political Sci Dept Partnership Director N. McNeill
k) A commitment to quality, timeliness, and continuous improvement	None Required	n/a	n/a
<b>Program Criteria</b>			
a) Knowledge and competency in GD&T	None Required	n/a	n/a
b) Knowledge and competency in the selection, set-up and calibration of .....	1. give assessment later in ENGR 435 2. monitor progress over time	Sp 2017	N. McNeill New MET hire
c) Knowledge and competency in industry codes, specs and standards	1. Use more diligence in ENGR 325 2. Monitor next cycle	Fall 2016	S. Kessler
d) Knowledge and competency in manufacturing processes	1. Showed good progress last year 2. Monitor to make sure the trend continues upward	Fall 2016	S. Lanci
e) Knowledge and competency in material science and selection	1. Monitor class since big improvement occurred last 2 years	Fall 2016	S. Lanci
f) Knowledge and competency in solid mechanics	None Required. Note CI results in b) & f).	n/a	n/a
g) Knowledge and competency in the thermal sciences	1. Monitor future assessments 2. Expected that with new MET hire consistency will improve	Fall 2016	New MET Hire
h) Knowledge and competency in electrical circuits and controls	1. instructor will let students struggle more in ENGR 317 Circuits	Sp 2017	A. Affrunti

## **CRITERION 5. CURRICULUM**

### **A. Program Curriculum**

#### **1. Plan of Study**

The Program curriculum is semester based. The plan of study and recommended schedule for students in the program is shown in Table 5-1. Maximum section enrollments are given for all courses over the two terms immediately preceding the visit. A summary of the changes to the program required courses that have evolved over these four years is given in Table 5-0. In order to better evaluate student transcripts, each transcript will have notes attached explaining the specific program sheet under which the student graduated.

#### **2. Alignment with the Program Educational Objective**

The PEO expresses the mission of the institution and the program. The PEO plus a synthesis of ABET criteria and Student Outcomes determine the undergraduate curriculum and individual course learning objectives. The courses in the Mechanical Engineering Technology curriculum are thus designed to achieve the Program's PEO.

The curriculum provides broad preparation in engineering and science fundamentals, as well as focused technical electives that prepare students to succeed in professional careers in mechanical engineering and related fields. Extensive design experience offered during 1<sup>st</sup> Year Engineering Projects, Integration Projects I and II, and through the full-year capstone design course, with projects offered by industrial partners, prepares students to successfully pursue professional careers in engineering. Additionally, extensive experience in teams and opportunities to hone communications skills prepare students to exercise leadership and contribute effectively in professional settings. Finally, while the Mechanical Engineering Technology curriculum is focused on preparation for careers in this field, successful completion of the curriculum also supports success in other professional fields, such as business, law and medicine, by providing extensive experience in problem solving, teamwork, critical thinking and design skills that are valuable in these other professions.

#### **3. Curriculum Support for the Attainment of Student Outcomes**

As reflected by the general nature of the PEO, our students are destined for all sectors of the economy and industry, but are uniquely prepared for careers as mechanical engineers. Our Student Outcomes include similarly general skills and abilities appropriate to the wide range of achievements we expect of our students, but the PEO is also formed around a synthesis of the general ABET Criteria 3 a-k, Criterion 5, and the MET program-specific criteria. The curriculum follows a fairly traditional sequence, beginning with a combination of basic sciences and calculus, followed by increasingly complex disciplinary topics. Prerequisites are specified to support this sequence. In addition, special attention has been paid to providing a design experience in the first year. An emphasis on experiential learning is reflected in laboratory experiences in the sophomore level courses of Materials Science and Dynamics and the junior level classes of Fluids, Circuits, and Component Design. Courses in humanities and social sciences are spread throughout, so that students maintain contact with disciplines outside of engineering. The sophomore level course SOCI 120 was specifically developed to expose our MET students to the social, political and economic consequences of engineering solutions in our world.

#### 4. Flowchart Illustrating Pre-requisites

Figure 5-2 illustrates the Program courses and the prerequisite chain. The graduating student transcripts provided to the ABET team should reflect this curriculum map except for the details provided in Table 5-0. A unique set of pre-requisites will be provided with each student transcript.

**Table 5-0 Changes to MET Program over last 4 years, Math, Hum/SS, Science, and Technology courses in the curriculum**

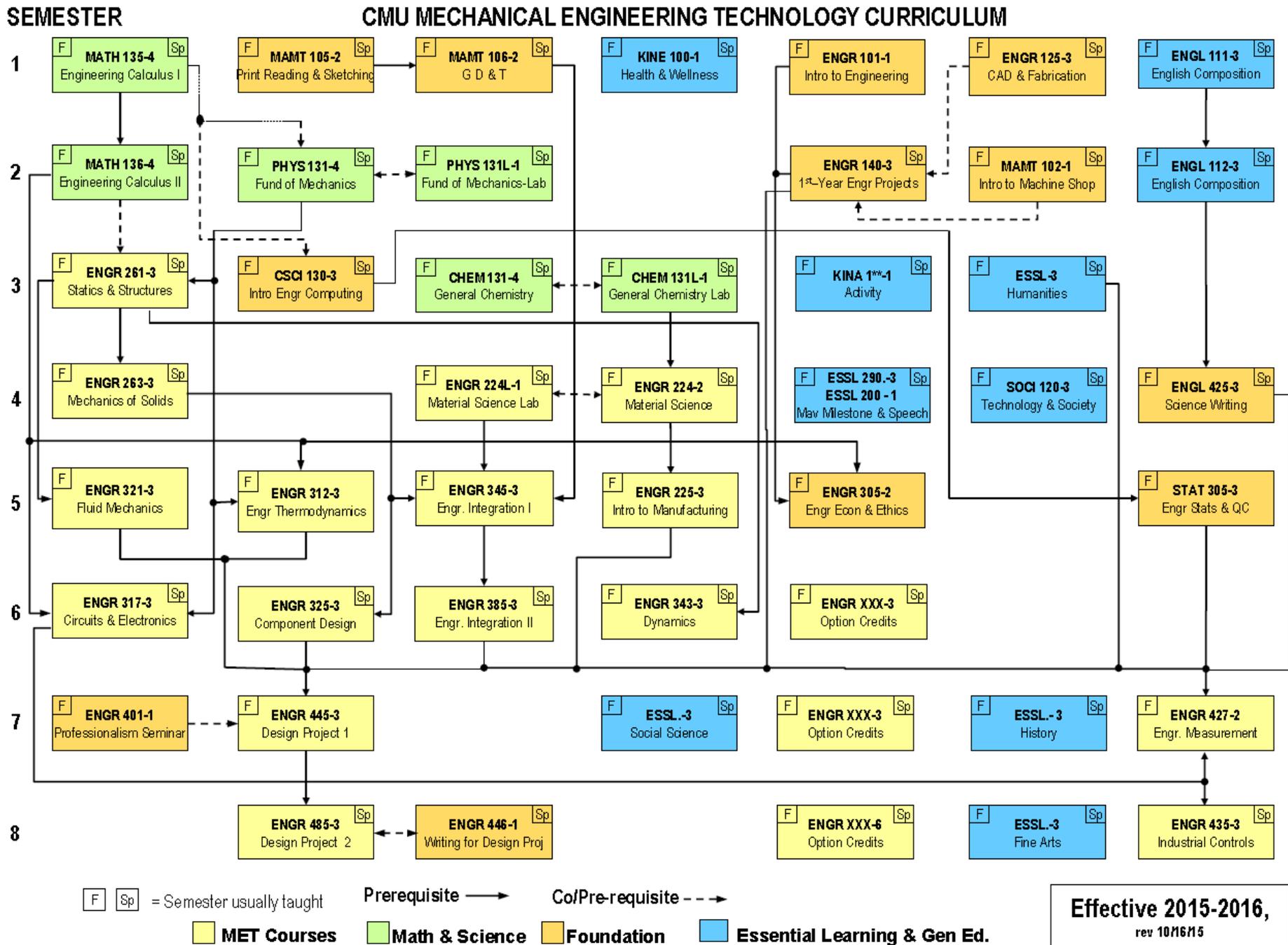
2014-15 & 2015-16			2012-13 & 2013-14			2011-12			2010-11			Continuous Improvement Rational
MET Program	Course Name	Cr	MET Program	Course Name	Cr	MET Program	Course Name	Cr	MET Program	Course Name	Cr	
<b>Mathematics</b>			<b>Mathematics</b>			<b>Mathematics</b>			<b>Mathematics</b>			
			MATH 119	Pre-Calculus	5	MATH 119	Pre-Calculus	5	MATH 119	Pre-Calculus	5	eliminate to increase tech cr
MATH 135	Engr Calc I	4	MATH 135	Engr Calc I	4	MATH 151	Calc I	5	MATH 151	Calc I	5	aligns better with UCB curriculum
MATH 136	Engr Calc II	4	MATH 136	Engr Calc II	4	MATH 152	Calc II	5	MATH 152	Calc II	5	aligns better with UCB curriculum
STAT 305	Engr. Statistics & Quality Contrl	3	STAT 200	Probability & Statistics	3	STAT 200	Probability & Statistics	3	STAT 200	Probability & Statistics	3	add more technical content to course
<b>General Ed. HUM &amp; SS</b>			<b>General Ed. HUM &amp; SS</b>			<b>General Ed. HUM &amp; SS</b>			<b>General Ed. HUM &amp; SS</b>			
SOCI 120	Tech & Society	3	SOCI 120	Tech & Society	3		Gen Soc Sci Elect	3		Gen Soc Sci Elect	3	add to address SO (j)
<b>Science</b>			<b>Science</b>			<b>Science</b>			<b>Science</b>			
CHEM 131	Gen Chemistry	4	CHEM 121 or 131	Gen Chemistry	4	CHEM 121 or 131	Gen Chemistry	4	CHEM 121 or 131	Gen Chemistry	4	eliminate option to take lower-level course to add rigor
CHEM 131L	Gen Chem Lab	1	CHEM 121L or 131L	Gen Chem Lab	1	CHEM 121L or 131L	Gen Chem Lab	1	CHEM 121L or 131L	Gen Chem Lab	1	eliminate option to take lower-level course to add rigor
PHYS 131	Fundamentals of Mech	4	PHYS 111 or 131	Fundamentals of Mech	4	PHYS 111 or 131	Fundamentals of Mech	4	PHYS 111 or 131	Fundamentals of Mech	4	eliminate option to take lower-level course to add rigor
PHYS 131L	Fund of Mech Lab	1	PHYS 111L or 131L	Fund of Mech Lab	1	PHYS 111L or 131L	Fund of Mech Lab	1	PHYS 111L or 131L	Fund of Mech Lab	1	eliminate option to take lower-level course to add rigor
<b>Technology</b>			<b>Technology</b>			<b>Technology</b>			<b>Technology</b>			
MAMT 102	Intro to Machine Shop Print Read & Sketch	1 2	MAMT 115	Intro to Machine Shop	3	MAMT 115	Intro to Machine Shop	3	MAMT 120	Machine Technology I	4	eliminate 2 credits, then add 2 cr to increase technical content
MAMT 106	GD&T	2*							MAMT 106	GD&T	1	ASME 2030 advice
			MAMT 151	Industrial Welding	3	WELD 151	Industrial Welding	3	WELD 151	Industrial Welding	2	ASME 2030 advice eliminate to increase tech cr
			MAMT 151	Numerical Controls I	3	MAMT 151	Numerical Controls I	3	MAMT 151	Numerical Controls I	3	eliminate to increase tech cr
			MAMT 155	Numerical Controls II	3	MAMT 155	Numerical Controls II	3	MAMT 155	Numerical Controls II	3	eliminate to increase tech cr
ENGR 305	Engr Econ & Ethics	2										FE results

**Table 5-1 Curriculum for the Colorado Mesa University Mechanical Engineering Technology Program**

Course (Department, Number, Title) List all courses in the program by term starting with the first term of first year and ending with the last term of the final year	Indicate if Course is Req, Elec or a Selected Elect by R, E or SE.	Curricular Area (Credit Hours)				Last 2 Terms Course was Offered: Yr & Sem	Average Section Enrollment for the Last Two Terms the Course was Offered
		Math & Basic Sciences	Engr Topics Significant Design (√)	ESSL & General Education	Other		
<b>Semester 1</b>							
ENGR 101 Intro to Engineering	R		1			F14, F15	76, 76
MATH 135 Engineering Calculus I	R	4				F15,Sp16	23, 31
ENGL 111 English Composition	R			3		F15,Sp16	26, 27
KINE 100 Health & Wellness	R			1		F15,Sp16	100, 100
ENGR 125 Comp. Aided Design & Fabr.	R		3√			F15,Sp16	24, 24
MAMT 105 Print Reading & Sketching	R	2				F15,Sp16	23, 22
MAMT 106 GD&T	R	2				F15,Sp16	23, 19
<b>Semester 2</b>							
MATH 136 Engineering Calculus II	R	4				F15,Sp16	25, 26
PHYS 131 Fundamental Mechanics	R	4				F15,Sp16	24, 39
PHYS 131L Fundamental Mechanics Lab	R	1				F15,Sp16	23, 24
ENGL 112 English Composition	R			3		F15,Sp16	26, 27
ENGR 140 First-Year Engineering Projects	R		3√			Sp15,Sp16	20, 21
MAMT 102 Intro to Machine Shop	R		1			F15, Sp16	12, 12
<b>Semester 3</b>							
CHEM 131 General Chemistry	R	4				F15,Sp16	65, 71
CHEM 131L General Chemistry Lab	R	1				F15,Sp16	24, 23
CSCI 130 Intro. to Engr Computing	R		3			F15,Sp16	23, 20
ENGR 261 Statics & Structures	R		3			F15,Sp16	20,27
KINA 1** Activity	R			1		F15,Sp16	variable
ESSL Humanities Elective	R			3		F15,Sp16	20, 20
<b>Semester 4</b>							
SOCI 120 Technology & Society	R			3		F15,Sp16	39, 40
ENGR 224 Materials Science	R		2			F15,Sp16	24, 34
ENGR 224L Materials Science	R		1			F15,Sp16	12, 12
ENGL 425 Scientific Writing	R			3		F15,Sp16	20, 20
ENGR 263 Mechanics of Solids	R		3			F15,Sp16	32, 20
ESSL 200 (1) & 290 (3) 1 <sup>st</sup> time taught F'15	E			4		F15,Sp16	variable

<b>Semester 5</b>						
ENGR 225 Intro to MFG Called ENGR 426 prior to F15	R		3			F14, F15 7, 15
ENGR 305 Engr Econ & Ethics 1 <sup>st</sup> time taught F'15	R		2			F15 10
ENGR 312 Thermodynamics	R		3			F15, Sp16 9, 7
ENGR 321 Fluid Mechanics	R		3			F14, F15 9, 12
ENGR 345 Integration Project I 1 <sup>st</sup> time taught F'15	R		3√			Sp16 8
STAT 305 Engr Stats & Quality Control	R	3				F14,F15 3, 5
<b>Semester 6</b>						
ENGR 317 Circuits & Electronics	R		3			Sp15, Sp16 12, 17
ENGR 325 Component Design	R		3√			Sp15, Sp16 10, 12
ENGR 343 Dynamics	R		3			F15, Sp16 , 18
ENGR 385 Engr Integration Project 2 1 <sup>st</sup> time taught Sp'16	R		3√			Sp16 8, 7
Technical Electives	SE		3			F15,Sp16 variable
<b>Semester 7</b>						
ENGR 401 Professionalism Seminar	R		1			F15, F16 10, 9
ENGR 427 Measurements Lab 1 <sup>st</sup> time taught F'15	R		2			F15 3
ENGR 445 Senior Project I	R		3√			F14, F15 6, 9
ESSL History Elective	E			3		F15, Sp16 variable
ESSL Social Science Elective	E			3		F15, Sp16 variable
Technical Electives	SE		3			F15, Sp16 variable
<b>Semester 8</b>						
ENGR 435 Industrial Controls	R		3√			Sp15, Sp16 13, 14
ENGR 446 Writing for Design Projects 1 <sup>st</sup> time taught Sp16	R		1			Sp16 9
ENGR 485 Senior Projects II	R		3√			Sp15, Sp16 5, 6, 9
Technical Electives	SE		6			F15, Sp16 variable
ESSL Fine Arts Elective	E			3		F15, Sp16 variable
<b>TOTALS</b> .....		25	71	30		
<b>OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM.....126</b>						
<b>PERCENT OF TOTAL</b> .....		20%	56%	24%		

Figure 5-2. Flowchart Illustrating Pre-requisites, effective Fall 2015



## 5. Hours and Depth of Study

Credit-hour requirements are satisfied by the specified required courses shown in Table 5-1. Technical electives are required in excess of the requirements. Humanities, history, fine arts, and social science electives are broad and consistent with all programs offered at CMU.

## 6. Major Design Experiences

Students are exposed to a minimum of five semesters of major design experiences in the Mechanical Engineering Technology curriculum. In this case “major” means semester long design projects. The major design experiences span the freshman through senior years:

- ENGR 140 1<sup>st</sup> Year Engineering Projects
- ENGR 345/385 Engineering Integration Projects I and II
- ENGR 445/446/485 Senior Projects 1, Writing for Senior projects, & Senior Projects 2 called the Capstone Design series of courses

These courses expose students to increasing levels of complexity of multiple competing design criteria involving budget, schedule, and project specifications. By slowly increasing the project complexity, students’ skill levels grow allowing them to tackle more difficult projects (i.e. need to satisfy more challenging technical, schedule, and budget constraints) , culminating in the two-semester Senior Design Projects (Capstone Design) course sequence.

Senior Projects are based on an industrially sponsored project model. In this model, local companies specify projects with a design, build and test component. The sponsoring company owns all intellectual property. All expenses are paid by the sponsoring company.

Projects typically cover the gamut of mechanical engineering disciplines (mechanical, thermal, measurement, etc.) and are of some reasonable, but not critical, importance to the sponsoring company. There is an expectation set for the teams that the sponsor will receive a working, tested, and well-documented prototype or product.

Student teams (typically 3-4 students/team) are formed by the instructor with the help of CATME (described in more detail below) to be balanced based on project interest, MET and ME students (that is, teams intentionally consist of both MET and ME students to represent the diversity of project teams in industry), skills in leadership, manufacturing/technical, and GPA. Teams write proposals to the sponsoring companies that lay out the expected timeline, budget and resources needed to accomplish the project. Teams meet regularly with their Faculty Advisor and an experienced engineer from the company during the two-semester course sequence to discuss progress, resolve issues and determine action items for the following meeting. The company engineer plays the role of “Industry Mentor” by setting project requirements, providing guidance, and feedback to the team. A Preliminary and Critical Design Review are scheduled and other faculty are invited to flush out important issues in the design process. At the end of the second semester a final presentation is given to show the characteristics of the final design as well as recommendations for future improvements. The one-credit ENGR 446 Writing for Senior Projects was implemented to specifically be taken alongside the second semester Senior Project course to help students in their writing.

The participation of the industry mentor is important from three perspectives. Since the project requirements come from a real-world need at the company, they can often be ambiguous and may change, especially early in the project. The students must learn how to adapt as well as solidify the requirements. Secondly, the industry mentors help teams learn professional standards of behavior (meeting agendas and minutes, appropriate dress for meeting/presenting, presenting to an audience they have not met before, etc.). They can also be instrumental in setting standards of performance (quality of work, setting and meeting schedules, etc.). Lastly, the industry mentor (as well as faculty advisor) helps the team develop and execute a strategy to successfully address the multiple competing, and often conflicting, project requirements.

Lectures and workshops are scheduled to provide relevant material at the optimum time for students with regard to their project requirements. For example, a project management workshop is held at the beginning of the semester while workshops on how to prepare reports and presentations effectively are held concurrently in the second semester of the senior project in the course ENGR 446 Writing for Senior Projects.

Given this course structure, many Student Outcomes are embedded throughout the Senior Design Project as indicated below. However, not all outcomes are assessed in this sequence of courses.

- SO (d) an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives;
- SO (e) an ability to function effectively as a member or leader on a technical team;
- SO (g) an ability to apply written, oral, and graphical communication in both technical and non- technical environments; and an ability to identify and use appropriate technical literature;
- SO (k) a commitment to quality, timeliness, and continuous improvement.

Once the teams begin working on a project they have multiple report and presentation milestones to meet throughout both semesters:

Fall Semester:

- Specification and Planning (turn qualitative requirements into quantitative specifications)
- Preliminary Design Review
- Critical Design Review
- End of Semester Project Summary

Spring semester:

- Spring Semester Planning Report
- Analysis, Tolerance, and Test Plan Report and Prototype Test Results
- Redesign, and Redesign Test Results
- Final Project Report Outline
- Senior Design Project Expo display & Poster Presentation- Judged by members of the Industry Advisory Council.
- Student Showcase Display & Poster Presentation at the Colorado Mesa University Main Campus
- Final Report, Hardware & Presentation to company

Surveys of students, faculty advisors, and industry mentors are conducted during the course to determine progress, identify problems, and make improvements for the coming year. In addition, peer assessments are conducted each semester using the Comprehensive Assessment for Team-Member Effectiveness (CATME) system from Purdue: <http://www.CATME.org>. The results are used in several ways. One is to help find and/or corroborate any problems within teams so the faculty advisor can intervene. The feedback is also used to help set grades at the end of the semester. Finally the results are shared with students by the faculty advisors as necessary to provide feedback on student performance.

The different needs of various projects require meeting a number of different standards and regulations. Therefore, the senior project course allows students to become familiar with a broad array of engineering standards. For example, in projects where human-machine interaction is required, students become familiar with the Occupational Safety & Health Administration (OSHA) regulations. In projects related to conducting and developing testing procedures, students refer to the American Society for Testing and Materials (ASTM) standards. For activities that require handling hazardous materials, students must be familiar with the corresponding Material Safety Data Sheet (MSDS) information. Finally, another standard with which students become familiar when performing selection and purchase of materials and products is the one established by the International Organization of Standardization (ISO).

In summary, ENGR 445/446/485 Senior Projects 1 & 2 provides a capstone design experience for the students in the program. By increasing project complexity during their education, student skills are developed to a point where they can be presented with a challenging, multiple-semester, industry-sponsored project and be successful.

