CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

The student outcomes are identical to the listed (a) through (k) outcomes in Criterion 3. Table 5.a.2 shows the mapping of the program courses to the student outcomes.

Graduates of the PCE program must have:

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

B. Relationship of Student Outcomes to Program Educational Objectives

Student outcomes support the Program Educational Objectives as shown in Table 3.B.1. The objectives are made up of two general categories – career success and success in continued studies.

The career success requires all student outcomes as they require technical, business, communication, professionalism, and individual outcome categories. The success in continued studies focuses on technical, communication, and individual outcome categories.
<table>
<thead>
<tr>
<th>Objective and Evidence</th>
<th>Student Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Success in their chosen profession as evidenced by:</strong></td>
<td></td>
</tr>
<tr>
<td>career satisfaction</td>
<td>a, b, c, d, e, f, g, h, i, j, k</td>
</tr>
<tr>
<td>career advancement</td>
<td>a, b, c, d, e, f, g, h, i, j, k</td>
</tr>
<tr>
<td>life-long learning</td>
<td>e, h, i, j, k</td>
</tr>
<tr>
<td>professional visibility</td>
<td>b, c, g, h, i, j</td>
</tr>
<tr>
<td>entrepreneurial activities</td>
<td>d, f, g, h, i</td>
</tr>
<tr>
<td><strong>success in continued studies as evidenced by:</strong></td>
<td></td>
</tr>
<tr>
<td>satisfaction with the decision to further their education</td>
<td>a, b, c, e, g, i</td>
</tr>
<tr>
<td>graduate and professional degrees earned, and/or</td>
<td>a, b, c, e, g, i</td>
</tr>
<tr>
<td>academic credits earned.</td>
<td>i</td>
</tr>
</tbody>
</table>

Table 3.B.1 Outcomes Support of PEOs
CRITERION 4. CONTINUOUS IMPROVEMENT

The continuous improvement process used to regularly assess student outcomes is shown in Figure 4.1. The numbers on Figure 4.1 correspond to the numbered paragraphs that follow. The inputs to the process (top of figure) are the published student learning outcomes, program education objectives and course specifications (defining the course content and course learning outcomes). A mapping matrix relates the program level student outcomes to each of the courses (see Table 5.a.2). This matrix also stipulates which courses are used for assessing attainment of student outcomes at the Introductory, Reinforcement and Mastery (IRM) levels. This matrix is presented and discussed under Criterion 5.

1. **Course Level Evaluation:** Instructors are responsible for ensuring that course outcomes, as defined in the course specifications, are being met. They are able to improve the course as they see fit in a manner that is consistent with the published course specification using their own observations, student evaluations and program feedback. All courses have a lead faculty assigned (or group of faculty) who has responsibility for coordination. The lead faculty is indicated on the course syllabi sheets in Appendix A.

For courses used to assess the student outcomes defined by the program, the instructor works with the program director to identify suitable assessment methods for collecting the required data. These methods target the performance indicators used in rubrics developed for each outcome (see Appendix E.1). The instructor collects the data using these agreed upon methods and passes this on to the program director for evaluation.

Instructors provide informal course updates to the program faculty at end-of-term meetings (ongoing). Changes to courses taken only by majors of the PCE program may be approved at this time. Changes for courses that are required by other programs are passed forward to the ENGD Curriculum Committee for further deliberation.

In addition to the informal course updates, each course is on a three year formal review cycle (see Table 4.1). The instructor at the time of the review must give a presentation to the ENGD Curriculum Committee, or Program depending on the student make-up of the course, describing how the course is meeting the published outcomes and providing recommendations for improvement.

The extent to which the outcomes are being obtained can be seen in Appendix E.3.

**Documentation:**
- Course specification sheets/Syllabi
- Outcome Rubrics
- Outcome Assessment Worksheets (Sample)
- Program Outcome Assessment
- Course Outcomes 3-Year Reviews (Sample)

Appendix A
Appendix E.1
Appendix E.2
Appendix E.3
Appendix E.4

2. **Program Level Evaluation:** Assessment data is evaluated by the program on a 3 year cycle for each course in the program used to measure attainment of student outcomes. If targets set by the program are not achieved, course modifications are proposed to address the deficiency.
These are overseen by the lead faculty assigned to the course in question. Evaluation data and recommended changes to courses that are also required by non-PCE majors are passed on for consideration to the ENGD Curriculum Committee (Department Level Evaluation) before final approval. As mentioned previously, instructors give informal updates of the student learning in the courses they teach at the end-of-term program meetings. This provides a mechanism to address a problem that might arise within the formal, 3 year cycle. This is particularly useful in guiding the development of new courses where the content and outcomes are evolving.

The program is also responsible for defining and modifying, as needed, the student outcomes, program educational objectives, mappings and assessment methods and targets.

### Documentation:

- Course to Outcome Mapping: Table 5.a.2
- Outcome Rubrics: Appendix E.1
- Outcome Assessment Worksheets (Sample): Appendix E.2

3. **IAC Review:** The program uses its Industrial Advisory Committee to provide feedback on all major curriculum changes. In cases where assessment driven changes require significant modifications to a course’s content and outcomes, the guidance of the IAC is sought to maximize harmonization with regional industrial practice. The IAC also provides guidance on the introduction of new material to the curriculum and in helping the program set its educational objectives. The IAC meets once per year in the spring.