#### 7. Cooperative Education

A cooperative experience has not currently been used to satisfy program curricular requirements. However, consideration may be given for a cooperative experience in the future.

#### 8. Materials to be Available during the Visit

The materials that will be available are individual course notebooks or dossiers, prepared for each required course. Each notebook contains the syllabus, faculty CV, assignments, exams, examples of student work, and textbook. Videos of student presentations will also be available.

### **B. Course Syllabi**

Appendix A includes syllabi for each course used to satisfy the mathematics, science, and discipline-specific requirements required by Criterion 5.

### **C. Advisory Committee**

The Industry Advisory Council (IAC) meets a minimum of twice per year, typically once in late October and once in early May. The IAC has been an active participant in the life of both the Mechanical Engineering and Mechanical Engineering Technology programs since their inception, supplying adjunct instructors when called upon, conducting mock interviews for students in their junior and senior years, hiring interns and graduates, and most of all advising the programs in matters important to their success. The makeup of the IAC includes companies all over the Grand Valley and consists of: Engr. Manager, Spendrup Fan Co.; Owner, Express Employment Professionals; P.E., JVA. Inc.; (IAC President) P.E. Assistant District Manager, Halliburton Corp.; Public Works Admin, Mesa County Government; President, B & B Electric, Inc; V.P., Engineering and Quality Control, Reynolds Polymer Technology; VP, Operations, Capco, Inc.; (IAC Vice Chair) Engineering Manager, Innovative Textiles, Inc; President, Schauenburg Flexadux Corp; Engr. Manager, C5 Medical Werks, LLC; Ph.D. Texas A&M, Retired Professor; Engineering Manager, SimGenics Simulation Systems; P.E., President, Lewis Engineering; P.E. President, Grand Valley Engineering Solutions; Laser and Manufacturing Manager, Coorstek; Business Development Specialist, Motus; Retired, Owner, Rolland Engineering; Business Counselor, Colorado SBDC Network; P.E., Western Slope Industries; President and CEO, Grand Junction Chamber of Commerce; General Manager, Grand Valley Power; VP - General Manager GPD Global

## **CRITERION 6. FACULTY**

### **A. Faculty Qualifications**

We have a highly qualified and diverse faculty, whose expertise spans both traditional and non-traditional areas of Mechanical Engineering. The former include fluid mechanics and thermal science, design and manufacturing, solid mechanics and materials science, while the latter are reflected by areas such as forensic analysis and biomedical engineering. Faculty qualifications are summarized in Table 6-1. The MET program offers the B.S. degree, and currently has on the UCB side 2 Instructors, 1 Senior Instructor and 1 Laboratory Technician. On the CMU side the program has 2 Tenure-Track (TT) Assistant Professors, one TT Associate Professor, and 1 Laboratory Technician. A search for one additional TT Professor is underway. All faculty are dedicated to the undergraduate program and are shared by both programs as needed. Faculty resumes are found in Appendix B.

### **B. Faculty Workload**

Faculty Workload Summary is presented in Table 6-2. Workload expectations for CMU and UCB engineering faculty are eight and six 3-credit classes per academic year, respectively.

### **C. Faculty Size**

The number and commitment of program faculty members is sufficient to provide for program continuity, adequate frequency of course offerings, appropriate levels of student-faculty interaction, and effective student advising and counseling. Typically lower-division courses are offered each semester while upper-division courses are offered once per academic year. At the current time, the faculty is large enough to teach all required courses. Adjuncts are used for a limited number of courses. Student advising is the job of all full-time faculty.

Interaction of faculty with employers occurs through the industry-sponsored senior project course, the biannual Industry Advisory Council meetings and the monthly meetings of the local Manufacturing group, the Colorado Advanced Manufacturing Alliance (CAMA). All engineering faculty participate in the IAC.

### **D. Professional Development**

Details of the professional development activities in which faculty members have participated are provided in Table 6-3.

### **E. Authority and Responsibility of Faculty**

Full leadership responsibility for the MET program lies with the program director. The director is responsible for all local curriculum and program decisions. If a decision or issue arises that affects the consistency or quality of the program, then the director communicates with the Physical and Environmental Sciences Department Chair, Vice President of Academic Affairs, or President of CMU to resolve the issue.

**Table 6-1. Faculty Qualifications**

Faculty Name	Highest Degree Earned- Field and Year	Rank	Type of Academic Appointment T, TT, NTT	FT or PT	Years of Experience			Professional Registration/ Certification	Level of Activity H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Affrunti, Andrew	M.S. EE, 1965	I	NTT	PT	40+	25+	3		L	M	M
Anderson, Max	B.S. ME, 2014	A	NTT	PT		2	2		L	L	L
Atkins, Rebecca	B.S. CE,	A	NTT	PT		1	1		L	L	M
Bevill, Scott	Ph.D. ME, 2009	ASC	TT	FT	0	7	6	EIT	M	M	L
Brower, Skylar	B.S. CE, M.S., 2014	A	NTT	PT	11	1	1	PE	L	L	H
Brower, Tim	Ph.D., CE, 1997	SI	NTT	FT	15	16	6	EIT	H	H	M
Burns, Shaun	B.S. ME, 2002	A	NTT	PT	12	1	1	EIT	H	H	H
Castro, Francisco	Ph. D. ME, 2009	I	NTT	FT	4	9	6		M	L	M
Goertz, Eric		A	NTT	PT		1	1		M	M	H
Hensley, Brett	B.S. MSE, 1993	A	NTT	PT	21	1	1		L	M	H
Kessler, Scott	Ph.D. ME, 2005	AST	TT	FT	20+	6	4	PE, ASNT Level III	H	H	H

Kliska, Jody	B.S.C.E., 1986	A	NTT	PT	30+	2+	1	PE	L	L	H
Johnson, Anna	M.S. 1993	A	NTT	PT	6	1	1		L	L	M
Lanci, Sarah	M.S. Metallurgical Engr, 2007	AST	TT	FT	7	2	1		L	L	H
McNeill, Nathan	Ph.D. Engineering Education, 2010	I	NTT	FT	6	4	3	PE	H	L	L

NTT – Non Tenure Track, TT – Tenure Track, T – Tenured, I = Instructor, SI – Senior Instructor, A-Adjunct, AST – Assistant Professor, ASC – Associate Professor.

**Table 6-2. Faculty Workload Summary**

Faculty Member (name)	PT or FT	Classes Taught**** (Course No./Credit Hrs.) Term and Year	Program Activity Distribution			% of Time Devoted to the MET/ME Programs
			Teaching MET/ME	Research or Scholarship	Other MET/ME	
Affrunti, Andrew	PT*	MCEN 3017/3/F/15 ENGR 317/Sp/16, ENGR 465/Sp/16	50/30	0	10/10	40/60
Bevill, Scott	FT	ENGR 261/3/F/15, ENGR 125/3/F/14, ENGR 343/3/F/15, ENGR 345/3/F/15, ENGR 385/3/F/16 ENGR 343/3/Sp/16, ENGR 263/3/Sp/16,	80/10	10	0	50/50
Brower, Tim	FT	ENGR 401/1/F/15, MCEN 3021/3/F/16, MCEN 2000/1/F/15 MCEN 4047/2/Sp/16, MCEN 4228/3/Sp/15, ENGR 321/3/F/15,	10/40	10	20/20**	40/60
Castro, Francisco	FT	MCEN 3030/3/F/15, MCEN 4043/3/F/15, MCEN 4045/3/F/15 MCEN 4037/2/Sp/16, MCEN 4085/3/Sp/16	10/80	10	0	10/90
Kessler, Scott	FT	ENGR 101/1/F/16, ENGR 224/3/F/15, ENGR 263/3/F/15 ENGR 224/3/Sp/16, ENGR 325/3/Sp/16	80/10	10	0	90/10
Kliska, Jody	PT	ENGR 125/3/F/15 ENGR 140/3/Sp/16	100	0	0	100
Lanci, Sarah	FT	ENGR 225/3/F/15, ENGR 426/3/F/14 ENGR 140/3/Sp/16, ENGR 224L/1/Sp/15, ENGR 425/3/Sp16	80/10	0	0	80/20
McNeill, Nathan	FT	MCEN 3012/3/F/14, MCEN 4037/2/F/14, MCEN 4026/3/F/14 MCEN 3025/3/F/15, MCEN 3032/3/Sp/15, ENGR 435/3/Sp/15	20/70	10	0	20/80

\*PT CU Lab Tech/Instructor & PT CMU Instructor; \*\*Admin duties; \*\*\*Adjunct Professor; \*\*\*\*MCEN prefix courses are ME, ENGR prefix are CMU including MET

**Table 6-3. Full-Time Faculty Professional Development Activities**

Faculty Member	Professional Development Activity
Affrunti, Andrew	Siemens Programmable Logic Controllers Training (40 hours). National Instruments LabVIEW Training (40 hours).
Bevill, Scott	<p>ASEE Annual Conf., June 2015.</p> <p>American Society of Biomechanics Rocky Mountain Division, Estes Park, CO, April 11-12, 2014.</p> <p>“Keeping the Garage Door Open: Understanding and Applying Concepts of Neuroscience to Teaching and Learning in the Higher Education Classroom” workshop, presented by Ms. Leslie Myers, Aug 13, 2014.</p> <p>Attended online course through ASME "EL505 Basic Geometric Dimensioning and Tolerancing Online Course Y14.5," earning 2.3 continuing education units, Spring 2013.</p> <p>“Lumina Degree Profile” Workshop, presented by Dr. Paul Gaston, Jan 5-6, 2012.</p> <p>“What the Best College Teachers Do” workshop, presented by Dr. Ken Bain, Aug 9-10, 2012.</p> <p>“Revitalizing General Education and Program Assessment” workshop, presented by Dr. Jessica Herrick, Jan 13-14, 2011.</p> <p>"Deep Learning" discussion panel, presented by Colorado Mesa University's Teacher2Teacher, Dec 6, 2012.</p> <p>“What do you do...?” discussion panel, presented by Colorado Mesa University's Teacher2Teacher, Nov 20, 2013.</p> <p>“Innovations in Orthopaedic and Engineered Material Interfaces: Collaborative Research and Curriculum Development,” CU-Boulder seed grant of \$5,000</p> <p>MATLAB webinar "Making Project-based Learning Easy and Affordable with MATLAB" January 20, 2012</p> <p>Dr. Jessica Herrick's Workshop on "Revitalizing General Education and Program Assessment" January 13-14, 2011</p> <p>ASME Summer Bioengineering Conference, multiple workshops including "Development Strategies for Postdocs and Early Investigators" June 22-25, 2011</p>
Brower, Tim	<p>ABET Commissioner Training, ETAC, 2014, 2015</p> <p>ABET Program Evaluator visits (10 over the past 10 years)</p> <p>Brower, T., “Unique Collaboration between Engineering and Engineering Technology Programs,” AC 2014-9065, <i>Proceedings</i>, American Society of Engineering Education Annual Conference &amp; Exposition, Indianapolis, Indiana, June 2014.</p> <p>Brower, T., “Innovative Partnership Collaborations in Engineering Education,” ETD 425, <i>Proceedings</i>, 2007 ASEE Conference for Industry and Education Collaboration, Savannah, GA, February 2014.</p> <p>Brower, T., “Using a Systems Engineering Approach for Students to Design &amp; Build Laboratory Equipment,” AC 2012-3136, <i>Proceedings</i>, American Society of Engineering Education Annual Conference &amp; Exposition, San Antonio, Texas, June 2012.</p> <p>Brower, T., “Going With the Flow in a Service Learning Project,” AC 2011-751, <i>Proceedings</i>, American Society of Engineering Education Annual Conference &amp; Exposition, Vancouver, B.C., June 2011.</p> <p>Director, Project Lead The Way for Oregon, 2004-2008</p> <p>Sabbatical; taught 2 engineering courses at Shanghai University, 2007</p> <p>ASEE Engineering Technology Division (ETD) Program Chair Duties, 2008</p> <p>ASEE ETD Vice Chair, 2007</p> <p>ASEE CIEC Program Chair, 2006</p> <p>ASEE Engineering Technology Council (ETC), Director (2008-10)</p> <p>MET Dept Heads (METDHC): chair (2007-08), vice chair (2006-07), secretary (2005-06)</p> <p>2007, PLTW "Engineering Design and Development" Training</p> <p>12 ASEE Annual Conf. and ASEE CIEC Papers &amp; Presentations: 2006-2015</p> <p>2 AIAA Papers &amp; Presentations 2006 (J. Spacecraft &amp; Rockets), 2004</p> <p>Principal Investigator –</p> <p>“Teaching Modules for Fluid Mechanics,” CU-Boulder seed grant of \$7,000</p> <p>"Research Experiences for Undergraduates" NSF program announcement 07-569 (\$12,800 for 1-year)</p> <p>Oregon Department of Education Grant, 2007 – \$250,000</p> <p>ETIC, 2006 - \$100,000, 2007 - \$273,000</p>

Castro, Francisco	<p>2013-Present: MATLAB Webinars (<a href="http://www.mathworks.com/products/matlab/webinars.html">http://www.mathworks.com/products/matlab/webinars.html</a>)</p> <ul style="list-style-type: none"> <li>o Modeling Physical Systems in Teaching - Technology and Didactics</li> <li>o Developing Robotics Applications with MATLAB, Simulink, and Robotics System Toolbox</li> <li>o <u>Modeling Physical Systems in Teaching - Technology and Didactics</u></li> <li>o <u>Teaching Mechatronics with MATLAB, Simulink, and Low Cost Hardware</u></li> </ul> <p>“Design and Fabrication of a Small-Scale Oilseed Processing System to Support Local Biofuel Markets”, 2014 Unconventional Energy Center at Colorado Mesa University grant of \$24,000. Project is performed in collaboration with CSU and CMU personnel. 2013 American Society of Engineering Education Annual Conference Attendee, June 2013 2012 American Society of Engineering Education Annual Conference, June 2012 “Advanced Sensing of Air Pollution to Reduce Impacts of Oil and Gas Development,” CU-Boulder seed grant of \$8,000 MATLAB Online Seminars, “Making Project-based Learning Easy and Affordable with MATLAB,” January 20, 2012 National Instrument WebCasts, Do Education: Teach Electronics and More with NI ELVIS and Circuit Design Suite, Oct 28, 2011 4 published articles in <i>Mechanics of Materials</i>, <i>Journal of Engineering Materials and Technology</i>, <i>Mechanics of Time-Dependent Materials</i>, &amp; <i>Polymer Testing</i></p>
Kessler, Scott	<p>Maintained PE license Continued service to industry clients Dr. Paul Gaston’s workshop regarding general education and the “The Degree Qualifications Profile,” January 2011 Dr. Paul Gaston’s 2nd workshop regarding general education, January 2012 several sessions of CMU Teacher to Teacher sessions CMU, D2L training sessions “Assessing Outcomes and Improving Achievement: Tips and tools for Using Rubrics,” Terrey L. Rhodes “May the Course be with You” MS&amp;T Conference, San Diego, CA 2014 Ogden, Skyler and Kessler, B. Scott, “Anisotropic Finite Element Modeling of the Fused Deposition Modeling Process,” Proceedings of 2014 Annual Materials Science &amp; Technology Conference, San Diego, California Kessler, B. Scott, El-Gizawy, Sherif, and Smith, Douglas E., “Incorporating Neural Network Material Models within Finite Element Analysis for Rheological Behavior Prediction,” <i>Journal of Pressure Vessel Technology</i>, Vol. 192, pp. 58-65</p>
Lanci, Sarah	<p>2013 PCC Airfoils Technical Conference – presenter (proprietary topic), June 2013 2012 PCC Airfoils Technical Conference – presenter (proprietary topic), June 2012 2012 PCC Structurals Technical Conference – poster (proprietary topic), Nov 2012 Recently hired at CMU in Aug 2014</p>
McNeill, Nathan	<p>Siemens automation for educators training, 2012 Presenter at American Society for Engineering Education (ASEE) annual conference, 2012 Session moderator at American Society for Engineering Education (ASEE) annual conference, 2013</p>

## CRITERION 7. FACILITIES

### A. Offices, Classrooms and Laboratories

It is expected that a new engineering facility will be built on the main campus of CMU located on the corner of 7<sup>th</sup> and Elm Streets in Grand Junction by January 2018. This building will house the Mechanical Engineering Technology, Mechanical Engineering and the new Civil Engineering programs.

Currently, all engineering programs are housed on the vacated premises of the Leitner-Poma of America manufacturing facility at 2510 Foresight Circle, Grand Junction, Colorado. This facility is shared with the CMU Construction Management Program, and the Western Colorado Community College Manufacturing Technology Program along with the Mechanical Engineering Partnership Program. The facility has since been renamed the Archuleta Engineering Center (AEC).

Table 7-1. Engineering Facility Space and Use

<b>Space Designation</b>	<b>Dedicated Area, ft<sup>2</sup></b>
Student Study/Lounge Area	1,389
6 Faculty Offices	800
1 Meeting Room	401
3 Classrooms	1,834
Computer Laboratories	973
Laboratories	5,026
Machine Shop	3,228
Storage	2,653
<b>Total Area</b>	<b>16,300</b>

Phase I of the renovation project was finished Fall 2009 and includes 3 classrooms totaling 1834 ft<sup>2</sup>, one shared 973 ft<sup>2</sup> computer lab, 12 faculty/lab tech offices totaling 1855 ft<sup>2</sup> (7 of which are dedicated to the engineering programs), one 414 ft<sup>2</sup> laboratory and three shared student study areas totaling 925 ft<sup>2</sup>. The reception, administration and copy area adds 329 ft<sup>2</sup>. A shared meeting room is 401 ft<sup>2</sup> and a safety/breakout/lunch room is 464 ft<sup>2</sup>. The total finished square footage of Phase I dedicated to the engineering programs is approximately 3,480 ft<sup>2</sup>.

Phase II of the project was completed August 2010 and includes a 1,068 ft<sup>2</sup> laboratory plaza (with 185 ft<sup>2</sup> of storage space) and an 858 ft<sup>2</sup> high-bay ME Laboratory, a machine shop area of 3,228 ft<sup>2</sup>, machine shop computer lab of 835 ft<sup>2</sup>, shared Kiosk/Demonstration area of 1517 ft<sup>2</sup>, and a High Bay construction area of 2302 ft<sup>2</sup>. Misc. space includes 3744 ft<sup>2</sup> (stairways, utility and additional storage spaces). The grand total of finished usable space for the shared facility is 20,932 ft<sup>2</sup>. Part of the Phase II renovations included the installation of an IP Video Conferencing System. It uses a H.323 Standard interface with an integrated Smart Class room set-up.

Construction for Phase III of the Archuleta Engineering Center (AEC) was completed in November 2011. Phase III is defined as approximately a 5568 ft<sup>2</sup> metal building erected

southeast and adjacent to the existing AEC building. This phase includes three dedicated classrooms of approximately 1550 ft<sup>2</sup> each, one for the First Year Projects (named the Dieter-Sanders Lab), ME Design Projects I and II, and the Material Science Lab. A storage area of 2468 ft<sup>2</sup> is also available.

Typically, the majority of the first two years of the engineering courses are taught on the main campus with the exception of ENGR 140 First Year Projects, ENGR 224, 224L Materials and Materials Lab, and MAMT 102 Machining Fundamentals. These courses have a significant laboratory component and the AEC labs are necessary for their successful completion.

## **B. Computing Resources**

The computer labs available to the engineering students are on the main campus in Houston Hall Rooms 232 (26 terminals) and 233 (8 terminals), at the Archuleta Engineering Center in AEC 123 (23 terminals), AEC 227 (8 terminals), AEC Bldg B (6 terminals), and 8 terminals in the student lounge areas located throughout AEC. All engineering dedicated computers have SolidWorks, LabVIEW and MATLAB installed along with the MS suite of programs. All Houston Hall computers are accessible to students via a “swipe card” access determined at the beginning of each semester. Select computers in the CMU Library have these programs available also. All spaces on campus have wireless internet capability and many students use a personal laptop. The computing resources in these facilities are adequate to support the scholarly and professional activities of the students and faculty in the program.

## **C. Guidance**

Freshmen in the engineering program are introduced to safety considerations and proper use of machine shop tools in MAMT 102 Machining Fundamentals. This course deals with speeds and feeds of machines, materials, tooling, tapping, boring, and manufacturing processes. Emphasis is placed on use of mills and lathes. Earlier than 2010 when MAMT102 was not required, freshmen were required to take a one-day intensive machining course when enrolled in ENGR 140 First-Year Engineering Projects that covered similar material. Students are further exposed to safety considerations and proper use of hand- and power-tools in ENGR 140. Lectures cover general shop safety precautions as well as basics of hand- and power-tool use.

Additional laboratory safety instruction is given to students in the MCEN 3017 electronics lab. Guidance is focused on personal safety, appropriate selection and use of instruments, accuracy and precision of measurements and clearly written technical reports. Students are placed in teams and advised (provided guidance) in areas of collaboration, task division and responsibilities, cooperation and behavior. Guided discovery is the primary teaching method utilized in the lab. Instructors suggest methodology and allow students to arrive at conclusions themselves. Guidance is aimed at individual growth resulting in productive, ethical, multi-disciplinary, communicative, and safe engineers.

In upper-division courses that have a laboratory component, faculty advise students to:

- familiarize themselves with the location of the fire extinguishers, first aid kits, safety shower, and eye wash or sink area in the laboratory,

- wear approved goggles or safety glasses with side shields at all times while students are working with particles that can get into a person's eye,
- in case of a chemical splash, students are advised to flush the area with water for at least 15 minutes, a laboratory coat must be worn if working with chemicals,
- appropriate clothing must be worn which includes closed-toe shoes,
- laboratory activities are permitted during class periods only when an instructor is present,
- after hour activities are allowed only with permission of instructor,
- smoking, eating, or drinking are not allowed in the laboratory,
- once the laboratory activity has finished students must clean the work area and dispose of all materials according to the faculty's instructions,
- all accidents must be reported to the instructor.

#### **D. Maintenance and Upgrading of Facilities**

The procedures for maintaining and upgrading the tools, equipment, and laboratories used by students and faculty in the program fall on the faculty of each laboratory class along with the CMU and UCB dedicated Laboratory Technicians. As faculty identify needs, priorities for the current budget year are assessed; either the equipment is purchased or additional budget is requested in the UCB and CMU shared budget process.

#### **E. Library Services**

Library services available to engineering students are:

Books etc. -A search of the broad subject "Engineering" in the library's public catalog retrieves nearly 1,400 books and other monographic items, 64 percent of which have been published within the last 10 years. Within those materials are 646 e-books and 127 visual items, nearly all of which have been published within the last 10 years. There are nearly 600 print books with the subject of engineering, over 20 percent of which were published within the last 10 years. Under the subject "Mechanical Engineering" the CMU Tomlinson Library holds 176 titles, nearly 90 percent of which have been published in the last 10 years. E-materials (e-books and e-videos) are available from anywhere 24 hours a day. The LC classification number "TJ" which covers mechanical engineering, contains about 1,000 e-books (mostly 2005 or newer), and about 400 print titles (15 percent dated 2005 or newer). When the online catalog is searched, one may limit by "e-book" to retrieve just those resources.

Journals -The library provides access to over 100 databases, many of which provide online full-text access. Databases of particular interest to engineering include PROLA (Physical Review Online Archive), Science Direct, Academic Search Premier, and Wilson OmniFile Select. The Wilson database includes full text from the Applied Science and Technology database. Databases are available any time and may be accessed from the library's home page. The Tomlinson Library currently provides the "EBSCO Discovery Service" discovery tool, which allows nearly all databases to be searched at once.

Facilities and Reference -During regular terms, the library is open every day for a total of 93.5 hours per week. A study room within the library is also available 24/7. The Reference Desk is staffed 76 hours per week, which also includes telephone, email, and chat assistance

to remote users. After hours the chat help reverts to AskAcademic, which answers questions when our Reference Desk is not available. There are also research guides available online specifically for CMU engineering students.

Interlibrary Loan - Tomlinson Library is part of Prospector, a cooperative catalog containing over 32,000,000 books, journal titles, DVDs, CDs, videos and other materials. Items found in this catalog may be requested by the patron and are available to be checked out at CMU in just a few days. Additionally, the library provides similar access to Mobius, which provides access to more than 27,000,000 items. The student may specify the item be delivered to either the main (Tomlinson) library or AEC. Articles not available online or in the library print collection may be obtained free of charge through interlibrary loan. The average fill time for article requests is approximately 11 hours. Additionally, CMU engineering students may request materials directly from the Engineering Library at CU Boulder. A special online form has been created for this purpose.

New Materials Requests -Collection development is a cooperative process between faculty and the library liaison. Faculty are encouraged to request items. The library sends selection slips either in paper or electronically on new books to the faculty monthly. They may also request other items via email, telephone, or campus mail. The yearly budget for engineering related Library materials has consistently been about \$3,000 since the inception of the program. New journal titles are considered on an individual basis dependent on content and available funds.

#### **F. Overall Comments on Facilities**

Student safety is of utmost concern to the University, staff and faculty. Students are required to wear safety glasses in the appropriate laboratories. Faculty and staff verify that all experimental equipment is in proper working order prior to students proceeding with assignments. A dedicated Safety Officer on the AEC site serves the Program 1/3-time. This officer shares the title of CMU laboratory technician.

Students are granted access to equipment only after completing appropriate safety training. In addition, staff supervision is required for specific equipment, such as machining tools. Supervision responsibilities are shared with the dedicated machine shop personnel and the laboratory technician. Safety in all laboratories is overseen by both the CMU and UCB Lab Technician/Coordinator. In addition, staff supervision is required for specific equipment, such as machining tools.

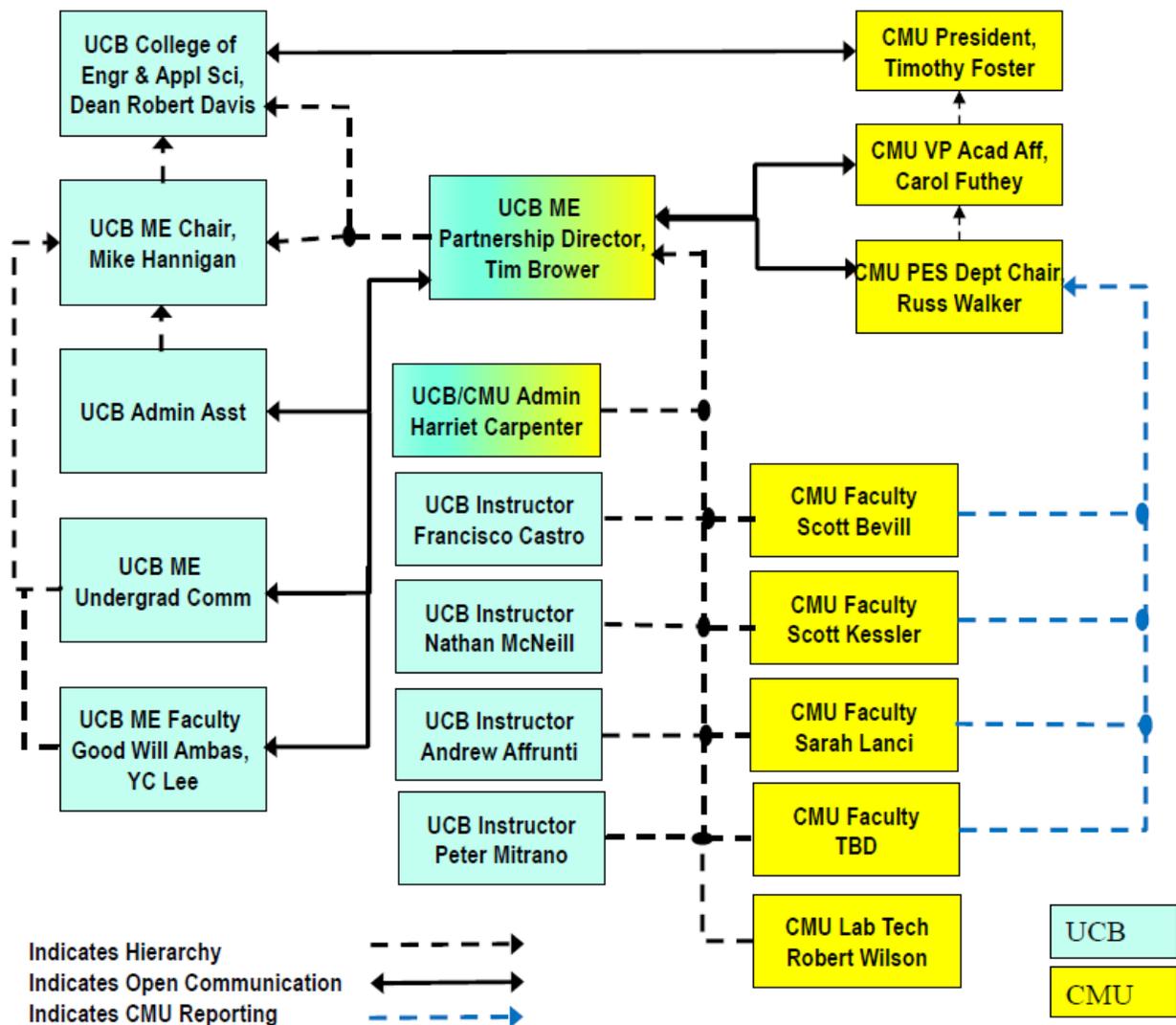
In general, Facilities Services at Colorado Mesa University strives “To provide a physical environment that is clean, comfortable, functional, safe, aesthetically pleasing and stimulating, in an effort to support Colorado Mesa University in its mission of teaching, learning and community service.” Facilities Services support of the University’s larger mission is accomplished by providing solid waste removal and recycling programs, landscape and grounds maintenance services, pest management, custodial services and through the implementation of various life health and safety standards and procedures in campus buildings.

## CRITERION 8. INSTITUTIONAL SUPPORT

### A. Leadership

The Program's leadership consists of a Partnership Director located at the Archuleta Engineering Center and Physical and Environmental Sciences Department Chair located on the main campus. The MET Assessment Committee resides on the CMU campus and consists of all Partnership UCB and CMU engineering faculty. A graphical image of the leadership of the engineering programs is given in Fig. 8.1.

Fig. 8.1 Engineering Program Leadership



## B. Program Budget and Financial Support

The working budgets for the MET and ME engineering programs are tightly entwined. Here, the UCB budget is noted due to the fact that any piece of equipment that is bought by UCB becomes CMU equipment. The amounts spent by UCB over the past 5 years are listed in Table 8.1 where the rows are defined as: CU-CMU Partnership; CU-CMU MechE Operations; CU-CMU MechE Equipment.

**Table 8.1. CU-Boulder Individual Contribution to Partnership Program, 6/30/2015.**

	$\Sigma$ Spent FY2011	$\Sigma$ Spent FY2012	$\Sigma$ Spent FY2013	$\Sigma$ Spent FY2014	$\Sigma$ Spent FY2015
<b>CU-CMU Partnership</b>	\$271,017	\$343,179	\$329,835	\$304,294	\$302,870
<b>CU-CMU MechE Operations</b>	\$11,388	\$20,645	\$21,426	\$14,441	\$17,591
<b>CU-CMU MechE Equipment</b>	\$95,265	\$74,997	\$6,929	\$12,592	\$0
<b>Totals</b>	<b>\$377,670</b>	<b>\$438,821</b>	<b>\$358,190</b>	<b>\$331,327</b>	<b>\$320,461</b>

CMU's individual contribution is made up of: (1) the day-to-day operation of all CMU engineering related programs including faculty salaries, part-time adjunct faculty salaries, benefits, student assistants, travel, software, office, course supplies and equipment; and (2) the Engineering Program facility investments since the inception of the program. Details of the CMU individual contributions are given in Table 8.2.

**Table 8.2. CMU Engineering Program Budget/Investments as of 9/15/15.**

<b>Investments</b>	<b><u>Learning Materials</u></b>	<b><u>Faculty &amp; Staff</u></b>	<b><u>Other Instruction</u></b>	<b><u>Capital &amp; non-Capital Equipment</u></b>	<b><u>Software &amp; Computer Equip</u></b>	<b><u>Course Supplies</u></b>	<b><u>Facilities</u></b>	<b><u>Total</u></b>
<b>FY15</b>	\$6,992	\$368,386	\$3,107	\$24,707	\$10,938	\$13,430	\$0	\$427,560
<b>FY14</b>	\$4,445	\$341,160	\$4,694	\$8,817	\$15,241	\$13,328	\$0	\$387,685
<b>FY13</b>	\$3,000	\$284,877	\$28,992	\$28,815	\$1,265	\$369	\$0	\$347,318
<b>FY12</b>	\$3,000	\$183,485	\$19,814	\$74,996	\$2,018	\$8,658	\$353,659	\$645,630
<b>FY11</b>	\$3,035	\$165,678	\$11,648	\$115,563	\$43,779	\$5,593	\$559,530	\$904,826
<b>FY10</b>	\$3,000	\$53,751	\$59,123	\$3,727	\$2,767	\$0	\$865,286	\$987,654

### **C. Staffing**

The Mechanical Engineering Technology program relies heavily on the staffing of the UCB ME Partnership program. The Director has the leeway to mix and match UCB and CMU engineering faculty in courses at his discretion. Staffing can be best explained by which institution pays the individual faculty. The salary of some employees is shared by both institutions, however, the check and benefits come from the institution noted below.

First, UCB pays 100% of the following salaries:

*Full-time Instructors*, Francisco Castro, Nathan McNeill, and Peter Mitrano (new hire, begins fall 2016): responsible for teaching primarily upper-level ME courses.

*Part-time Instructor/Lab Tech*, Andrew Affrunti: responsible for teaching primarily upper-level ME courses, responsible for operating and maintaining the Program's electronics and measurements laboratories including infrastructure and equipment. Affrunti acts as a part-time instructor for CMU at times and at those times gets paid as a CMU adjunct.

Second, CMU pays 100% of the following salaries:

*Assistant Professors*, Scott Kessler and Sarah Lanci, responsible for teaching primarily lower-level ME & MET courses and upper-level MET courses.

*Associate Professor*, Scott Bevill, responsible for teaching primarily lower-level ME & MET courses and upper-level MET courses.

*Part-time Laboratory Technician*, Robert Wilson spends 33% of his time with engineering related duties: responsible for operating and maintaining the program's lower-level teaching laboratories including infrastructure and equipment.

The third category is staff that get a portion of their salaries from both UCB and CMU:

*Partnership Director*, Tim Brower, 75% UCB/25% CMU: responsible for ½-time administration and ½-time teaching primarily upper-level ME courses. Responsible for the upper-level of the ME Program. Contracted for oversight of the lower CMU portion of the ME Program. He has taken on the responsibilities of defining the direction of the MET program outside of his contracted duties.

Administrative Assistant, Harriet Carpenter, a half-time employee of CMU. Her salary comes from 25% UCB/25% CMU, responsible for the upper and lower-level ME portion of the partnership.

### **D. Faculty Hiring and Retention**

The engineering program director and PES Department Chair provide advice and direction to the CMU administration for strategies used to hire and retain faculty.

### **E. Support of Faculty Professional Development**

CMU engineering faculty are given \$600 per year for professional development. CMU provides various opportunities on-site for professional development throughout the year.

The relationship that the MET program has with UCB provides opportunities to collaborate at times. In a recent collaboration the UCB College of Engineering & Applied Science Dean provided \$20,000 Seed Funds for proposals to enhance the CU-CMU ME Partnership Program. The funds were dispersed to the following individuals this past academic year:

- Innovations in Orthopaedic and Engineered Material Interfaces: Collaborative Research and Curriculum Development - Ferguson/Bevill: the proposed work will establish collaborative research in osteoarthritis, providing biomedical research experiences for students in Boulder and Grand Junction. Independent study students will work collaboratively across the divide to complete design, manufacturing and testing requirements for the proposed project.
- Advanced Sensing of Air Pollution to Reduce Impacts of Oil and Gas Development - Milford/Hannigan/Castro: the proposed work deals directly with interests in the Western Slope – the oil and gas industry. The proposal encourages faculty interaction between the Boulder and Grand Junction campuses through research collaboration and curriculum development. The PI's will use the seed grant funds to sponsor a Senior Design project at the Grand Junction campus. The Senior Design project will require students to refine, test and deploy a hand-held (smart phone) air quality monitor to be utilized in the oil and gas fields outside of Grand Junction. Preliminary data will be used to engage local oil and gas industry in novel data collection, air quality research and proposal collaboration. The PI's have also committed to curricular development for MCEN 4228: Sustainable Energy and MCEN 4131: Air Pollution Control, which the research team hopes to offer in a long distance format to the CU-CMU Partnership students.
- Teaching Modules for Fluid Mechanics - Brower/Hertzberg: the proposed work will bring innovative real-world fluid mechanics curriculum to the Boulder and Grand Junction campuses. The curricular model requires significant interaction between the PI's and demonstrates potential for funding through the NSF TUES program. The seed grant fund will be used to develop curriculum that integrates computation and experimental approaches to fluid mechanics. Student will have the opportunity to utilize contemporary experimental and computational tools that are essential in fluid mechanics. Particle Image Velocimetry (PIV), Computer Aided Design (CAD) and Computational Fluid Dynamics (CFD) software will be used to create iterative design problems for students, which will teach verification and validation techniques as well as fundamental fluid mechanics concepts.

**PROGRAM CRITERIA**

As described in Criterion 3, the MET Program Criteria in addition to the ABET Student Outcomes (a)-(k) are addressed herein. Attainment of the MET Program Criteria, PC-(a) through PC-(h) requirements has been addressed in this report under Criterion 4. A refinement of Program Criteria is given in Appendix F.

## Appendix A1 – Course Syllabi – Engineering Courses

### 1. ENGR 101 Introduction to Engineering

2. 1 credit hour, class meets once a week for 50 minutes
3. Instructor: Scott Kessler
4. There is no required “textbook” for this course, but an engineering related book, Henry Petroski’s “To Engineer is Human: The Role of Failure in Successful Design” is required as a way to encourage discussion about what it is to be an engineer, an engineer’s responsibilities, and design. The Arduino Uno Ultimate Starter Kit is also required. The kit provides several tutorial assignments that are to be completed during the course.
5. Course Information:
  - a. Catalog Description: Facets of engineering. Includes history of the profession, mechanical engineering and mechanical technology curriculum, industries in which engineers practice, and expectations and tools for academic success. Introduces engineering tools used in later courses. Hands-on experiences, visiting industry, oral presentations, meeting faculty and practicing professions.
  - b. Prerequisites: None.
  - c. This is a required course.
6. Course Goals:
  - a. **Learning Objectives**

#### Careers in mechanical engineering

- Describe career options that utilize mechanical engineering training, including careers in law, medicine and business, as well as engineering
- Explain engineering employment opportunities in the electronics, environmental, power, automotive, aerospace and biomedical sectors
- Describe trends in mechanical engineering careers, including employment patterns, opportunities for international work, and entrepreneurship
- Describe the need for continuing professional and personal development throughout their prospective career(s)
- Apply structured innovation techniques to engineering problems
- Describe entrepreneurial principles as they relate to engineering

#### Mechanical engineers and society

- Review the basic mechanical engineering challenges for the 21st Century.
- Identify the societal conflicts over mechanical engineering-related technologies, such as the environmental impacts of fossil fuel combustion
- Explain ethical conflicts that can arise in the mechanical engineering profession

#### The CMU/CU mechanical engineering program

- Identify the staff and faculty in the mechanical engineering department, and recognize other students in the program
- Explain the rationale behind the required elements of our curriculum, and

how they relate to the expectations of prospective employers and accreditation requirements

- Differentiate between our mechanical engineering and applied mechanical engineering programs
- Understand their role, the role of the departmental undergraduate advisor, and the role of departmental faculty in registration, course selection and degree program planning, and career guidance
- Understand the role of various approaches for assessing our program and their mastery of mechanical engineering, including course grades, FCQs, ABET assessment, the FE exam and professional licensing

The engineering design and reporting process

- Employ structured innovation methods
- Describe basic business structures
- Demonstrate the ability to properly structure short technical reports

Academic expectations and effective study methods

- Understand ethical standards and CMU policies on academic honesty
- Describe simple techniques for managing their time
- Describe effective techniques for taking notes on lectures and reading material, and for organizing writing
- Demonstrate effective use of technical literature
- Describe where to get academic and emotional support at CMU

**b. ABET Student Outcomes & Program Criteria Supported:**

SO(h) an understanding of the need for and an ability to engage in self-directed continuing professional development;

SO(i) an understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity;

7. Topics Covered:

- What is an engineer? & Syllabus Info
- Mechanical Engineering/Applied Mechanical Engineering Curriculum
- ME Profession
- Core disciplines in ME: technical issues and case studies
- Technical Report Guidelines; engineering problem solution and presentation
- Library Resources,
- Structured Innovation
- Engineering Solutions, Ethics
- Ethics and societal impacts of engineering;
- Career Opportunities Industry Reps

## 1. ENGR 125 Computer-Aided Design & Fabrication

2. 3 credit hours, 2 x 110 minutes per week
3. Instructors: Scott Kessler, Jody Kliska, Max Anderson, Anna Johnson
4. Howard & Musto, *Introduction to Solid Modeling Using Solidworks 2014*, 10<sup>th</sup> ed. McGraw-Hill, 2014 and Selected chapters from “Fundamentals of Graphics Communication, 6th ed.” by Bertoline & Wiebe is also used in ebook form
5. a. Course Catalog Description: Introduces engineering design graphics. Includes learning a contemporary computer-aided design (CAD) software application and relevant engineering graphics concepts, such as orthographic projection, sections, engineering drawing practices, geometric dimensioning and tolerancing, and an introduction to manufacturing methods. Entails a final design project using rapid prototyping.  
b. No prerequisite or co-requisites  
c. Required course

### 6. Learning Objectives:

At the completion of this course students should be able to:

#### Know elements of sketching and orthographic projection theory

- Generate hand-drawn multi-view technical sketches
- Create a multi-view sketch given an isometric pictorial and vice versa

#### Be able to construct 3-D solid models on a modern CAD system

- Create 3-D solid models of complex objects given a multi-view representation
- Create solid models of individual parts
- Create reference geometry features (planes, axes)
- Create solid features using sweeping and lofting operations
- Measure properties of 3-D CAD models
- Create assemblies of CAD parts with appropriate mating relationships

#### Be able to create multi-view, auxiliary and section drawings from 3-D solid models

- Know the principal planes of projection and the principal views
- Be able to distinguish between first-angle and third-angle projection
- Be able to create hidden lines, center lines, etc. based on graphics conventions
- Create multi-view drawings from 3-D solid models on a CAD system
- Be able to represent typical features: e.g. holes, threads, chamfers, and fillets
- Create multi-view drawings given isometric pictorials of complex objects using 3-D solid models
- Create auxiliary views automatically from 3-D solid models
- Be able to generate appropriate section views

#### Create dimensioned drawings from 3-D solid models

- Understand the basic terminology associated with dimensioning practice
- Demonstrate size, location, and coordinate dimensioning
- Create dimensioned drawings from 3-D solid models
- Create complete working drawings including assembly and detailed drawings for a “real-life” object

#### Be able to apply geometric dimensioning and tolerancing (GD&T)

- Understand the overall concept of GD&T
- Be able to recognize GD&T dimensioning on an engineering drawing
- Be able to determine maximum material condition (MMC) and its implications

- Calculate bonus tolerance allowances as features deviate from MMC
- Be able to recognize and specify GD&T datums
- Be able to visualize tolerance zones as specified in GD&T
- Be able to create GD&T control features on an engineering drawing

Demonstrate a basic understanding of basic manufacturing processes

1. Describe basic machining processes
2. Describe casting and forming processes
3. Describe basic sheet metal operations
4. Create a prototype using a contemporary rapid prototyping process

b. Student Outcomes per ABET/ETAC Criterion for this course

For baccalaureate degree programs, these student outcomes must include, but are not limited to, the following learned capabilities:

SO(a.) an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities;

SO(g.) an ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature.

Program Criterion a): demonstrated proficiency in Geometric Dimensioning & Tolerancing

7. Topics:

- Solid Modeling
- Orthographic Projection
- Hand Drawing
- Assembly Constraints
- Dimensioning
- GD&T
- Intro to Simulation
- Presentation Techniques

## 1. ENGR 140 First-Year Engineering Projects

2. 3 credit hours, class meets for 110 minutes twice per week
3. Instructors: Jody Kliska, Sarah Lanci
4. The textbook for this course, “Introductory Engineering Design: A Projects-Based Approach,” is available on the CU website at:  
[http://itll.colorado.edu/index.php/courses\\_workshops/geen\\_1400/resources/textbook/](http://itll.colorado.edu/index.php/courses_workshops/geen_1400/resources/textbook/)
5. Course Information:
  - a. Catalog Description: Provides first-year engineering students with the opportunity to apply mathematic and scientific skills in interdisciplinary engineering projects. Students work in teams to design and build engineering projects under the guidance of engineering faculty. Prototype projects are exhibited at an end-of-semester design expo.
  - b. Prerequisite: MATH 119 or higher, and MAMT 102 or MAMT 115 (may be taken concurrently).
  - c. This is a required course.
6. Course Goals:
  - a. Learning Objectives:
    - Provide an introduction to engineering through a series of team-based design projects.
    - Learn in a hands-on method of design.
    - Practice important skills such as communication, how to function in teams, and a apply variety of computer tools as appropriate to projects.
  - b. ABET Student Outcomes & Program Criteria Supported:
    - SO(e) an ability to function effectively as a member or leader on a technical team;
    - SO(g) an ability to apply written, oral, and graphical communication in both technical and non- technical environments; and an ability to identify and use appropriate technical literature;
    - SO(k) a commitment to quality, timeliness, and continuous improvement
7. Topics Covered:
  - Team Dynamics Exercises are fun, moderately physical activities and problem-solving games in which we work together to solve a variety of interesting challenges.
  - There are two team design projects for this class:
    - The intro design project will be the trebuchet design project. This project will require students to prototype, design, and build trebuchet devices. This project will culminate in a Trebuchet Challenge where teams will compete against each other.
    - The major design project will involve design, testing, analysis, construction and demonstration. This project will take up a majority of the semester culminating with a demonstration at the CMU Student Showcase.
  - Guest Lectures throughout the course will be presented by industry and faculty members from a sampling of engineering disciplines. They will talk about

projects they are working on or other topics relevant to engineering to give students a flavor of the various engineering disciplines.

- Several workshops throughout the semester will introduce students to some of the hands-on skills they will need to work on projects, such as shop safety and use of tools.

## 1. ENGR 224/224L Materials Science

2. 3 credit hours, 2 x 50 minutes lecture and 110 minutes laboratory per week
3. Instructors: Scott Kessler (lecture and lab), Sarah Lanci (lab)
4. "Metals Handbook Desk Edition, 2<sup>nd</sup> Edition" edited by J.R. Davis, 1998
5. a. Course Catalog Description: Structure, properties, and processing of metallic, polymeric, ceramic, and composite materials. Perfect and imperfect solids; phase equilibria; transformation kinetics; mechanical behavior; material degradation. Approach incorporates both materials science and materials engineering components.  
b. Prerequisites: CHEM 131, 131L General Chemistry and PHYS 131, 131L Fundamental Mechanics.  
c. This is a required course.
6. a. Learning Objectives:

At the completion of this course students should be able to:

- i. Structure
  - Understand covalent, metallic and ionic primary bonding; understand the nature and role of secondary bonding.
  - Be able to describe the most important crystal structures by their unit cells. Be able to specify planes and directions by their indices. Execute density calculations. Understand polymorphism and allotropy. Distinguish between single crystal and polycrystalline materials.
  - Distinguish between isotropy and anisotropy, and homogeneity and inhomogeneity in materials.
  - Be able to describe semi-crystalline and non-crystalline structures.
  - Have the ability to describe important deviations from perfect crystalline structures: point, line, planar and volume defects. Understand their role in shaping material properties. Develop a qualitative understanding of the role of dislocations in the yielding of crystalline materials.
- ii. Mechanical Behavior
  - Be able to use the concepts of stress and strain in one dimension. Understand the tensile test, and be able to derive relevant mechanical parameters from such a test.
  - Understand the stiffness parameters for Young's modulus and shear modulus, as well as Poisson's ratio, for small deformations.
  - Know how to derive yield points from tensile tests. Be able to describe test curves past the yield point. Understand elastic recovery in a yielded material.
  - Relate yield strength to number of slip systems in various crystalline structures and to resolved shear stresses.
  - Understand differences between compression and tensile tests. Be able to relate hardness values to yield stress.
  - Understand the variability (statistical nature) of many mechanical parameters.
- iii. Dislocations and Strengthening Mechanisms for Crystalline Materials
  - Understand the concepts of dislocations and slip systems in the plastic deformation of crystalline material systems.
  - Know the basic principle of strengthening: hindering dislocation motion.
  - Understand the four basic methods of strengthening: formation of solid solutions, grain size refinement, formation of fine dispersions of a second phase, and cold working.

- Be able to solve one dimensional steady state and non-steady state diffusion problems involved in thermal processing of metals. Understand the factors that influence diffusion.
- Understand the processes of recovery, recrystallization and grain growth used to “undo” cold work.

iv. Failure

- Know the principal modes of failure: brittle fracture, ductile fracture and creep.
- Be able to describe brittle fracture. Be able to use the elementary parameters of fracture mechanics: stress concentrations, critical strain energy release rate, fracture toughness. Know impact test methods, and be able to interpret brittle to ductile transitions.
- Be able to describe the generalized creep behavior of metals, including stress and temperature effects. Be able to apply temperature-time extrapolation methods.

v. Phase Diagrams

- Be able to calculate all relevant quantities in binary equilibrium phase diagrams: number of phases, composition of phases, and phase amounts. Be able to identify the eutectic and eutectoid, as well as the peritectic and peritectoid reactions.
- Be able to interpret the Gibb’s phase rule.
- Be familiar with the equilibrium Fe-C phase diagram. Be able to explain the development of equilibrium microstructures in these alloys, and the role of additional elements on the development of these microstructures.
- Understand the influence of other alloying elements on the binary phase diagram.

vi. Metal Alloys, Ceramics and Polymers

- Understand the basic material structure, including the role of structural features on properties.
- Be able to describe and interpret the mechanical behavior and properties of metal alloys, ceramics and polymers. Understand the role of temperature and composition on mechanical behavior.
- Be familiar with applications and processing approaches for basic metal alloys, ceramics and polymer systems

vii. Additional Topics (to be addressed with time permitting): Material properties – chemical, electrical, mechanical, physical; Composites – structure, types, purpose, mixing laws; Corrosion mechanisms and control; Surface conditions – corrosion, degradation, coatings, finishes

b. Student Outcomes and Program Criteria per ABET/ETAC Criterion for this course

For baccalaureate degree programs, these student outcomes must include, but are not limited to, the following learned capabilities:

SO(b) an ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;

SO(c.) an ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes;

SO(f) an ability to identify, analyze, and solve broadly-defined engineering technology problems;

SO(g.) an ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature;

SO(h.) an understanding of the need for and an ability to engage in self-directed continuing professional development;

PC(c) demonstrated proficiency in application of Industry Codes, Specs and Standards;

PC(e) demonstrated proficiency in Material Science & Selection

## 7. Topics Covered

- a. Mechanical Properties
- b. Atomic Structure
- c. Structure of Solids
- d. Imperfections
- e. Diffusion
- f. Dislocation and Strengthening
- g. Failure
- h. Phase Diagrams
- i. Transformation in Metals
- j. Metal Alloys
- k. Ceramics and Applications of Ceramics
- l. Polymer Structures and Application of Polymers
- m. Composites and Application of Composites

## 1. ENGR 225 Introduction to Manufacturing

2. 3 credit hours, 2 x 50 minutes and 1 x 110 minute lab per week
3. Instructor: Sarah Lanci
4. Metals Handbook Desk Edition, 2<sup>nd</sup> Edition, ASM International, J. R. Davis (Editor), ISBN: 978-0-87170-654-6, 1998
5. a. Course Catalog Description: Principles, processes, and problems associated with the conversion of engineered materials into useful goods. Fundamentals of geometric specification, casting, machining, plastic deformation, bulk deformation, joining processes, and additive processes for metals, plastics, ceramics, and composites.  
b. Prerequisite: ENGR 224  
c. This is a required course.
6. Course Objectives:  
At the completion of this course students should:
  - a. Be able to communicate effectively
  - b. Demonstrate an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities using SolidWorks
  - c. Demonstrate a knowledge and understanding of manufacturing processes
  - d. Demonstrate a knowledge and understanding of material science and selection

### Learning Objectives:

- a) Central Role of Manufacturing
  - Define manufacturing and explain its relationship to design and marketing.
  - Describe the value added by manufacturing and its role in creating wealth in a nation.
  - Provide a historical perspective on the changing nature of manufacturing in the USA.
- b) Material Properties, Product Attributes and Related Phenomenon
  - Describe the nature of materials including atomic structure, crystalline and non-crystalline structures, and engineering materials.
  - Explain stress-strain relationships.
  - Discuss effect of temperature on properties.
- c) Engineering Materials
  - Explain alloys and phase diagrams.
  - Discuss ferrous and non-ferrous metals and super alloys.
  - Discuss fundamentals of polymer technology, including thermosetting and thermoplastic polymers and elastomers.
  - Introduce students to composite materials such as metal matrix composites, ceramic matrix composites and polymer matrix composites.
  - Explain the fundamentals of heat treatment for ferrous and non-ferrous materials.
- d) Metal Casting
  - Discuss the fundamentals of casting metals including casting terminology, solidification analysis, cast structure, shrinkage and common defects.
  - Explain different expendable mold casting processes.
  - Discuss the different multi-use mold casting processes.
  - Introduce students to good foundry practices and product design considerations.
- e) Metal Forming and Sheet Metal Working

- Explain fundamentals of metal forming including material behavior and temperature in metal forming.
  - Cover fundamentals of rolling, forging, extrusion, wire and bar drawing.
  - Describe basics of sheet metal working from cutting, bending and drawing operations to dies and presses for sheet metal processes.
- f) Material Removal Processes
- Provide theory of chip formation in metal machining.
  - Describe force relationships and the Merchant Equation, and provide energy and power relationships in machining.
  - Introduce students to turning, drilling, milling, grinding and broaching operations.
- g) Polymer Processing
- Describe the technology and the underlying physics of shaping processes for plastics.
  - Discuss properties of polymer melts.
  - Explain fundamental polymer processing including extrusion, spinning, coating processes, injection molding, compression and transfer molding.
  - Provide an introduction to shaping processes for polymer matrix composites.
- h) Principles of World Class Manufacturing
- Introduce students to basic practices of World Class Manufacturing.
  - Explain the principles underlying inspection, quality control, SPC and process capability indices.
- i) Joining and Assembly Processes
- Provide an overview of welding technology; discuss the weld joint and the physics of welding. Introduce students to different welding processes including arc, resistance, oxyfuel gas and solid-state welding.
  - Discuss the basics of brazing, soldering and adhesive bonding. Describe the different soldering processes including vapor phase, wave and infrared soldering.
  - Explain the basic differences between the different joining processes.
- j) Ceramics Processing
- Discuss the fundamentals of ceramics (composition and use) including how differences in atomic bonds affect the physical properties of ceramic products
  - Explain the basic processing methods and applications for ceramics
  - Discuss finishing operations for ceramic products

ABET Student Outcomes and Program Criteria Supported or Assessed:

SO(a) an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities (using SolidWorks);

PC(a) demonstrated proficiency in Geometric Dimensioning & Tolerancing

PC(d) demonstrated proficiency in Manufacturing Processes;

PC(e) demonstrated proficiency in Material Science & Selection

7. Topics to be covered:

- World class manufacturing
- Engineering materials (properties and use)
- Metal Casting & Metal Forming Processes
- Material Removal, Joining and Assembly & Polymer and Ceramic Processes & processing

## 1. ENGR 261 Statics and Structures

2. 3 credit hours, two 75-minute lectures per week

3. Instructors: Farzad Taghaddosi (2014-15), Scott Bevill (2015-16)

4. Hibbeler's *Engineering Mechanics: Statics, Thirteenth Edition*, Pearson 2013

5. a. Course Catalog Description: Covers statics of particles, equivalent force systems, rigid bodies, equilibrium of rigid bodies in two and three dimensions, analysis of truss and frame structures, uniaxially-loaded members, deformation and stress, distributed force systems, friction. Lectures and homework assignments involve computer work and hands-on laboratory work documented by written reports.

b. Prerequisites: MATH 152 or MATH 136 and PHYS 131/131L

c. This is a required course.

6. Course objectives:

a) Statics of Particles

- Represent a directed distance and a force as a vector in either two- or three-dimensions in Cartesian coordinates.
- Add forces and resolve forces into rectangular components.
- Explain the idea of force equilibrium and Newton's first law of motion, and determine when a system of forces is in equilibrium.
- Isolate an appropriate particle in a physical system and develop a free-body diagram for the system of forces acting on the particle.
- Do the above for both forces in a plane (2-D) or in space (3-D).

b) Equivalent Force Systems: Rigid Bodies

- Explain the ideas of a rigid body and its connection to a particle, the moment of a force about a point, the moment of a force about an axis, a couple, and external and internal forces.
- Compute the moment of a force about a point using formal 3-D vector multiplication (cross product), and identify the simplification that results in two-dimensions.
- Compute the moment of a force about an axis using formal vector multiplication in three-dimensions (dot product and mixed triple product), and identify the simplification that results in two-dimensions.
- Compute the rectangular components of a moment & the moment of a couple
- Resolve a given force (and system of forces) into an equivalent force-couple system.

c) Equilibrium of Rigid Bodies in Two- and Three-Dimensions

- Identify when a force system acting on a rigid body is in equilibrium and express this in both vector and component form.
- Identify equivalent force/moment systems.
- Isolate an appropriate free body of a physical system and develop a free-body diagram for the system of forces and moments acting on the body. Apply this to such elements as pulleys, hinges, beams, cables, bearings, etc.
- Classify the types of reaction supports and connections for two- and three-dimensional structures (pinned, built-in, etc.).
- Write and solve the equilibrium equations for rigid body in 2 and 3-D.

d) Analysis of Truss and Frame Structures

- Define truss, frame, and machine structures and describe the various load, joint, and boundary conditions that are possible.
  - Draw free body diagrams of two-dimensional truss members and joints.
  - Compute the forces in two-dimensional truss members using the methods of joints and sections.
  - Identify multi-force members in frame structures and draw free body diagrams of two-dimensional frame members and joints.
- e) Shear and Moment Diagrams
- Determine shear and moment equations for beams or loaded members
  - Draw the shear and moment diagrams
  - Explain the relationship between moment and shear force distribution
- f) Distributed Force Systems
- Define the terms: center of gravity, centroid, and first moment of an area or line.
  - Compute the center of gravity of a two-dimensional body, the centroid of an area and a line, and the first moments of an area about an axis.
  - Take advantage of symmetry in these computations.
  - Compute the center of gravity of composite bodies.
  - Compute concentrated loads that are equivalent to a specified distributed load.
  - Determine forces due to hydrostatic pressure in fluids
  - Define area and mass moments of inertia and explain their importance
- g) Friction
- Define static and kinetic friction, friction force, the coefficients of static and kinetic friction, and the angles of static and kinetic friction.
  - Draw free body diagrams of each part in a frictional system.
  - Analyze problems of friction for cases when motion is and is not impending.

ABET Student Outcomes & Program Criteria supported:

SO(b) an ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;

SO(f) an ability to identify, analyze, and solve broadly-defined engineering technology problems;

PC(f) demonstrated proficiency in Solid Mechanics

7. Topics Covered:

- Vector algebra
- Statics of Particles
- Equivalent Force Systems
- Rigid Bodies
  - Equilibrium of Rigid Bodies in Two Dimensions
  - Equilibrium of Rigid Bodies in Three Dimensions
- Analysis of Truss and Frame Structures
- Shear and Moment Diagrams
- Distributed Force Systems, Hydrostatic Pressure, Moments of Inertia, Friction

## 1. ENGR 263 Mechanics of Solids

2. 3 credit hours, 3 50-minute lectures per week
3. Instructors: Scott Kessler, Scott Bevill
4. *Mechanics of Materials*, Ninth Edition. R. C. Hibbeler, 2013
5. a. Catalog Description: Covers shear force and bending moment, torsion, stresses in beams, deflection of beams, matrix analysis of frame structures, analysis of stress and strain in 2-D and 3-D (field equations, transformations), energy methods, stress concentrations, and columns. Lectures and homework assignments involve computer work and hands-on laboratory work documented by written reports.
  - b. Prerequisite: ENGR 261.
  - c. This is a required course.

## 6. Course Learning Objectives

- Uniaxial Loading
  - Analyze statically indeterminate problems
  - Analyze stresses in members subjected to temperature changes as well as applied loads.
  - Understand the displacement method for systems with many elements subjected to axial loading.
- Torsional Loading of Circular Shafts
  - Understand the basic relationships between torque, angular deflection, shear stress, shear strain, and torsional stiffness.
  - Determine stresses and deflections for statically determinate and indeterminate systems.
  - Use the displacement method for torsional systems.
  - Calculate power transmitted to rotating parts and its relationship to torque and speed.
- Shear and Bending in Beams
  - Develop both shear and bending moment diagrams.
  - Understand and derive the differential equations relating load, shear and bending moment.
  - Solve for shear and bending moments in a beam when the applied loads are described by singularity functions.
- Beam Flexure
  - Derive and determine shear and normal stress.
  - Derive and determine deflections in beams subjected to bending.
  - Perform stress and deflection analyses of beams containing non-uniform cross-sections.
  - Use double integration and superposition methods to obtain beam deflections.
  - Solve simple statically indeterminate problems.
- Stress and Strain
  - Understand the general state of stress at a point on a body in three dimensions.

- Understand the equilibrium relationships of stress components at a point in a body in a state of plane stress or plane strain.
- Perform stress and strain transformations and determine the principal and maximum shear stresses in a body.
- Calculate the stresses in thin walled pressure vessels (cylindrical and spherical).
- Develop the relationship between strain and displacement in a body subjected to plane strain or plane stress.
- Understand the relationship between stress and strain for linear elastic materials.
- Combined Loading
  - Calculate the stresses in a body subjected to combined axial, bending and/or torsional loading.
- Buckling
  - Derive relationships leading to the calculation of critical buckling loads for axially loaded beams with different boundary conditions. Course Learning Objectives

ABET Student Learning Outcomes & Program Criteria Supported:

Upon completion of this course students should demonstrate:

SO(b) an ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;

SO(f) an ability to identify, analyze, and solve broadly-defined engineering technology problems;

PC(f) proficiency in Solid Mechanics

7. Topics Covered:

- Assessment, Statics Review
- Stress, Shear Stress, Safety Factors
- Strain, Mechanical Properties
- Stress/Strain, Poisson's Ratio
- Axial Loading, Statically Indeterminate Systems
- Thermal Stresses and Strains
- Stress Concentration, Power Transmission
- Shear Moment Diagrams
- Flexure, Bending
- Bending Stress Concentrations, Transverse Shear
- Transverse Shear, Combined Loading
- Combined Loading
- Stress Transformation, Mohr's Circle
- Ductile Brittle Failure, Buckling, Reviewed:

## 1. ENGR 305 Engineering Economics and Ethics

2. 2 credits, two 50-minute lectures per week

3. Instructor: Sarah Lanci

4. *Engineering Economic Analysis* (11th ed), Newnan, D., 2011

5. Course Information:

- a. Catalog Description: Applications of economics, statistics, and ethics for mechanical engineers. Topics include cost concepts and design economics, money-time relationships, and comparison of alternatives. Engineering ethics includes personal vs. professional ethics, ethical problem-solving techniques, rights and responsibilities of engineers, and whistle-blowing.
- b. Prerequisites: ENGR 101, ENGR 140, and MATH 119, MATH 135, or MATH 151.
- c. This is a required course.

6. Course Goals:

a. Learning Objectives:

Upon completion of this course, students should be able to:

- Cash Flow and Equivalence
  - Understand the terminology used in engineering economic analysis
  - Understand cash flow, time value of money, discount factors and equivalence, functional notation, non-annual compounding, and continuous compounding.
  - Develop cash flow analysis problem solving techniques for passing exams including the Engineering Economics portion of the FE exam.
- Depreciation and Special Topics
  - Understand and apply risk analysis techniques for depreciation, book value, equivalent uniform annual cost, capitalized cost, bonds, inflation, and probabilistic problems.
- Comparison of Alternatives
  - Understand the criteria for making economic-based decisions.
  - Understand how to perform alternative comparisons, present worth analysis, annual cost analysis, rate of return analysis, benefit-cost analysis, and break-even analysis.
  - Experience working in a team to solve an economic problem and make a presentation of the solution.
  - Formulate economic solutions to real-world case study problems.
  - Demonstrate capability to use Excel spreadsheet analysis in solving economic problems.
- Ethical Problem-Solving
  - Understand personal versus professional ethics.
  - Apply ethical problem-solving techniques.
  - Understand the rights and responsibilities of engineers through creeds, codes, canons, statutes, and rules.
  - Understand how to take an ethical stance on dealing with clients, employers, suppliers, and other engineers and how those ethics affect the public.

b. ABET Student Outcomes & Program Criteria Supported:

SO(i): an understanding of and commitment to address professional and ethical responsibilities including a respect for diversity

7. Topics Covered:

- applications of economics and ethics for mechanical engineers
- time value of money and other cash-flow concepts
- economic practices and techniques used to evaluate and optimize engineering decisions
- principles of benefit-cost analysis and comparison of alternatives
- personal versus professional ethics
- ethical problem-solving techniques
- rights and responsibilities of engineers
- whistle-blowing

## **1. ENGR 312 Engineering Thermodynamics**

2. 3 credit hours, two 75-minute lectures per week

3. Instructors: Rebecca Atkins (2015-2016), Farzad Taghaddosi (2014-2015)

4. *Fundamentals of Thermal-Fluid Sciences*, Çengel et al., 4th Edition, McGraw-Hill 2012.

5. a. Course Catalog Description: An introductory course in thermodynamics, the science of heat energy conversion. Develops understanding of energy, heat, work, efficiency, and ideal thermodynamic cycles. Teaches first and second laws of thermodynamics and perfect gas law.

b. Prerequisites: MATH 136 or MATH 152, and PHYS 131/131L.

c. This is a required course.

8. Course Goals:

### Learning Objectives:

- a) Develop the student's ability to analyze problems in engineering thermodynamics in a simple, logical and systematic manner by applying fundamental principles to their solution,
- b) Expose the student to various aspects of thermodynamic engineering through lecture, class presentation and problem solving,
- c) Develop the student's process of reasoning in the solution of complex problems through the use of schematic diagrams, cycle diagrams, and thermodynamic tables,
- d) Develop the an ability to apply knowledge of mathematics, science, and engineering,
- e) Develop the education necessary to understand the impact of engineering solutions on society,
- f) Develop a knowledge of contemporary issues.

### ABET Student Outcomes & Program Criteria Supported:

SO(b) an ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;

SO(f) an ability to identify, analyze, and solve broadly-defined engineering technology problems;

SO(k) a commitment to quality, timeliness, and continuous improvement.

PC(g) demonstrated proficiency in Thermal Sciences

9. Topics Covered:

- Introduction to Thermal-Sciences
- Basic Concepts in Thermodynamics: Work, Heat, and Energy
- Properties of Pure Substances; Property Tables
- Ideal Gases; Specific Heats
- Energy Analysis of Closed and Open Systems (1st Law of Thermodynamics)
- Entropy and The 2nd Law of Thermodynamics
- Entropy Change of Pure Substances
- Isentropic Efficiency
- Power and Refrigeration Cycles
- Introduction to Heat Transfer

## **ENGR 317 Fundamentals of Circuits and Electronics**

1. 3 credit hours, two 50-minute lectures per week plus one 110-minute lab
2. Instructor: Andrew Affrunti
3. Textbook: *Electronics Fundamentals; Circuits, Devices, and Applications*; Thomas L. Floyd and David M. Buchla; 8e, Pearson 2010; ISBN-13: 978-0-13-507295-0  
Lab Manual: *Experiments in Electronics Fundamentals and Electric Circuits Fundamentals*, 8e, David M. Buchla, Prentice Hall, 2010; ISBN: 13: 978-0-13-506327-9
4. Course Information:
  - a. Catalog Description: Resistive circuits, operational amplifiers, capacitors, inductors, transient analysis, sine waves, AC circuit analysis, resonance, transformers. Not for Electronics Engineering Technology and Computer Engineering Technology students.
  - b. Prerequisites: MATH 136 or MATH 152, and PHYS 131/131L
  - c. This is a required course.
5. Course Goals:
  - a. Learning Objectives:
    1. DC Circuits
      - Introduction into SI, measurements, safety.
      - Fundamental quantities; voltage, current and resistance.
      - Ohm's Law, energy and power.
      - Series circuits, parallel circuits and series-parallel circuits.
      - Magnetism and Electromagnetism.
    2. AC Circuits
      - Understand alternating voltage and current.
      - Working with capacitors and resistor-capacitor circuits. The first order system.
      - Working with inductors and resistor-inductor circuits. The first order system.
      - Analyze resistor-capacitor-inductor circuits; series and parallel resonance. The second order system.
      - Understanding transformers.
      - Survey of time response in circuits containing capacitance and inductance. Focus on integrators and differentiators in steady state circuits.
    3. Devices
      - Introduction to the diode and the semiconductor PN junction.
      - Introduction, study and analysis of transistors and applications. The Bipolar Junction Transistor is analyzed as a switch, Class A, Class B and Class C amplifier. The Field Effect Transistor is introduced studied and analyzed as an amplifier and oscillator.
      - The Operational Amplifier is introduced. The input differential amplifier is used to demonstrate the inverting and non inverting inputs. Its characteristics, parameters and analysis are first examined in the ideal case. Then, losses,

offsets and other imperfections are added to best model the real case. Negative feedback is studied in order to show common configurations.

- Basic Op-Amp circuits are covered; comparators, summing amplifiers, integrators and differentiators, oscillators, active filters and voltage regulators.
- Special purpose Op-Amp circuits are covered; instrumentation amplifiers, isolation amplifiers, operational transconductance amplifiers, active diode circuits, current sources and converters.
- A measurement section is included which contains; temperature, strain, pressure and flow rate. Sample and hold and analog to digital conversion is demonstrated. Power control and motion measurement are also covered.

b. ABET Student Outcomes & Program Criteria Supported or Assessed:

SO(a) An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities

SO(c) An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes

PC(b) demonstrated proficiency in Instrumentation & Sensors

PC(h) demonstrated proficiency in Electrical Circuits (ac and dc) & Electronic Controls

6. Topics Covered:

**Description:** This is a survey of electrical engineering for Mechanical Engineering Technology students. It incorporates concepts of physics and mathematics and applies them to electrical engineering phenomena. Experiments are designed and utilized to obtain ‘hands-on’ experience in laboratory as well demonstrate class room theory. One of the course objectives is to develop interdisciplinary skills in order to communicate, contribute and work in teams consisting of other skill sets; i.e., chemical, aeronautical, civil engineering, medicine, etc. Class room and Laboratory sessions emphasize presentation and communication skills in electrical engineering and across other disciplines.

**Brief List of Topics:** DC Circuits, AC Circuits, and Electronic Devices.

## 1. ENGR 321 Fluid Mechanics

2. 3 credit hours, two 75-minute lectures per week plus one 70-minute lab. per week.
3. Instructors: Timothy Brower (2015-16), Farzad Taghaddosi (2014-15)
4. *Applied Fluid Mechanics*, Mott & Untener, 7th Edition, Pearson 2015.
5. a. Course Catalog Description: Covers fluid properties, laws of fluid statics and fluid dynamics, measurement of flow, viscous flow, laminar and turbulent flow, flow in ducts, forces due to fluid motion, and fluid machinery.
  - b. Prerequisites: MATH 152 or MATH 136, and PHYS 131/131L.
  - c. This is a required course.
6. Course Goals:

### Learning Objectives:

- h) Students will be able to analyze and model physical systems or components using principles of engineering, basic science and mathematics,
- i) Students will be able to conduct, analyze and interpret experiments and apply experimental results to improve processes in fluid mechanics,
- j) An ability to identify, formulate, and solve engineering problems,
- k) Students will be able to function effectively on teams,
- l) Students will be able to work professionally in mechanical systems,
- m) Students will be able to communicate effectively,
- n) Develop the an ability to apply knowledge of mathematics, science, and engineering,
- o) Develop an understanding of professional and ethical responsibility

### ABET Student Outcomes & Program Criteria Supported or Assessed:

SO(b) an ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;

SO(d) an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives;

SO(e) an ability to function effectively as a member or leader on a technical team;

SO(f) an ability to identify, analyze, and solve broadly-defined engineering technology problems;

SO(k) a commitment to quality, timeliness, and continuous improvement.

PC(g) demonstrated proficiency in Thermal Sciences

### 7. Topics Covered:

- Fluid Properties, Fluid Statics and Buoyancy
- Fluid Flow & Bernoulli's Equation, General Energy Equation
- Major and Minor Losses in Pipes
- Laminar and Turbulent Flows
- Analysis of Series and Parallel Pipelines
- Pump Selection and Performance
- Introduction to Flow Measurement
- External Flows
- Lift and Drag
- Introduction to Boundary Layers

## 1. ENGR 325 Component Design

2. Three credit hours, 2 x 75 minutes lecture per week

3. Instructor: Scott Kessler

4. Textbook: "Machine Elements in Mechanical Design, 5<sup>th</sup> Ed." by Robert L. Mott, 2013

5. a. Course Catalog Description: Knowledge and skills developed in preceding courses are extended and applied to design and selection of machine elements and machines. Attention is given to functional requirements, methods of manufacture, choice of materials and economic factors.

b. Prerequisites: C or better in ENGR 224 and ENGR 263

c. This is a required course.

### 6. a. Learning Outcomes:

On completion of this the course, the student should be able to:

1. Apply principles of engineering, basic science and mathematics, to model, analyze, and design physical systems, components or process; and prepare students to work in mechanical systems (Partial Program Criteria).
2. Understand the strength characteristics of different materials.
3. Determine the force-deflection characteristics of simple bodies under torsion, tension and bending.
4. Use energy relationships to determine the response to dynamic loads.
5. Use various failure theories to design elements under static loading.
6. Understand the concept of safety factor and how to apply it.
7. Calculate fatigue stress correction factors relating to machining, size, loading, etc.
8. Perform fatigue failure calculations making use of the S-N curve and applying relationships for fatigue failure for non-zero mean stress.
9. Analyze the contact stresses and deformation between two bodies with known contact geometry, and apply this to a variety of machine elements.
10. Understand the basic dimensions associated with shafts, keys, couplings, gear, spring, screw and welding systems.

### b. Student Outcomes & Program Criteria per ABET/ETAC Criterion for this course

For baccalaureate degree programs, these student outcomes must include, but are not limited to, the following learned capabilities:

SO(d) an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives;

PC(c) demonstrated proficiency in application of Industry Codes, Specs, & Standards;

PC(f) demonstrated proficiency in Solid Mechanics

## 7. Topics Covered

1. Introduction to Design

2. Concepts Review

a. Materials and Processes

b. Load Determination: Static and Dynamic Loads

c. Stress and Strain: Axial, Shear and Bending and Combined Stresses

d. Principal Stresses

3. Static Failure Theories
  - a. Ductile Materials
  - b. Failure of Brittle Materials
  - c. Fracture Mechanics
4. Fatigue Failure Theories
  - a. Failure Criteria
  - b. Correction Factors
  - c. S-N diagrams
  - d. Stress Concentrations
5. Surface Failure: Wear and Friction and Contact Stress
6. Introduction to Finite Element Analysis
7. Applications:
  - a. Shafts, Keys, and Couplings
  - b. Bearings and Lubrication
  - c. Gears Trains
  - d. Spring Design
  - e. Screws and Fasteners
  - f. Welding

## 1. ENGR 343 Dynamics

2. 3 credits, three 50-minute lectures per week
3. Instructor: Scott Bevill
4. *Engineering Mechanics Dynamics*, Thirteenth Edition, R.C. Hibbeler, 2012
5. Course Information:
  - a. Catalog Description: Kinematics of particles and rigid bodies. Kinetics of particles and rigid bodies in plane motion, including Newton's second law, work and energy, impulse and momentum.
  - b. Prerequisites: ENGR 261
  - c. This is a required course.
6. Course Goals:
  - a. Learning Objectives:
    - Kinematics of Particles
      - Describe the distinction between a particle and a rigid body.
      - Define position, velocity, and acceleration of a particle in rectilinear motion. The concepts of position, distance traveled, velocity, and speed should be understood, and not confused.
      - Write the relationships between position, velocity, and acceleration of a particle in rectilinear motion, under general conditions, as a function of time. Solve for two of them, given the third, by differentiation and/or integration. This requires an understanding of the appropriate initial conditions in each case.
      - Describe the physical interpretation of position, velocity, and acceleration of a particle.
      - Identify and analyze special cases of rectilinear motion (uniform motion, uniformly accelerated motion).
      - Write the relationships between position, velocity, and acceleration of a particle in curvilinear motion, under general conditions, as a function of time using vector notation.
      - Compute the derivative of a vector function and compute the components of vector fields in Cartesian, path, polar, and cylindrical coordinate systems. Use these concepts to analyze problems of projectile motion in both two- and three-dimensions.
      - Describe the concept of relative motion and compute position, velocity, and acceleration of particles in relative motion and dependent relative motion.
    - Kinetics of Particles: Newton's 2nd Law
      - Define mass and linear momentum and explain the concept of a Newtonian reference frame.
      - Write and explain Newton's 2nd Law of motion.
      - Write and explain Newton's 2nd Law of motion, and explain the concept of conservation of momentum.

- Systematically use Newton's second law to analyze the motion of a particle acted upon by forces that are constant, and explicit functions of time, position, and velocity. Identify the appropriate initial conditions in each case, and describe physical examples of each case. This should be done for both rectilinear and curvilinear motion.
- Describe the concept of angular momentum of a particle, write Newton's 2nd law in terms of angular momentum, and describe the principle of angular momentum.
- Kinetics of Particles: Energy and Momentum Methods
  - Define and compute the work of a force and the kinetic energy of a particle. Develop the principle of work and energy.
  - Apply the method of work and energy to problems involving a single body or connected bodies.
  - Define conservative forces, potential energy, and the principle of conservation of energy. Identify mechanical loss mechanisms. Apply the principle of conservation of energy to problems involving a single body or connected bodies.
  - Define the concept of linear impulse and derive the principle of impulse and momentum.
  - Apply the principle of impulse and momentum to problems of direct and oblique central impact.
  - Select the method of analysis that is best suited for the solution of a given problem (Newton's Law, Work and Energy, Impulse and Momentum) and the combination of these methods.
  - Develop the fundamental dynamics equations and principles for a system of particles.
- Two-Dimensional Rigid-Body Kinematics
  - Define the fundamental types of plane motion.
  - Derive relations defining the velocity and acceleration of any particle on a rigid body for translation and rotation about an axis in two- and three-dimensions.
  - Decompose general plane motion into the sum of a translation and a rotation.
  - Define and compute the instantaneous center of rotation.
  - Describe and analyze the plane motion of a particle relative to a rotating frame. Determine the Coriolis acceleration in plane motion.
- Two-Dimensional Rigid-Body Kinetics
  - Solve problems in two-dimensional rigid-body dynamics, regardless of their kinematic characteristics, by equating the sum of the forces acting on the rigid body to the vectors  $ma$  and  $m\omega$ . To effect this solution, construct appropriate free-body diagrams.
  - Define the work of a couple and the kinetic energy of a rigid body.
  - Apply the method of work and energy to the plane motion of a rigid body.

- b. ABET Student Outcomes & Program Criteria Supported/Assessed: Upon completion of this course students should demonstrate:
- SO(b) an ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;
  - SO(f) an ability to identify, analyze, and solve broadly-defined engineering technology problems;
  - PC(f) demonstrated proficiency in Solid Mechanics

#### 7. Topics Covered

- Intro & 1D Kinematics
- Curvilinear motion, Projectile Motion, Cylindrical and n-t coordinates
- Dependent Motion of two Particle, Equations of Motion
- Principle of Work & Energy,
- Conservation of Energy, Principle of Impulse & Momentum
- Conservation of Linear Momentum, Angular Momentum
- Rigid body kinematics
- Absolute and relative motion, Instantaneous center
- Rotating axes, Moment of Inertia, Rigid body
- Equations of motion for rigid bodies (General Plane Motion), Friction
- Principle of Work & Energy

## 1. ENGR 345/385 Engineering Integration I & II

2. 3 credit hours, two 75-minute class meetings per week
3. Instructor: Scott Bevill
4. No textbook required. The suggested textbook is “The Mechanical Design Process, 5th Edition” by David G. Ullman (2015.)
5. Course Information:
  - a. Catalog Description: First course in a design sequence integrating concepts from the mechanical engineering technology curriculum. Emphasis on laboratory experience and the design, analysis, and testing of mechanical systems. Team project work on “design-and-build” projects will require manufacture of mechanical systems and/or electronic circuits.
  - b. Prerequisites: ENGR 224, ENGR 263, and MAMT 106.
  - c. This is a required course.
6. Course Goals:
  - a. Learning Objectives: ENGR 345 is a cornerstone design class in the Mechanical Engineering Technology sequence. As such, it is expected that students will demonstrate effectiveness with:
    1. Understanding how to collaboratively work on a team in pursuit of a common design goal
      - a. Contributing to the team’s work
      - b. Interacting with teammates
      - c. Keeping the team on track
      - d. Expecting quality
      - e. Having relevant knowledge, skills, and abilities
    2. Developing proficiency with written technical communications (e.g., email, reports, technical manuals, user guides)
    3. Developing proficiency with oral technical communications
    4. Developing proficiency with managing long-term projects
      - a. Setting realistic project goals & milestones
      - b. Formulating concise problem definition statement(s) for open-ended design problems
      - c. Establishing quantitative design requirements
      - d. Understanding how to prepare for and conduct constructive design reviews
      - e. Maintaining project budget
      - f. Meeting project goals and milestones
    5. Technical Skills
      - a. Generation of alternative design concepts and evaluation of alternative designs based on design requirements/objectives
      - b. Application of engineering design skills to create CAD models and drawings to support machining, fabrication, and assembly
      - c. Use results of engineering analyses to make design decisions in a methodical manner
      - d. Fabricate and test physical prototypes to help make decisions

b. ABET Student Outcomes & Program Criteria Supported/Assessed: Upon completion of this course students should demonstrate:

SO(a) an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities;

SO(d) an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives;

7. Topics Covered:

ENGR 345 is the first course in a design sequence integrating concepts from the mechanical engineering technology curriculum. Emphasis is on laboratory experience and the design, analysis, and testing of mechanical systems. Team project work on “design-and-build” projects will require manufacture of mechanical systems and/or electronic circuits.

This sequence applies material from prior course work along with concepts of:

- project management,
- problem definition,
- determining design requirements,
- design optimization,
- engineering analysis,
- proof-of-concept prototype, and
- CAD drawings.

Students make multiple design presentations and prepare design documentation.

**1. ENGR 401 Professionalism Seminar**

2. 1 credit hour, one 50-minute lecture per week

3. Instructors: Timothy Brower, Eric Goertz

4. *Drive* by Daniel Pink (2011), *Outliers* by Malcolm Gladwell (2011),  
[www.coloradomesa.edu/careers](http://www.coloradomesa.edu/careers)

5. Course Information:

- a. Catalog Description: Preparation for a career in the engineering profession. Topics in professionalism, ethics, resume building, innovation, internships, and current engineering issues explored.
- b. Prerequisite: junior standing or higher
- c. This is a required course.

6. Course Goals

a. Learning Objectives:

The outcomes for this course are that students will:

- develop an ability to apply written, oral, and graphical communication in both technical and non-technical environments (be able to communicate effectively),
- develop an understanding of the need for and an ability to engage in self-directed continuing professional development,
- develop an understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity.

b. ABET Student Outcome Assessed:

(h) an understanding of the need for and an ability to engage in self-directed continuing professional development;

7. Topics Covered

Specific topics addressed include:

- engineering resumes,
- cover letters,
- technical interviews, and
- an overview of professionalism and business ethics.

Course format includes lectures, reading & writing assignments, group work, and presentations.

## 1. ENGR 427 Engineering Measurements

2. 2 credit hours, two 110-minute meetings per week

3. Instructor: Nathan McNeill

4. No textbook required.

5. Course Information:

- Catalog Description: Methods of experimentation and data analysis. Specific skills used in planning an experiment, applying sound procedures, keeping proper records, and communicating results orally, with posters and in written reports developed.
- Prerequisites: ENGR 263, ENGR 317, STAT 305, and ENGL 425.
- This is a required course.

6. Course Goals:

- Learning Objectives

1. Measurement Fundamentals

- Demonstrate Understanding of the purposes of measurements: comparison with models, performance measurements, process/quality control and physical constant determination.
- Utilize experiment systems: transduction, signal conditioning, data acquisition and display.
- Apply statistical concepts to understand variability, error and resolution.
- Carry out calibration and uncertainty and statistical data analysis.
- Explore different classes of measurement including stationary and transient systems.

2. Uncertainty in Experimental Measurements and its Propagation

- Apply uncertainty analysis for real experiments.
- Compute uncertainty for the following circumstances: design stage, repeated measurements, single measurements, propagation of uncertainty.
- Apply objective outlier rejection techniques.

3. Confidence Intervals

- Calculate confidence intervals and use them to make probabilistic statements about data sets.

4. Professional Skills

- Learn how to work in a careful and orderly fashion.
- Learn how to systematically record and document experimental activities and results.
- Learn how to present experimental findings clearly and effectively using written, visual, and oral presentation formats.
- Improve teamwork and communication skills.

- ABET Student Outcomes & Program Criteria Supported/Assessed:

SO(a) an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities (LabView);

SO(c) an ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes; riments; and to apply experimental results to improve processes;

PC(b) demonstrated proficiency in Instrumentation & Sensors

7. Topics Covered:

- Analyzing photos/report writing
- Uncertainty/Error/Propagation of error
- Statistics
- Presenting data & findings
- Statistical Process Control
- Sensors
- Power/Transient data collection
- Temperature/Calibration/Response time
- Strain/force/pressure
- Fourier analysis/Sampling rate/Filtering

## **ENGR 435 Industrial Controls**

1. 3 credit hours, class meets for 110 minutes twice per week
2. Instructor: Nathan McNeill
3. No textbook required
4. Course information:
  - Catalog description: Fundamentals of control of manufacturing processes. Applications of relay logic, input/output devices, and programmable logic controllers (PLC). Design of complete control circuits, selection of components, and cost estimation. PLC programming for discrete event control and for analog applications.
  - Prerequisite: ENGR 317.
  - This is a required course.
5. Course goals:

- a. Learning Objectives

In this course students will learn to:

- Wire automation control circuits including
  - PLC networking
  - Input devices including both digital and analog sensors
  - Output devices including pneumatics and motors
- Program a programmable logic controller (PLC) including
  - Basic logic operations
  - Ladder logic and function block programs
  - Human machine interface (HMI) layout and connection
- Design and build automated systems involving
  - Multiple inputs and outputs
  - The selection of appropriate sensors
  - The selection of appropriate actuators

- b. ABET Student Outcomes & Program Criteria Supported/Assessed:

PC(b) demonstrated proficiency in Instrumentation & Sensors

PC(h) demonstrated proficiency in Electrical Circuits & Electronic Controls

6. Topics Covered:
  - Load Cell Summing
  - Electrical Circuits
  - PLC Programming
  - Conveyor Design
  - Counting/Speed Measurement
  - Conveyor Control
  - Analog systems

**1. ENGR 445/485 MET Design Project I & II**

2. 3 credit hours, class meets for 110 minutes twice per week
3. Instructors: Brett Hensley, Francisco Castro, Scott Bevill (2014-15)
4. *A Pocket Style Manual* by Hacker and Sommers, 7<sup>th</sup> Edition, 2014
5. Course Information:
  - a. Catalog Description: The first of a two-course comprehensive group capstone design experience, focusing on the design proposal. This sequence applies material from prior course work, along with concepts of project management, problem definition; determining design requirements, design optimization, engineering analysis, proof-of-concept prototype, CAD drawings. Students make several oral design reviews, a final design presentation, and prepare a written report.
  - b. Prerequisites: ENGR140, ENGR 312, ENGR 321, ENGR 325, MAMT 115, and ENGL 425.
  - c. This is a required course.

6. Course Goals:

**a. Learning Objectives:**

1. Develop an understanding of the necessary professional skills needed to succeed in industry
  - Punctuality, personal scheduling, interpersonal skills, professional attire
2. Understand how to collaboratively work in a team toward a common design goal
  - Contributing to the team's work
  - Interacting with teammates
  - Keeping the team on track
  - Expecting quality
  - Having relevant knowledge, skills, and abilities
3. Become proficient at written technical communications
  - e-mails, reports, technical manuals, user guides, etc.
4. Become proficient at oral technical communications
5. Become proficient at managing long term projects
  - Setting realistic project goals & milestones
  - Formulate concise problem definition statement for an open-ended design problem
  - Develop quantitative design requirements
  - Understand how to conduct constructive design reviews
  - Maintain project within budget
  - Meet project goals & milestones
6. Technical Skills
  - Develop the knowledge and ability to use skills in heat transfer, fluid mechanics, electric circuits, etc. to perform engineering analysis

- Generate alternative design concepts and evaluate using design requirements
- Apply engineering design skills to create CAD models and drawings to build physical prototypes
- Use results of engineering analysis to make design decisions (engineering and business) in a methodical manner
- Fabricate and test physical prototypes to help make decisions

**b. ABET Student Outcomes & Program Criteria Supported/Assessed:** Upon completion of this course, student will demonstrate:

- SO(e) an ability to function effectively as a member or leader on a technical team;
- SO(g) an ability to apply written, oral, and graphical communication in both technical and non- technical environments; and an ability to identify and use appropriate technical literature;
- SO(k) a commitment to quality, timeliness, and continuous improvement

#### 7. Topics Covered

The course will last for two semesters and projects will be carried out with industrial support. At the beginning of the semester students will be placed in a team. Each team will then be required to write a project proposal for the sponsored project. Once a team has been assigned to a project, students will be required to meet a number of deadlines to ensure timely progress toward successful completion of the project. Faculty advisors and company mentors will work with students to develop and meet the project goals.

Topics to be covered include:

- Design Method
- Project Management
- Deliverables
- Project Roles
- Task Definition
- Specs and Planning
- Teamwork/Collaboration
- Presentation Skills
- Peer Assessment

## Appendix A2 – Course Syllabi

### Supporting Courses – Chem, Comp Sci, Math, Phys

#### 1. CHEM 131 General Chemistry I

2. 4 credit hours, 4 x 50 minute lectures, 2 x 50 minute labs per week
3. Instructor: Tim D'Andrea
4. Textbook: *General Chemistry: Atoms First* by McMurry and Fay, Pearson Prentice Hall (2010).
5. Course Catalog Description: Chemistry 131 is the first semester of a two-semester series covering general chemistry for science majors. In this semester, we will learn many of the basics of chemistry and set the stage for much of the work for 132.

Prerequisites: One year of high school chemistry, mastery of high school algebra, and a passing score on the chemistry assessment exam. Chem 121 may be substituted for these requirements. This is a required class.

6. Course objectives. This course meets two of the general education objectives:  
Understand the structure and discipline of mathematical thought and its use in problem solving;  
Have knowledge of the natural world and an understanding of the scientific method.
7. Topics Covered:
  - 1 Measurements, significant figures (MF chapter 1) (BLB chapter 1)
  - 2 Atomic structure (MF chapter 2, 3) (BLB chapter 6)
  - 3 Electronic structure of atoms (MF chapter 3) (BLB chapter 6)
  - 4 Finish electronic structure, (MF chapter 3) (BLB chapter 6)
  - 5 Ionic bonding and main-group chemistry (MF chapter 4) (BLB Chapter 7 & 8)
  - 6 Ionic bonding and main-group chemistry (MF chapters 4) (BLB Chapter 7 & 8)
  - 7 Covalent bonding and Lewis structures (MF chapter 5) (BLB Chapter 8)
  - 8 Lewis structures and molecular geometry, MF chapter 5) (BLB Chapter 8)
  - 9 Finish molecular geometry, (MF chapter 5) (BLB Chapter 8)
  - 10 Stoichiometry (MF chapter 6) (BLB Chapter 3)
  - 11 Finish stoichiometry (MF chapter 6) (BLB Chapter 3)
  - 12 Reactions in aqueous solutions, (MF chapter 7) (BLB Chapter 4)
  - 13 Thermochemistry (MF chapter 8) (BLB Chapter 5)
  - 14 Finish thermochemistry, Thanksgiving break (MF chapter 8) (BLB Chapter 5)
  - 15 Gas laws (MF chapter 9) (BLB Chapter 10)
  - 16 More gas laws and review, **EXAM 4** (MF chapter 9) (BLB Chapter 10)

## **1. CHEM 131L General Chemistry I Laboratory**

2. 1 credit hour, 1 x 3 hour lab per week
3. Instructor: Tim D'Andrea
4. Textbook: There is no lab manual. Lab handouts will be distributed on the H drive. It is the student's responsibility to print the handouts weekly. You can find them under the following directory: H:\DOWNLOAD\ ChemLab\CHEM131-Lab
5. Course Catalog Description: Chemistry 131L is the laboratory that goes along with Chemistry 131.

Co-Prerequisites: Chem 131.

6. Course objectives. This course meets two of the general education objectives:  
Understand the structure and discipline of mathematical thought and its use in problem solving;  
Have knowledge of the natural world and an understanding of the scientific method.
7. Topics:  
Safety, Measurements and Significant Figures  
Density and Graphing Lab  
Nylon Synthesis  
Atomic Spectra  
Separations  
Oxides  
Molecular Geometry  
Limiting Reactant  
Formulas of Chemical Compounds  
Reactions Lab I  
Reactions Lab II  
Thermodynamics

## **1. CSCI 130 Introduction to Engineering Computing**

2. 3 credit hours, 3 x 50 minute lectures, 2 x 50 minute labs per week
3. Arun Ektare
4. TEXTS: "EXCEL for Engineers" by Moore, Holly 4th Ed, "MATLAB for Engineers" by Larsen 4th Ed
5. This is a course on importance of Computers in Engineering Problem Solving. We will study the tools for helping us to solve the problems. These tools include Microsoft EXCEL and Mathworks MATLAB. These tools will be introduced in the class and sample problems will be used as demo problems. It is necessary that all the students become reasonable familiar with the usage of these two software programs. We will try to learn these tools in sufficient details, but students will have to try out some of the details themselves. We will show how a given problem, related to different engineering disciplines, can be simulated and solved on the computers. Also you will have opportunity to see how some parameters can be changed to get variety of outcomes, suitable for particular situations. There is heavy emphasis on problem solving, therefore home-assignments are very important part of the course. These assignments must be done and turned in. In addition, we will have a special assignment as a final project.

Pre/Co-Requisite: MATH 135 Calculus I

This is a required course.

6. MATLAB INTERFACE, BUILT-IN MATLAB FUNCTIONS  
MATRIX MANIPULATION IN MATLAB  
PLOTTING IN MATLAB  
USER-DEFINED FUNCTIONS IN MATLAB  
USER INPUT/OUTPUT, LOGICAL FUNCTION & CONTROL STRUCTURES  
LINEAR EQUATIONS WITH MATRIX ALGEBRA  
HANDLING OF ARRAYS IN MATLAB  
NUMERICAL TECHNIQUES: DIFFERENTIATION & INTEGRATION  
ADVANCED MATLAB GRAPHICS  
EXCEL ENVIRONMENT  
GRAPHING WITH EXCEL, EXCEL FUNCTIONS  
MATRIX OPERATIONS IN EXCEL  
LINEAR REGRESSION IN EXCEL  
STATISTICS USING EXCEL, ITERATIVE SOLUTIONS  
EXCEL INTERFACE WITH OTHER PROGRAMS e.g. MS WORD  
PIVOT TABLES  
MACROS & USER-DEFINED FUNCTIONS  
NUMERICAL DIFFERENTIATION WITH EXCEL  
NUMERICAL INTEGRATION WITH EXCEL  
DIFFERENTIAL EQUATIONS WITH EXCEL

**1. MATH 135 Engr Calc**

2. 4 credit hours, 4 x 50 minutes lectures per week
3. Instructor: Phil Gustafson
4. Textbook: *Calculus*, First Edition, by Briggs and Cochran, Pearson Publishing, 2011.
5. Course Catalog Description: Math 151 is an introduction to higher mathematics. This first course in calculus includes the study of limits, differentiation and integration of algebraic, exponential, logarithmic, and trigonometric functions and their applications. A more detailed listing of daily topics is given later in this document.

Pre-requisite: A grade of C or better in MATH 119 (Pre-calculus) or appropriate Accuplacer score.

This is a required class.

6. Course objectives: In this course you will learn concepts of calculus and technical facility for each of the topics listed above. You will also develop some facility with calculators, as well as developing your problem solving skills and communication skills.

7. Topics Covered:

1 Review of Functions, Representing Functions, Trigonometric Functions

2 The Idea of Limits, Definition of Limits, Computing Limits, Infinite Limits, Limits at Infinity, Continuity; IVT, Limits: Precise Definitions

3 Intro to the Derivative, Differentiation Rules, Product & Quotient Rules, Trig Function Derivatives, Derivatives: Rates of Change, The Chain Rule, Implicit Differentiation, Related Rates

4 Maxima and Minima, First & Second Derivative Tests, Optimization Problems, Optimization Problems, Linear Approximation & Differentials, Mean Value Theorem, L'Hopital's Rule, Antiderivatives,

5 Area Under Curves, Definite Integrals, Fundamental Theorem of Calculus, Working with Integrals, Substitution Rule

6 Velocity and Net Change, Regions Between Curves, Volume by Slicing, Volume by Shells, Length of Curves, Physical Applications

7 Natural Log and Exp Functions, General Log and Exp Functions

**1. MATH 136 Engr Calc**

2. 4 credit hours, 4 x 50 minutes lectures per week
3. Instructor: Phil Gustafson
4. Textbook: *Calculus*, Sixth Edition, by James Stewart, Brooks/Cole Publishing, 2008.
5. Course Catalog Description: Math 152 is the second course in a sequence of three calculus courses. Topics covered include inverse functions, transcendental functions, techniques of integration, applications of the definite integral, solving elementary differential equations, infinite series, parametric equations and polar coordinates. We will cover material found in Stewart chapters 7-12 and some topics in chapter 13, time permitting.

Prerequisite: A grade of C or better in MATH 151 Calculus I.  
This is a required class.

6. Course objectives: In this course you will learn concepts of calculus and technical facility for each of the topics listed above. You will also develop some facility with calculators, as well as developing your problem solving skills and communication skills.
7. Topics Covered:
  - a. Inverse Functions: Exponential, Log, Trig Functions; L'Hospitals Rule — 3 weeks
  - b. Techniques of Integration — 3 weeks
  - c. Further Applications of Integration — 1 week
  - d. Infinite Sequences and Series — 4 weeks
  - e. Parametric Equations and Polar Coordinates — 2 weeks

**1. PHYS 131 Fundamental Mechanics**

2. 4 credit hours, 4 x 50 minute lectures per week
3. Instructor: Jared Workman
4. Textbook: Understanding Physics, Volume 1, Karen Cummings, et al.
5. Course Catalog Description: First of a foundation series of three physics courses for scientists and engineers. The Newtonian dynamics of matter is presented, along with the laws of momentum and energy conservation. Specific force laws are used to analyze problems drawn from engineering, biology, astronomy, and physics. Galilean relativity is discussed, and cultural as well as philosophical and practical aspects of physics are studied. The language of calculus and vector spaces is used throughout the course.

Prerequisite: MATH 151 (may be taken concurrently).  
This is a required class.

6. Course objectives. The general objective for each student in this course is to learn the fundamentals of Newtonian Mechanics, a working knowledge of differential and basic integral calculus is required but as it may be a co-requisite feel free to come to me for math assistance as well. Physics 131 focuses on fundamental Newtonian mechanics and an introduction to scaling and dimensional analysis. This course incorporates laboratory experience.
7. Topics Covered:
  - Scalings, Dimensional Analysis, & Unit Conversions
  - Vectors
  - Motion in 1, 2, & 3 Dimensions
  - Forces and Equilibria
  - Momentum, Impulse
  - Kinetic and Potential Energy
  - Rotational Motion
  - Equilibrium
  - Gravity

**1. PHYS 131L Fundamental Physics Laboratory**

2. 1 credit hour, 1 x 3 hour lab per week
3. Instructor: Chad Middleton
4. Textbook: Understanding Physics, Volume 1, Karen Cummings, et al.
5. Course Catalog Description: First of a foundation series of three physics courses for scientists and engineers. The Newtonian dynamics of matter is presented, along with the laws of momentum and energy conservation. Specific force laws are used to analyze problems drawn from engineering, biology, astronomy, and physics. Galilean relativity is discussed, and cultural as well as philosophical and practical aspects of physics are studied. The language of calculus and vector spaces is used throughout the course. Prerequisite: MATH 151 (may be taken concurrently). Four lectures and one two hour laboratory per week.

This is a required class.

6. Course objectives: Physics is an experimental science. The nature and validity of the theoretical framework is inferred by the outcomes of experiments, these experiments must be able to be performed repeatedly. PHYS 131L is the lab that accompanies PHYS 131. In this course, you will conduct experiments and make observations of various physical phenomena. The goal of this course is to help reinforce the theoretical framework developed in PHYS 131 by getting hands-on experience by doing experiments.

## **1. SOCI 120 Technology and Society**

2. 3 Credit hours and 45 contact hours
3. Dr. Tim Casey, Professor
4. Two textbooks are required: Nye, David (2007) *Technology Matters: Questions to live with*, (MIT Press). ISBN 978-0-262-64067-1 AND Teich, Albert (ed.) (2013) *Technology and the Future* (12th edition), (Wadsworth/Cengage) ISBN 978-1-111-82854-7
5. Specific Course Information:
  - a. Overview of technological innovations and human societies throughout modern history. Emphasizes impacts of technology within a social, political, economic, and environmental context.
  - b. No prerequisites or co-requisites.
  - c. Required elective course fulfills part of Humanities and Social Science lower division elective requirements.
6. Student learning outcomes
  - a. Students will:
    - i. Develop an understanding of the impact of technology in a global, economic, political and environmental context.
    - ii. Be introduced to the historical impact of technology on social and political systems.
    - iii. Recognize the professional and ethical responsibility of the designers of technology regarding their designs.
    - iv. Develop the ability to assess the intended and likely unintended consequences of technological design on the larger social, economic and environmental context.
    - v. Understand the relationship between technology and the desired needs of the larger society
    - vi. Develop an ability to communicate effectively the discourse of technology and science to a broader social setting that may not understand that discourse.
    - vii. Recognize the need for, and the ability to engage in life-long learning, and understand the role technology can play in that process.
    - viii. Recognize how diverse cultures can be affected differently by technology and how they differ in their approach to the development and application of technology.
  - b. This course addresses the following student outcomes of the ME program:
    - i. (h.) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

- ii. (i.) A recognition of the need for, and an ability to engage in life-long learning
- iii. (j.) A knowledge of contemporary issues

7. Topics to be covered include:

- a. Defining Technology
- b. History of Technology and Society
- c. Media, Communications and Education Technology
- d. Medical and Psychological Technology
- e. Geography, the Environment and Technology
- f. Technological Infrastructure
- g. Technology and the Economy
- h. Technology, Politics and Security

## Appendix B – Engineering Faculty Vitae

### **1. Name: Andrew J Affrunti**

#### **2. Education**

M.S.E.E., University of Illinois, Urbana, Spring 1965

B.S.E.E., University of Illinois, Urbana, Spring 1964

#### **3. Academic experience**

- a. University of Colorado ME Partnership Program, Grand Junction, CO Adjunct Instructor 2011 to present
- b. Colorado Mesa University MET Program Grand Junction, CO Adjunct Instructor 2011 to present
- c. Substitute Teacher District 51 CO K12 2009 to 2011
- d. Western Colorado Community College Grand Junction, Adjunct Instructor 2008 to 2009

#### **4. Non-academic experience**

- a. Analog Hardware Design Engineer Motorola, Inc., 1965 to 1980
- b. Technical Marketing Semiconductors Motorola Semiconductor 1980-2005
- c. National Ski Patrol Instructor Outdoor Emergency Care 1966 to present
- d. National Ski Patrol Instructor Trainer and Rocky Mountain Training Advisor 1995-1997

#### **5. Certifications or professional registrations– FCC License**

#### **6. Current membership in professional organizations - none**

#### **7. Honors and awards**

- a. Forty Years Service Award from Motorola
- b. Forty Years Service Award from National Ski Patrol
- c. Yellow Merit Star Emergency First Aid rendered from National Ski Patrol
- d. AT&T-Motorola first successful JIT program from Motorola
- e. Avaya-Motorola VoIP DSP Program
- f. JPL-Motorola Mariner 71 Flight Subsystem

#### **8. Service activities**

- a. None during retirement
- b. Prior, Aurora Community College Computer Advisory Board

#### **9. Publications and presentations from the past five years**

- a. None during retirement.
- b. Prior, Planning, Executing and Maintaining a JIT Program.
- c. Prior, Forced Ranking: A Counterproductive Approach to Performance Appraisal.
- d. Prior, AN/PRC-68 Marine Corps concealed antenna VHF Radio User's Manual, Theory of Operation and Alignment.
- e. Prior, Starlight 48 Channel UHF Point-to-Point Transceiver Noise Measurements, Group Delay Distortion and Alignment.

**10. Most recent professional development activities**

- a. Honing teaching skills in Western Colorado Community College, District 51 K12 and University of Colorado – Colorado Mesa University ME Partnership Program.
- b. Prior, Cisco Certified Network Associate.
- c. Prior, Six Sigma
- d. Prior, Program Management
- e. Prior, Target Account Selling
- f. Prior, Numerous courses from Motorola University, Northern Illinois University and Illinois Institute of Technology

**Name: Maximilian Anderson**

**1. Education:**

B.S., Mechanical Engineering, University of Colorado, Boulder

**2. Academic Experience:**

Colorado Mesa University, Part-Time Lecturer for ENGR 125 (Computer Aided Design/Fabrication), Fall 2014 to present

**3. Non-academic Experience:**

**Ford Motor Company, Dearborn, Michigan**

Manufacturing Intern - 3 months

- Increased efficiency of assembly and decreased scrap costs by analyzing and improving gauging process for a new transmission oil pump design.
- Designed and implemented a modified holding pallet for EMAG vertical lathes, decreasing machining faults and increasing production output.
- Drafted and implemented new documentation for scrap part tracking by working closely with floor operators, improving communication between engineering and production team.

**Engineers Without Borders, University of Colorado at Boulder**

R&D Consultant for the Structural Team of the Engineers Without Borders Rwanda Program - 4 months

- Designed portions of a new sustainable school building for the Rwanda Orphans Project in Kigali, Rwanda using Revit software.
- Successfully co-authored large building proposal documents according to Rwandan building codes.
- Utilized limited in-country resources in innovative ways while gaining structural design experience.

**SendGrid, Boulder, Colorado**

Technical Support Intern - 3 months

- Solved customers' technical issues regarding email deliverability via phone and instant messaging in a high pressure environment.
- Delegated pending support work amongst fellow team members, optimizing speed of feedback.

**4. Certifications or Professional Registrations:**

**5. Current membership in professional organizations:**

American Society of Mechanical Engineers (ASME)  
Engineers Without Borders (EWB).

**6. Honors and Awards:**

**7. Service activities (within and outside of the institution):**

**8. Publications and Presentations (from the past five years):**

**9. Most Recent Professional Development Activities:**

**1. Rebecca Atkins, Lecturer, Mechanical Engineering**

**2. Education:**

B.S., Engineering, Civil Specialty with minor in Environmental  
Colorado School of Mines, 1995

**3. Academic Experience:**

Colorado Mesa University, Part-Time Lecturer, 2015-16

**4. Non-academic Experience:**

- **Rolland Engineering**, Grand Junction, Colorado  
Project Manager, May 2002 to November 2004  
Manager and Project Engineer for various residential subdivisions, municipal projects, and commercial sites. Supervised the design of roadway, waterlines, sewer lines, storm drains, and irrigation. Prepared drainage reports, stormwater management plans, and applied for the associated permits. Provided proposal preparation, client representation, and coordination with review agencies. Represented clients in neighborhood and public meetings.
- **URBAN Engineering**, Annandale, Virginia  
Project Engineer, August 1998 to May 2002  
Project Engineer for large commercial and residential projects. Designed roadways, storm drains, water systems, and sewer lines. Prepared drainage reports and stormwater management plans.

**5. Certifications or Professional Registrations:**

Licensed Professional Engineer: Colorado #36840 (expired)

**6. Current membership in professional organizations:**

None

**7. Honors and Awards**

None

**8. Service activities (within and outside of the institution):**

None

**9. Publications and Presentations (from the past five years):**

None

**10. Most Recent Professional Development Activities:**

None

**1. Name: Scott L Bevill**

**2. Education**

- Ph.D. Mechanical Engineering, Stanford University – Stanford CA 2009
- M.S. Mechanical Engineering, Stanford University - Stanford, CA 2004
- B.S. Mechanical Engineering, University of Denver - Denver, CO 2003
- B.S. Computer Engineering, University of Denver - Denver, CO 2003

**3. Academic experience**

- a. Colorado Mesa University, Assistant Professor, 2010 – Present
- b. Post-Doctoral Research Fellow, University of Auckland, Auckland, New Zealand 2009 - 2010

**4. Non-academic experience – none**

**5. Certifications or professional registrations– none**

**6. Current membership in professional organizations**

- a. American Society of Mechanical Engineers
- b. Orthopaedic Research Society

**7. Honors and awards**

- a. Maurice and Phyllis Paykel Postdoctoral Research Fellow (2009-2010)
- b. Dept. of Veterans Affairs Pre-Doctoral Research Fellow (2007-2008)
- c. Colorado Engineering Council Outstanding Graduate (2003).

**8. Service activities**

- a. Judge for Student Paper Competition at ASME 2011 Summer Bioengineering Conference, Nemaquin Woodlands Resort, Famington, Pennsylvania, June 22-25, 2011.
- b. Search Committee: University of Colorado Instructor for Mechanical Engineering Partnership Program 2011
- c. Distinguished Faculty Award Committee - Vice Chair 2011

**9. Publications and presentations from the past five years**

Journal Articles

- a. Thambyah A., Zhao J.Y., Bevill S.L., Broom N.D., 2012, “Macro-, micro- and ultrastructural investigation of how degeneration influences the response of cartilage to loading”, *Journal of the Mechanical Behavior of Biomedical Materials* 5(1):206-15.
- b. Bevill, S.L., Thambyah, A., Broom, N.D., 2010, “New Insights Into the Role of the Superficial Tangential Zone in Influencing the Microstructural Response of Articular Cartilage to Compression,” *Osteoarthritis and Cartilage*, 18(10):1310-8.
- c. Bevill, S.L., Briant, P.L., Levenston, M.E., Andriacchi, T.P., 2009, “Central and Peripheral Region Tibial Plateau Chondrocytes Respond Differently to In Vitro Dynamic Compression,” *Osteoarthritis and Cartilage*, 17(8), pp. 980-7.
- d. Chaudhari, A. M. W., Briant, P.L., Bevill, S.L., Koo, S., Andriacchi, T.P., 2007, “Knee Kinematics, Cartilage Morphology, and Osteoarthritis Following ACL Injury,” *Med Sci Sports Exerc*, 40(2), pp. 215-222.

Conference Presentations

- e. Bevill, S.L., Thambyah, A., Broom, N.D., “Altered micromechanical function precedes overt surface roughening in early cartilage degeneration,” *Proceedings of the ASME 2011 Summer Bioengineering Conference, Nemaquin Woodlands Resort, Famington, Pennsylvania, June 22-25, 2011.*

- f. Bevill, S.L., Thambyah, A., Broom, N.D., "How Removal of the Superficial Zone Influences the Microstructural Response of Cartilage-on-Bone to Compression," 56<sup>th</sup> Annual Meeting of the Orthopaedic Research Society, New Orleans, LA, March 6-9, 2010.
- g. Bevill, S.L., Andriacchi, T.P., "Regional Variations in Cartilage Mechanics and Composition Suggest a Sensitivity to Changes in Chronic Joint Loading Patterns," Proceedings of the ASME 2009 Summer Bioengineering Conference, Lake Tahoe, CA, June 17-21, 2009.
- h. Bevill, S.L., Andriacchi, T.P., "Coactive Effects of Mechanical Stimulation and TNF $\alpha$  on Chondrocyte Gene Expression," 55<sup>th</sup> Annual Meeting of the Orthopaedic Research Society, Las Vegas, NV, February 22-25, 2009.
- i. Bevill, S.L., Andriacchi, T.P., "Dynamic Compression in the Presence of TNF $\alpha$  Differentially Affects Gene Expression in Tibial Plateau Cartilage Covered and Uncovered by the Meniscus," Proceedings of the ASME 2008 Summer Bioengineering Conference, Marco Island, FL, June 25-29, 2008.

**10. Most recent professional development activities**

- a. MATLAB webinar "Making Project-based Learning Easy and Affordable with MATLAB" January 20, 2012
- b. Dr. Jessica Herrick's Workshop on "Revitalizing General Education and Program Assessment" January 13-14, 2011
- c. ASME Summer Bioengineering Conference, multiple workshops including "Development Strategies for Postdocs and Early Investigators" June 22-25, 2011

**1. Name: Tim Brower**

**2. Education**

BS General Engineering, Idaho State University, 1981  
MS Mechanical Engineering, Montana State University, 1983  
PhD Civil Engineering, Colorado State University, 1997

**3. Academic experience**

- a. University of Colorado Boulder, Sr. Instructor, Director of ME Partnership Program, 2009 – Present, FT
- b. Oregon Institute of Technology, Professor, Department Chair for Mechanical & Manufacturing Engineering & Technology, 1998 – 2009, FT

**4. Non-academic experience**

- a. Lockheed Martin Corporation, Aerodynamic/Aerophysics Engineer, 1985-97, FT
- b. AVCO Systems Division, Mechanical Engineer, 1983-85, FT
- c. Bonneville Power Administration, Mechanical Engineer, 1981-83, FT

**5. Certifications or professional registrations– EIT**

**6. Current membership in professional organizations**

- a. American Society of Engineering Educators (ASEE), member
- b. American Institute of Aeronautics and Astronautics (AIAA), senior member
- c. American Society of Mechanical Engineers (ASME), member
- d. ABET Program Evaluator, representing ASME, 2004 – present
- e. Engineering Technology Accreditation Commission, Commissioner, 2014-present

**7. Honors and awards**

- a. ASEE Recognition of Service as Program Chair, 2008 Annual Conference, Engineering Technology Division.
- b. ASEE Recognition of Service as Program Chair, 2006 CIEC.
- c. ASME International, Student Section Advisor Award (1999).
- d. OIT Outstanding Club Advisor Award (1999/2000).
- e. OIT Faculty Achievement Award (**teacher of the year**), (2000).
- f. OIT Certificate of Recognition for summer activities (2000/01).
- g. OIT Student Affairs Most Valuable Partner Award (2001).
- h. ASEE Engineering Technology Division Best Presenter Award for CIEC Conference (2001).

**8. Service activities**

- a. Founding Director, Project Lead The Way for Oregon, 2004 – 2009
- b. Director, American Society of Engineering Education, Engineering Technology Council, 2008 – 2009
- c. Program Chair, 2008 ASEE Annual Conference in Pittsburg, PA.
- d. Associate Director, Oregon Space Grant, 2005 – 2007
- e. Program Chair, 2006 Conference for Industry and Education Collaboration, San Antonio, Texas.
- f. Assistant Vice-Chair for Programs for the 2007 ASEE Annual Conference in Honolulu, Hawaii.
- g. Mechanical Engineering Technology Department Heads Committee, Secretary (05-06), Vice Chair (06-07), Chair (07-08).

**9. Publications and presentations from the past five years**

- a. Brower, T., “Unique Collaboration between Engineering and Engineering Technology Programs,” AC 2014-9065, *Proceedings*, American Society of

- Engineering Education Annual Conference & Exposition, Indianapolis, Indiana, June 2014.
- b. Brower, T., "Innovative Partnership Collaborations in Engineering Education," ETD 425, *Proceedings*, 2007 ASEE Conference for Industry and Education Collaboration, Savanna, GA, February 2014.
  - c. Brower, T., "Using a Systems Engineering Approach for Students to Design & Build Laboratory Equipment," AC 2012-3136, *Proceedings*, American Society of Engineering Education Annual Conference & Exposition, San Antonio, Texas, June 2012.
  - d. Brower, T., "Going With the Flow in a Service Learning Project," AC 2011-751, *Proceedings*, American Society of Engineering Education Annual Conference & Exposition, Vancouver, B.C., June 2011.
  - e. Brower, T., "Systems Engineering in Undergraduate Education: An Activities, Project, Problem-Based Learning Approach," AC 2009-261, *Proceedings*, American Society of Engineering Education Annual Conference & Exposition, June 2009, Austin, TX, June, 2009.
  - f. Brower, T., "Linking High School Pre-Engineering with University E and ET Programs," *Proceedings*, ASEE Conference for Industry and Education Collaboration, Orlando, FL, Feb. 2009.
  - g. Brower, T., "Thinking Globally & Acting Locally in Oregon," *The Oregon Science Teacher*, Jan. 2008.
  - h. Brower, T. and Gummer, E. invited presentations: "Evaluation Model of PLTW" and "Teacher Professional Development Model," US Dept. of Ed. Mathematics and Science Regional Conference, San Francisco, CA, Feb. 14, 15, 2008.
  - i. Brower, T., Grimsley, R., and Newberry, P., "STEM is Not Just a Four Individually Lettered Word," AC 2007-884, ASEE Annual Conference & Exposition, Honolulu, Hawaii, June, 2007.
  - j. Fitzsimmons, V. and Brower, T., "An Evaluation Model for Senior Project Collaborations," Session ETD 426, 2007 ASEE Conference for Industry and Education Collaboration, Palm Springs, CA, Feb. 2007.
  - k. Brower, T., "STEM is Not a Four Individually Lettered Word," *The Oregon Science Teacher*, Sept. 2006.
  - l. Brower, T., "Can Engineering and Engineering Technology Programs Reside within the Same Academic Department?," 2006 ASEE Annual Conference & Exposition, Chicago, IL, June 2006.
  - m. Brower, T., "Titan Launch Vehicle: A Ground Test History," *AIAA Journal of Spacecraft and Rockets*, Vol. 43, No. 1, September, Jan.-Feb. 2006, pp 147-160.

#### **10. Most recent professional development activities**

Commissioner Training, ETAC, 2014

Principal Investigator –

"Research Experiences for Undergraduates" NSF program announcement 07-569 (\$12,800 for 1-year), 2009

Oregon Department of Education Math & Science Partnership (\$935K over 3-years)

Engineering & Technology Industry Council (\$373K over 2-years)

Intel (\$30K)

**1. Name: Francisco Castro**

**2. Education**

Ph. D., Mechanical Eng., University of Colorado-Boulder, December 2009

M. S., Mechanical Eng., University of Colorado-Denver, August 2003

B. S. E., Mechanical Eng., Catholic University of Peru, Lima, Peru, 1997

**3. Academic experience**

a. University of Colorado - Boulder, Instructor, 2010-present;

b. University of Colorado - Boulder, Teaching Assistant, 2005-2006

c. University of Colorado - Denver, Teaching Assistant, 2000

d. Catholic University of Peru, Lima, Peru, Teaching Assistant, 1996-2000

**4. Non-academic experience**

a. Assistant Maintenance Engineer, Americana de Aviacion, Lima, Peru, 1997

**5. Certifications or professional registrations– none**

**6. Current membership in professional organizations**

a. American Society for Engineering Education

b. American Society of Mechanical Engineers

c. American Society of Testing and Materials

**7. Honors and awards**

a. 2009 Mechanical Engineering Outstanding Ph.D. Dissertation

b. 2012 Seed Grant Award, Advanced Sensing of Air Pollution to Reduce Impacts of Oil and Gas Development

**8. Service activities**

a. Faculty Search Committee: 2011-Present

b. Industry Advisory Council Faculty Member: Senior Design Coordinator

c. Student Advisor for 40 students: 2010-Present

d. Program Website Administrator: 2011-Present

e. Faculty Host for Campus Visits from Middle and High School students, prospective students and industry representatives.

**9. Publications and presentations from the past five years**

a. K.K. Westbrook, P. H. Kao, F. Castro, Y. Ding, H.J. Qi, 2011. A 3D finite deformation constitutive model for amorphous shape memory polymers: A multi-branch modeling approach for nonequilibrium relaxation processes. *Mechanics of Materials*, 24: 853-869.

b. Castro, K.K. Westbrook, J. Hermiller, D.U. Ahn, Y. Ding, H.J. Qi, 2011. Time and temperature dependent recovery of epoxy-based shape memory polymers. *Journal of Engineering Materials and Technology*, v133: n 2, p 021025.

c. Castro, K.K. Westbrook, K.N. Long, R. Shandas, H.J. Qi, 2010. Effects of thermal rates on the thermomechanical behaviors of amorphous shape memory polymers. *Mechanics of Time-Dependent Materials*, 14: n 3, p 219-241.

d. K.K. Westbrook, F. Castro, K.N. Long, A.J. Slifka, H.J. Qi, 2010. Improved testing system for thermomechanical experiments on polymers using uniaxial compression equipment. *Polymer Testing*, 29: n 4, p 503-512.

e. Castro, K. Westbrook, J. Hermiller, D.U. Ahn, Y. Ding, H. J. Qi. Time dependent recovery of shape memory polymers. Conference Proceedings of the Society for Experimental Mechanics Series, v 3, p 307-312, 2011, Time Dependent Constitutive

Behavior and Fracture/Failure Processes - Proceedings of the 2010 Annual Conference on Experimental and Applied Mechanics, Indianapolis, IN.

**10. Most recent professional development activities**

- a. 2012 American Society of Engineering Association Conference, San Antonio, TX. Attendee, June 11-13, 2012.

2012 Online Seminars:

- b. Do Education: Teach Electronics and More with NI ELVIS and Circuit Design Suite, October 28<sup>th</sup>.
- c. Making Project-based Learning Easy and Affordable with MATLAB, January.

**1. Name: Scott Kessler**

**2. Education**

Ph.D., Mechanical & Aerospace Engineering, University of Missouri-Columbia, 2005.  
M.S., Mechanical & Aerospace Engineering, University of Missouri-Columbia, 2000.  
B.S., Mechanical & Aerospace Engineering, University of Missouri-Columbia/University of Missouri-Kansas City Coordinated Program, 1998.

**3. Academic experience**

- a. Assistant Professor, Colorado Mesa University, 2010 – present.
- b. GAAN Fellow, University of Missouri-Columbia, 2003-2005.
- c. Teaching Assistant, University of Missouri-Columbia, 2003.
- d. Research Assistant, University of Washington-Seattle, 2000-2002.

**4. Non-academic experience**

- a. Owner /President, Formed KESTEK, Inc. in 1991 providing high-quality testing services to industry. Specialization in root cause failure analysis and design for improvement. Extensive engineering/testing experience dealing with a variety of applications ranging from finite element analysis, metallurgical analysis, mechanical testing, to all types of nondestructive testing. Responsible for all company functions including, but not limited to: engineering design, training of outside personnel, and procurement of equipment, financial management, report writing, procedure development, and general engineering consulting.
- b. Lab Manager, Lab Engineer, and Laboratory Technician, Material Engineering Associates, 1982-1991.

**5. Certifications or professional registrations**

- a. Professional Engineer, PE-2003-14988
- b. ASNT NDT Level III, #66063, Penetrant Testing & Magnetic Particle Testing

**6. Current membership in professional organizations**

- a. American Society of Mechanical Engineers
- b. American Society of Engineering Educators
- c. ASM International

**7. Honors and awards - none**

**8. Service activities**

- a. Sponsor for the American Society of Mechanical Engineers club for CMU. Faculty sponsor for ten student showcase projects/presentations.
- b. Advisor for two sessions of Student Orientation Advising and Registration (SOAR).
- c. Faculty search committee for Forensic Anthropologist.
- d. Faculty search committee for CU-Boulder mechanical engineering position.

**9. Publications and presentations from the past five years**

- a. Kessler, B. Scott, El-Gizawy, Sherif, and Smith, Douglas E., “Incorporating Neural Network Material Models within Finite Element Analysis for Rheological Behavior Prediction,” Journal of Pressure Vessel Technology, Vol. 192, pp. 58-65.

**10. Most recent professional development activities**

- a. Maintained PE license.
- b. Renewed ASNT Level III Certification.
- c. Continued service to industry clients.

**1. Name: Jody K. Kliska      Title: Part-Time Lecturer (ENGR 125 and ENGR 140)**

**2. Education**

B.S.C.E., Northern Arizona University, December, 1986

B.S.J., Northern Arizona University, December, 1977

**3. Academic experience**

e. Colorado Mesa University, Adjunct Instructor, 2014 to present, PT

f. Ski Instructor, Powderhorn Resort 1995-2004 seasons

**4. Non-academic experience**

e. City Transportation Engineer, City of Grand Junction, CO, 1998-2013

f. City Development Engineer, City of Grand Junction, CO 1993-1998

g. District III Traffic Engineer, Arizona Department of Transportation, 1990-1993

h. Transportation Planning Engineer, Coconino National Forest, 1988-1990

i. Transportation Engineering Associate, Arizona Department of Transportation, 1979-1987

**5. Certifications or professional registrations**

a. Professional Engineer, Colorado #29379

b. Professional Engineer, Civil, Arizona #20922

c. PSIA Level II Ski Instructor Certification

**6. Current membership in professional organizations**

a. *American Society of Civil Engineers*

b. *Institute of Transportation Engineers*

c. *American Public Works Association*

**7. Honors and awards**

g. Community Bicycle Award, Grand Valley Road Cycling 2013

h. Golden Footprint Award, Colorado Walks 2007

i. Tonopah Award, AZ Section ASCE, for Engineers Week 1991

**8. Service activities**

c. President, Board of Directors, Interpretive Association of Western Colorado 2012-Present

d. Trails Summit committee, Healthy Mesa County, 2012 to present

e. Grand Junction Air Show Committee, Traffic Control & Parking, 2012 & 2008

f. Board member, Red Rock Riders (bicycle club) 2006-2007

g. ITE CO/WY Section Continuing Education Committee, 1998-99, 2011

h. President, Northern AZ Branch ASCE, 1989-1990

**9. Publications and presentations from the past five years**

a. Fort Uncompahgre Proposal, Delta, CO City Council, November, 2014

b. Urban Trails Master Plan Update to Planning Commission, August, 2013

c. Fruita Pedestrian & Bicycle Circulation Study, May, 2011

d. Employee Performance Appraisal, City Leadership Council, November, 2010

e. Managing the Systems of Traffic Control In Grand Junction, MSC, September, 2010

f. Street Capacities & Signal Progression, Planning Commission Workshop, July, 2009

g. Reclaiming a Downtown Gateway: Grand Junction's 7<sup>th</sup> Street Project ITE Western District Meeting July, 2009

h. US 50 Access Control Plan Presentation to Colorado Transportation Commission March, 2009

- i. Smart Growth, Transportation, Land Use – The Grand Junction Story, Colorado Dept. of Local Affairs Conference, April, 2008
- j. Building Multi-Disciplinary Partnerships – Downtown Grand Junction Case Study, Colorado Walks Conference September, 2007
- k. Integrating the three G’s – GPS, GIS, GBA, GBA Users Conference, October, 2006
- l. Seeing the Light: Getting the Most from Your Video Detection ITE Western District Meeting, July, 2005
- m. The Sock Puppet & Other Lessons Learned in Grand Junction, National Roundabout Conference, May, 2005
- n. Adding Fiber to Our System – Grand Junction’s Fiber Optic Interconnect System Presentation to Grand Valley MPO, January, 2005
- o. Solutions from Citizen Input PEDSAFE Case Study September, 2004
- p. Applying Grand Junction’s Transportation Engineering Standards in Assessing Site Development Impacts Training for local engineering consultants, staff, January, 2002
- q. Traffic Calming APWA Colorado Management Conference, June, 2001
- r. Foot & Pedal power: Building Urban Trails, APWA Colorado Chapter Road/Street Maintenance Conference, April, 2001
- s. The GIST of Using ArcView in Traffic Calming Efforts, Urban Transportation Monitor, Colorado Municipalities, February, 2000
- t. Grand Junction's Roundabout Public Education Journey, presented at Washington State Roundabout Conference & ITE Intermountain Conference, May, 2000

**10. Most recent professional development activities**

- a. Webinars, ITE and ASCE on various civil, transportation engineering topics
- b. Ethics training for Transportation Division personnel, 2013

**1. Name/Title: Sarah Lanci, Assistant Professor**

**2. Education:**

M.S. Metallurgical Engineering, Colorado School of Mines – Golden, CO 2007

B.S. Materials Science and Engineering, Michigan State University – East Lansing, MI 2005

**3. Academic Experience:**

Colorado Mesa University, Assistant Professor of Mechanical Engineering, 2015-present, full-time

Colorado Mesa University, Adjunct Instructor, 2014 – 2015, part-time

**4. Non-academic Experience:**

PCC Airfoils, LLC, process control engineer, 2011-2014, full-time

PCC Structurals, Inc, part/dimensional engineer, 2007-2011, full-time

**5. Certifications or Professional Registrations:**

None

**6. Current membership in professional organizations:**

None

**7. Honors and Awards**

None

**8. Service activities (within and outside of the institution):**

Volunteer ski patroller, National Ski Patrol, 2010-present

**9. Publications and Presentations (from the past five years):**

Presenter (proprietary topic), PCC Airfoils Technical Conference, June 2013 and June 2012

Poster (proprietary topic), PCC Structurals Technical Conference, Nov 2012

**10. Most Recent Professional Development Activities:**

None

**1. Name: Nathan McNeill**

**2. Education**

- a. Ph.D. in Engineering Education, PURDUE UNIVERSITY, West Lafayette, IN 2010.
- b. M.S. in Mechanical Engineering, THE GEORGIA INSTITUTE OF TECHNOLOGY, Atlanta, GA 2006.
- c. B.S. in Engineering, Concentration in Mechanical Engineering, WALLA WALLA UNIVERSITY, College Place, WA 1999.

**3. Academic experience**

- a. Fall 2009 Instructor – Classroom Acoustics in the Developing World (ME 497), PURDUE UNIVERSITY, West Lafayette, IN
- b. Fall 2008 Instructor – Thermodynamics I (ME 200), PURDUE UNIVERSITY, West Lafayette, IN

**4. Non-academic experience**

- a. Summer 2006 Mechanical Engineering Intern SCHLUMBERGER, Paris, France *A global oilfield services provider*. Developed thermal engineering design and testing guidelines for the cooling and lubrication of robotic oil well drilling tools. This work involved extensive use of published literature on gears and ball bearing units for theoretical modeling of heat generation within drilling tools.
- b. 1999 – 2005 Mechanical Design Engineer FORGE INDUSTRIAL ENGINEERING LTD., Abbotsford, BC, Canada *An engineering group offering turnkey solutions for the specialty concrete products industry*. Conducted economic feasibility studies, prepared project budgets, presented project proposals to clients, acquired building permits, developed factory layouts, designed custom concrete production equipment, prepared fabrication drawings, and managed equipment fabrication and on-site installations.
- c. Summer 1999 Mechanical Engineering Intern HARMS ENGINEERING, Pasco, WA, U.S.A. *Consulting company specializing in civil, structural, and forensic engineering*. Researched electrical and fire codes for forensic cases. Conducted structural and building envelope energy analyses.

**5. Certifications or professional registrations**

- a. 2007 Family Educational Rights and Privacy Act (FERPA) Certification
- b. 2007 Collaborative Institutional Review Board Training Initiative (CITI) Certification

**6. Current membership in professional organizations**

- a. American Society for Engineering Education (ASEE)
- b. American Society of Mechanical Engineers (ASME)
- c. Acoustical Society of America (ASA)
- d. American Society for Testing and Materials (ASTM)
- e. Engineers for a Sustainable World (ESW)

**7. Honors and awards**

- a. NSF Graduate Research Fellow, 2007 – 2010; Graduate Assistantship in Areas of National Needs (GAANN) Fellow, 2009 – 2010; Chemical Engineering Outstanding Teaching Assistant, Spring 2007

**8. Service activities - none**

**9. Publications and presentations from the past five years**

Journal articles:

- a. Cox, M. F., Cawthorne, J., McNeill, N. J., Cekic, O., Frye, M., & Stacer, M. (2011). Assessing the Pedagogical Impact of the VaNTH Engineering Research Center on Faculty and Postdoctoral Professionals. *International Journal for the Scholarship of Teaching and Learning*, 5(2), 1–19.
  - b. Cox, M. F., Hahn, J., McNeill, N., Cekic, O., Zhu, J., & London, J. (2011). Enhancing the Quality of Engineering Graduate Teaching Assistants through Multidimensional Feedback. *Advances in Engineering Education*, 2(3), 1–20.
- Conference papers:
- c. McNeill, N. J., & Cox, M. F. (2011). Global Engineering Programs: Identifying and Supporting a Diverse Array of Learning Outcomes. *American Society for Engineering Education Annual Conference*. Vancouver, BC.
  - d. Douglas, E. P., Koro-Ljungberg, M., Malcolm, Z., McNeill, N. J., Therriault, D. J., & Lee, C. S. (2011). Moving Beyond Formulas and Fixations: Exploring Approaches to Solving Open-Ended Engineering Problems. Presented at the American Society for Engineering Education Global Colloquium, Vancouver, BC.
  - e. Therriault, D. J., Lee, C. S., Douglas, E. P., Koro-Ljungberg, M., & McNeill, N. J. (2011). Open-Book Problem-Solving in Engineering: An Exploratory Study. Presented at the American Society for Engineering Education Global Colloquium, Vancouver, BC.
  - f. Koro-Ljungberg, M., Douglas, E. P., McNeill, N., Therriault, D. J., & Malcolm, Z. (2011). Layered data collection methods. Presented at the Seventh International Congress of Qualitative Inquiry, Urbana-Champaign, IL.
  - g. McNeill, N. J., Blevins, M., Drott, E., Kremer, A., Kusch, M., Pluhar, B., Ringer, A., et al. (2010). Classroom acoustics in the developing world: A student project to develop simple assessments and treatments. Presented at the Noise-Con, Baltimore, MD.
  - h. Wang, J. Q., Li, S. S., McNeill, N., & Jesiek, B. K. (2010). Growing Pains: Chinese Engineering Education During the Late Qing Dynasty. Presented at the American Society for Engineering Education Annual Conference, Louisville, KY.
  - i. Cox, M. F., & McNeill, N. (2010). Developing a Global Real-Time Assessment Tool for the Teaching Enhancement of Engineering Graduate Teaching Assistants. Presented at the American Society for Engineering Education Annual Conference, Louisville, KY.
  - j. McNeill, N. J., Hirleman, E. D., & Jesiek, B. K. (2009). Using an Engineering Virtual Organization to Support Global Service Learning: Case Study of a US-Rwanda Irrigation Project. Presented at the American Society for Engineering Education Global Colloquium, Budapest, Hungary.

#### **10. Most recent professional development activities**

- a. 2009 Delegate to the Student Platform for Engineering Education Development (SPEED)
- b. Global Student forum, Budapest, Hungary
- c. 2007 College Teaching Workshop Series (ten 2-hour modules)
- d. Purdue Center for Instructional Excellence

## Appendix C – Equipment

Major pieces of equipment used by the program in support of instruction follows:

Laboratory Equipment Item	Approximate date of purchase	Combined Amt
Flow Table	12/8/2009	\$10,100.00
NI components for Lab Panels	3/8/2010	\$37,921.81
PASCO for statics class		\$2,098.00
Lab Station Panels	5/18/2010	\$15,890.00
Formaspace Lab Tables	5/27/2010	\$9,990.80
Electronic Misc Equip	8/6/2010	\$30,441.56
Misc 1st year project tools	5/25/2010	\$4,843.06
3D Printer	6/14/2010	\$52,600.00
Computers for Lab Stations	6/30/2010	\$7,926.00
Material Testing System	11/17/2010	\$66,728.00
Armfield Heat Transfer Unit	1/19/2011	\$18,252.00
Misc Material Testing Equip	5/10/2011	\$59,618.00
Computer Cabinet for MTS	5/10/2011	\$487.82
PASCO Order for Dynamics	5/?/2011	\$2,666.00
Wind Tunnel	9/8/2011	\$69,388.00
Automation Equipment	5/29/2012	\$13,846.00
Misc Equipment, May 2013	5/6/2013	\$24,870.00
Fluid Power, June 2014	5/28/2014	\$21,756.00
MTS Upgrade	10/29/2014	\$7,572.00

This does not include approximately 60 computers located in the two dedicated computer labs and three common student lounge spaces.

## Appendix D – Institutional Summary

### 1. The Institution

- a. Name and address of the institution:

Colorado Mesa University  
College of Engineering and Applied Science  
422 UCB  
Boulder, Colorado 80309-0422

- b. Name and title of the chief executive officer of the institution:

Timothy Foster, President

- c. Name and title of the person submitting the self-study report:

Submitted by:

Tim Brower, Director of Engineering Programs  
2510 Foresight Circle  
Grand Junction, CO 81505  
(970) 248-1662  
[tbrower@coloradomesa.edu](mailto:tbrower@coloradomesa.edu)

Contact for ABET matters:

Tim Brower, Director of Engineering Programs  
2510 Foresight Circle  
Grand Junction, CO 81505  
(970) 248-1662  
[tbrower@coloradomesa.edu](mailto:tbrower@coloradomesa.edu)

- d. Organization by which the institution is now accredited and the dates of the initial and most recent accreditation evaluations:

Colorado Mesa University's general regional accreditation is from the Higher Learning Commission (HLC) of the North Central Association of Colleges and Schools (NCA). Accreditation at the baccalaureate level was granted in 1974 and reaffirmed in 1979, 1989, 1993, 2003, and 2013.

### 2. Type of Control

Colorado Mesa University of is a state-supported institution, governed by an elected Board of Trustees under the Colorado Commission on Higher Education.

### 3. Educational Unit

#### Campus Administration

The Department Chairs report to the Academic Vice President, who reports to the President. There are no Deans at CMU.

#### **4. Academic Support Units**

The Program is supported by Computer Science and Mathematics and Physical and Environmental Science Departments. The names and titles of the individuals responsible for these units are as follows:

1. Computer Science & Mathematics, Lori Payne, Department Chair
2. Physical & Environmental Sciences, Russ Walker, Department Chair

The courses provided by these academic support units are regularly reviewed by the engineering programs and at times meetings with key faculty provide an opportunity to relate best practices.

#### **5. Non-academic Support Units**

The engineering programs of CMU are served by several essential campus-wide support units:

1. Tomlinson Library, Sylvia Rael, Library Director
2. Information Technology Services, Jeremy Brown, Executive Director, Information & Communication Technology
3. Career Services, Amanda Nicksic, Coordinator of Career Services

#### **6. Credit Unit**

One semester credit represents one class hour or two laboratory hours per week. The Program offers fall and spring semester courses of 16 weeks each, a 10-week summer session is offered, and a two-week “J-Term” academic period between fall and spring semesters is available to students. The Program requires 126 semester hours to graduate.

#### **7. Tables - Complete the following tables for the program undergoing evaluation.**

**Table D-1. Program Enrollment and Degree Data**  
 Colorado Mesa University Mechanical Engineering Technology Program

	Academic Year		Enrollment Year**					Total Undergrad	Total Grad	Degrees Awarded			
			1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>			Associates	Bachelors	Masters	Doctorates
Current Year	2015-16	FT	8	19	8	40	n/a	74	n/a	2	6	n/a	n/a
		PT											
1	2014-15	FT	5	13	5	44	n/a	67	n/a	6	6	n/a	n/a
2	2013-14	FT	9	9	7	40	n/a	65	n/a	2	3	n/a	n/a
3	2012-13	FT	3	12	3	25	n/a	43	n/a	2	1	n/a	n/a
4	2011-12	FT	6	5	3	12	n/a	26	n/a	1	n/a	n/a	n/a

\*\* “Enrollment Year” is based on the number of credit hours completed. Totals include associate and bachelor degree seeking students. The engineering web page includes just BSMET student numbers.

- 30 Credit Hours = freshman/1<sup>st</sup>
- 31-59 Credit Hours = Sophomore/2<sup>nd</sup>
- 60-89 Credit Hours = Junior/3<sup>rd</sup>
- 90+ Credit Hours = Senior/4<sup>th</sup> (note, that students that take >4 years are classified as seniors)

**Table D-2. Personnel**

Year<sup>1</sup>: 2015-16

	HEAD COUNT		FTE <sup>2</sup>
	FT	PT	
Administrative <sup>3</sup>	0.25	0	0.25
Faculty (tenure-track)	3	3	4
Other Faculty (excluding student Assistants)	0	4	1
Student Teaching Assistants	0	0	0
Student Research Assistants	0	0	0
Technicians/Specialists	0.33	0	0.33
Office/Clerical Employees	0	0.25	0.25
Others <sup>4</sup>	4	0.5	4.5

Report data for the program being evaluated.

- <sup>1</sup> Data on this table should be for the fall term immediately preceding the visit. Updated tables for the fall term when the ABET team is visiting are to be prepared and presented to the team when they arrive.
- <sup>2</sup> For student teaching assistants, 1 FTE equals 20 hours per week of work (or service). For undergraduate and graduate students, 1 FTE equals 15 semester credit-hours (or 24 quarter credit-hours) per term of institutional course work, meaning all courses — science, humanities and social sciences, etc. For faculty members, 1 FTE equals what your institution defines as a full-time load.
- <sup>3</sup> Persons holding joint administrative/faculty positions or other combined assignments should be allocated to each category according to the fraction of the appointment assigned to that category.
- <sup>4</sup> UCB Instructors.

## Appendix E – Definition of Concept Inventories

Since its inception, the MET Program has made use of Concept Inventories (CIs), which are nationally administered tests of conceptual understanding, given at the beginning and end of the semester in key disciplinary courses. The development of CIs came out of the Physics Education Research (PER) community during the late 1980's. It was recognized that some students were leaving Newtonian physics with the ability to solve quantitative exercises, while being unable to answer a qualitative question on the same topic. This suggested that students were learning algorithmic problem solution methods while failing to grasp the fundamental concepts underlying the mathematics.

As a result, the Force Concept Inventory (FCI) was developed by Hestenes, Wells and Halloun.<sup>1,2</sup> This multiple-choice exam was designed to assess student understanding of fundamental Newtonian physics, and identify student misconceptions. The results showed that many students who performed well on homework and exams were unable to transfer that knowledge to solve problems different than those shown in class, yet founded upon the same topic area. Subsequent research has revealed that gains in student understanding of fundamental Newtonian physics could be achieved by employing alternative teaching techniques in the collegiate physics classroom. The FCI has become highly regarded in the physics education community, and is currently being utilized in high-school and collegiate physics classrooms across the country.

Inspired by the physics Force Concept Inventory, the Foundation Coalition — a partnership of six universities funded by the National Science Foundation — collaborated to develop Concept Inventories for specific engineering disciplines.<sup>3</sup> This collection of exams includes CIs in Strength of Materials, Dynamics, Circuits, Fluid Mechanics, Heat Transfer, Thermodynamic and Materials. The primary objective of the Foundation Coalition CIs is to assess student knowledge of fundamental concepts in engineering, and to promote evaluation of teaching methods. The range of concepts tested in a given exam has variable overlap with our course learning objectives. However, the exams have proven to be useful to faculty, while accounting for their limitations.

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<sup>1</sup> David Hestenes, Malcolm Wells, & Gregg Swackhamer (1992). Force Concept Inventory. *The Physics Teacher*, **30** (3), 141-151.

<sup>2</sup> David Hestenes & Ibrahim Halloun (1995). Interpreting the Force Concept Inventory. *The Physics Teacher*, **33** (8).

<sup>3</sup> Concept Inventories. Foundation Coalition. Accessed April 4, 2005.  
<<http://www.foundationcoalition.org/home/keycomponents/concept/index.html>>.

## Appendix F – Refinement of Student Outcomes and Program Criteria

The Student Outcomes (SOs) are refined into specific Learning Objectives (a-1, a-2, b-1, etc.) that are derived from each Student Outcome and are listed below. *Learning Objectives* are the elements of competency that the students will demonstrate by their graduation from the MET Program. *Performance Criteria* (a-1-a, a-1-b, b-1-a, etc.) are measurable statements and indicate the specific characteristics students should exhibit in order to demonstrate the desired attainment of the Student Outcome. Performance Criteria language is included in the rubrics used to assess student work.

### **SO a: An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities**

- a-1. Proficiently use LABVIEW to solve engineering problems
  - a-1-a. Basic commands are demonstrated
  - a-1-b. Virtual instruments are appropriately created
  - a-1-c. Program control elements (structure) are adequately built and used
  - a-1-d. Data acquisition techniques are demonstrated
- a-2. Proficiently use Solid Modeling to solve engineering problems
  - a-2-a. Solid models are created for components using appropriate modeling techniques
  - a-2-b. Parts drawings for machined components are fully dimensioned with appropriate tolerances and fabrication notes where appropriate
  - a-2-c. Solid model assembly files are complete; component mates provide appropriate degrees of freedom and accurately represent component interactions; exploded view(s) are utilized to clarify component positions
  - a-2-d. Appropriate clearances, interfaces, and tolerances used in solid modeling
  - a-2-e. Complete Bill of Materials accompanies solid model assembly file (including vendor/catalog #'s where appropriate; appropriate part naming; part quantities are listed)

### **SO b: An ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies**

- b-1. Apply knowledge of mathematics to the level required for fluency in the techniques of analysis and synthesis that are relevant to the broad field of engineering
  - b-1-a. Knowledge of mathematics is demonstrated & appropriate concepts are used to solve problems
- b-2. Apply knowledge of the physical sciences, life sciences, and information sciences to the broad field of engineering
  - b-2-a. Knowledge of scientific principles that underpin the broad field of engineering is demonstrated & appropriate principles are used to solve problems

- b-3. Apply knowledge of engineering & technology to real problems
  - b-3-a. Knowledge of engineering & technology principles is demonstrated & appropriate principles are used to solve problems

**SO c: An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes**

- c-1. Follow the design of experiment plan
- c-2. Acquire data on appropriate experimental variables
- c-3. Compare experimental data and results to appropriate theoretical models

**SO d: An ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives**

- d-1. Use engineering skills to design systems, components, or processes
  - d-1-a. Specifications and functions are clearly defined by the problem statement
  - d-1-b. Use of engineering judgment in the design process is demonstrated
  - d-1-c. Realization of the design that meets all specifications and functions

**SO e: An ability to function effectively as a member or leader on a technical team**

- e-1. Use professional skills to effectively function as a member of a technical team

**SO f: An ability to identify, analyze, and solve broadly-defined engineering technology problems**

- f-1. Identify engineering problems
- f-2. Formulate engineering problems
- f-3. Solve engineering problems

**SO g: An ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature**

- g-1. Use written communication tools (assessed in ENGR 446)
  - g-1-a. Written communication tools are effectively used
  - g-1-b. Figures and tables are effectively used
  - g-1-c. Appropriate technical literature is identified and incorporated
- g-2. Use oral communication techniques (assessed in ENGR 485)
  - g-2-a. Oral/Visual Communication Tools are effectively used
- g-3. Use graphical communication tools (assessed in ENGR 485)
  - g-3-a. Neatness is demonstrated
  - g-3-b. Appropriate content is shown

**SO h: An understanding of the need for and an ability to engage in self-directed continuing professional development**

- h-1. Demonstrate knowledge of professional development in an engineering discipline
  - h-1-a. Ability to plan, organize and assess learning through achieving project goals is demonstrated
  - h-1-b. The organization of required resources and information is demonstrated
  - h-1-c. The integration of knowledge from areas outside of the required curriculum is demonstrated

**SO i: An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity**

- i-1. Demonstrate knowledge of professional engineering code of ethics
  - i-1-a. Relevant professional code(s) of ethics is(are) understood
- i-2. Evaluate the ethical dimensions of an engineering problem in the discipline
  - i-2-b. The ethical dilemma is identified, courses of action are presented, and reasoned arguments for choices are provided.

**SO j: A knowledge of the impact of engineering technology solutions in a societal and global context**

- j-1. Describe and analyze the impact of engineering technology solutions
  - j-1-a. Social impacts of a particular technological solution to an engineering problem are demonstrated
  - j-1-b. Environmental impacts of a particular technological solution to an engineering problem are demonstrated
  - j-1-c. Global impacts of a particular technological solution to an engineering problem are demonstrated
  - j-1-d. The unintended impacts of a particular technological solution to an engineering problem are demonstrated

**SO k: A commitment to quality, timeliness, and continuous improvement**

- k-1. Show proficiency in following guidelines, meeting deadlines, and improving assigned tasks
  - k-1-a. Quality engineering work is demonstrated
  - k-1-b. A commitment to timeliness is demonstrated
  - k-1-c. A commitment to continuous improvement is demonstrated

**Program Criteria:** Along with the SOs given above, specific skills uniquely related to mechanical engineering technology have been developed to satisfy the MET Program Criteria. Hence, the Mechanical Engineering Technology Program requires that its graduates demonstrate knowledge and competency in:

**PC-a: Geometric dimensioning and tolerancing and computer aided drafting and design**

- PC-a-1. Ability to interpret GD&T correctly
  - PC-a-1-a. An ability to interpret GD&T correctly by comparing GD&T and coordinate tolerancing systems is demonstrated
  - PC-a-1-b. An awareness of ASME Y14.5 and/or ISO 1101 is demonstrated
- PC-a-2. Ability to apply GD&T in computer aided drafting and design
  - PC-a-2-a. A basic knowledge and use of CAD software is demonstrated
  - PC-a-2-b. An ability to apply GD&T in CAD and design is demonstrated

**PC-b: The selection, set-up and calibration of instrumentation and sensors used in mechanical design and equipment operation**

- PC-b-1. Proficiently select, set up and utilize a power supply, oscilloscope, multi-meter, universal counter, function/waveform generator
  - PC-b-1-a. Use of a power supply is demonstrated
  - PC-b-1-b. Use of an oscilloscope is demonstrated
  - PC-b-1-c. Use of a multi-meter is demonstrated
  - PC-b-1-d. Use of a universal counter is demonstrated
  - PC-b-1-e. Use of a function/waveform generator is demonstrated
- PC-b-2. Proficiently select, set up, calibrate and utilize sensors used in mechanical design and equipment operation
  - PC-b-2-a. Use of a proximity sensor is demonstrated
  - PC-b-2-b. Use of a temperature transducer is demonstrated
  - PC-b-2-c. Use of a signal conditioner is demonstrated

**PC-c: Industry codes, specs and standards**

- PC-c-1. Application of industry codes, specs and standards that are relevant to the broad field of engineering
  - PC-c-1-a. Applicable standard, code, and/or specification to a relevant engineering design problem is chosen
  - PC-c-1-b. Application of the applicable standard, code, and/or specification to a relevant engineering design problem is demonstrated
  - PC-c-1-c. Applicable standard, code, and/or specification to a relevant engineering design problem is interpreted
  - PC-c-1-d. Results of the use of the applicable standard, code, and/or specification to a relevant engineering design problem is presented

**PC-d: Manufacturing processes**

- PC-d-1. Apply knowledge of the equations used in manufacturing economics
  - PC-d-1-a. Knowledge of the equations used in manufacturing economics is demonstrated
- PC-d-2. Apply knowledge of manufacturing techniques
  - PC-d-2-a. Knowledge of manufacturing techniques is demonstrated
- PC-d-3. Apply hands-on skills to manufacturing processes
  - PC-d-3-a. Hands-on skills in manufacturing is demonstrated

**PC-e: Material science and selection**

- PC-e-1. Apply knowledge and problem solving ability to the selection of material in engineering design
  - PC-e-1-a. Application of knowledge and problem solving ability to the selection of materials in engineering design is demonstrated

**PC-f: Solid mechanics**

- PC-f-1. Apply problem solving skills and principles to a broad range of engineering design problems
  - PC-f-1-a. Free-Body Diagrams are drawn and labeled correctly
  - PC-f-1-b. Member Stresses and critical stress location are correctly identified and quantified
  - PC-f-1-c. Member deformation (strain, elongation, & angle of twist) are identified
  - PC-f-1-d. Components for prescribed loading or deformation conditions are specified

**PC-g: Thermal sciences (includes thermo and fluids)**

- PC-g-1. Apply problem solving skills and principles to thermodynamic engineering design problems
  - PC-g-1-a. The system, its boundary, and processes are correctly identified
  - PC-g-1-b. State of the substance is determined and its thermodynamic properties are correctly evaluated
  - PC-g-1-c. Equations for the first and second law (if applicable) are correctly applied and simplified
  - PC-g-1-d. Heat/work transfer and/or system efficiency (if applicable) are determined
- PC-g-2. Apply problem solving skills and principles to fluid mechanics engineering design problems
  - PC-g-2-a. System components and their characteristics are identified and fluid properties are determined
  - PC-g-2-b. Proper form of the energy equation is written between different points in the piping system
  - PC-g-2-c. Both major and minor losses are correctly calculated, using appropriate assumptions

PC-g-2-d. Power requirements for the pump are determined and an appropriate pump is selected

**PC-h: Electrical circuits and controls**

PC-h-1. An ability to problem solve and create solutions to electrical circuit problems

PC-h-1-a. Diagnosis and repair of an electrical circuit problem are demonstrated

PC-h-1-b. A solution to an electrical circuit problem is demonstrated

PC-h-2. An ability to problem solve and create solutions to control system problems

PC-h-2-a. Diagnosis and repair of a control system problem are demonstrated

PC-h-2-b. A solution to a control system problem is designed

## Signature Attesting to Compliance

By signing below, I attest to the following:

That Mechanical Engineering Technology Program at Colorado Mesa University has conducted an honest assessment of compliance and has provided a complete and accurate disclosure of timely information regarding compliance with ABET's *Criteria for Accrediting Engineering Technology Programs* to include the General Criteria and any applicable Program Criteria, and the ABET *Accreditation Policy and Procedure Manual*.

Carol Futhey, Provost and Vice President for Academic Affairs  
Dean's Name (As indicated on the RFE)

  
Signature

  
Date