### Documentation:

- IAC Meeting Minutes (Sample): Appendix. E.5

4. **Department Level Review:** The ENGD Curriculum Committee is responsible for curriculum oversight at the department level. Evaluation of assessment data for all courses with the ENGR designation (mostly pre-major classes) is the responsibility of this committee with input from the programs. Evaluation results and recommended changes for PCE courses, particularly those that are required by other programs, are also reviewed by this committee. This is done on a 3 year cycle, though the program is free to bring forward an issue that arises from evaluation at any time for consideration. Any curriculum changes that result in modifications to the published program and course descriptions in the WWU annual catalogue must be reviewed and approved by the curriculum committee. Examples of these include changes to course prerequisites, credit hours, descriptions and course requirements for the major. Web forms have been developed by the university for this purpose.

### Documentation:

- Course Outcomes 3-Year Reviews (Sample): Appendix E.4
- WWU Program and Course Change Forms (Sample): Appendix E.6
Figure 4.1 Continuous Improvement Process
5. Institutional Review: This occurs at two levels. The first is by the curriculum committee of the College of Science and Engineering. All program and course changes that impact information published in the university catalog must be reviewed and approved by this committee. A similar review is conducted at the university level by the Academic Coordinating Committee (ACC). As a case in point, the transition to engineering required forms to be submitted by the department, and approval at both levels for the creation of the new programs and for each new course required by the programs.

Documentation:
- WWU Program and Course Change Forms (Sample)  
  Appendix E.6

A. Student Outcomes
1. Documentation and Maintenance of Results
   The following mechanisms are used for documenting and maintaining the results of the outcomes assessment and evaluation process:
   a) Outcomes Assessment Worksheets (Appendix E.2)
      These are the primary mechanisms used for recording the results from assessment and evaluation. An Excel workbook is maintained for each outcome. Within each workbook a worksheet is created for every course identified in the mapping for collecting data at each of the IRM levels. Worksheets are designed around the rubrics and performance indicators that have been developed. These are distributed by the program at the start of the term to each of the instructors teaching a course for which assessment is being conducted. Instructors are required to document the assessment process used and to indicate the number of students attaining each level of achievement.
   b) Program Outcomes Assessment Results (Appendix E.3)
      A listing and description of the assessment processes used to gather the data upon which the evaluation of each student outcome is based.
   c) Course Outcomes 3-Year Reviews (Appendix E.4)
      These record attainment of course level outcomes and are performed by the instructor every three years. The instructor is required to report to the ENGD curriculum committee or program on the following questions:
      - Is the course meeting its learning objectives, and what is the evidence?
      - If learning objectives are not being met, what changes are recommended to improve student learning?
      - Are there other changes that are recommended be made to the course and/or its learning outcomes, and if so, why?
   d) Closing the Loop Documentation (Appendix E.4)
      These forms are the result of the review of each course as a whole, including the student learning outcomes. This is the documentation that describes the changes to be made for the course in the future. If the recommended changes are significant enough (i.e. large changes to content/delivery/etc.) then this form would be the starting point for more curricular discussions at the IAC level.

2. Description of Assessment Processes
   For each course review the PowerPoint template in Appendix E.4 is used to determine
where deficiencies in both the student learning outcomes and the course as a whole are present. The professor in charge of the course (typically the one who taught it last) leads the discussion. At the conclusion of that discussion the changes to the course are documented using a “Closing the Loop” form (Appendix E.4).

3. **Frequency of Assessment Processes**

   Formal assessment of student learning outcomes (a-k) and course outcomes occurs on a three year cycle. Table 4.1 documents the current schedule. However, for the initial ABET review, and to establish a baseline for comparison, assessment of all courses used to evaluate achievement of the a-k outcomes, have been conducted during the 2015-16 academic year.
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>3 Year Assessment Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Courses required for MFGE and PCE Majors</strong></td>
<td></td>
</tr>
<tr>
<td>ENGR 104</td>
<td>Introduction to Engineering and Design</td>
<td>X</td>
</tr>
<tr>
<td>MFGE 261</td>
<td>Introduction to Computer-Aided Design</td>
<td>X</td>
</tr>
<tr>
<td>ENGR 170</td>
<td>Introduction to Materials Science and Engineering</td>
<td>X</td>
</tr>
<tr>
<td>ENGR 214</td>
<td>Statics</td>
<td>X</td>
</tr>
<tr>
<td>ENGR 225</td>
<td>Mechanics of Materials</td>
<td>X</td>
</tr>
<tr>
<td>MFGE 231</td>
<td>Introduction to Manufacturing Processes</td>
<td>X</td>
</tr>
<tr>
<td>MFGE 332</td>
<td>Introduction to CAM and CNC</td>
<td>X</td>
</tr>
<tr>
<td>MFGE 362</td>
<td>CAD Modeling and Analysis Using Surfaces</td>
<td>X</td>
</tr>
<tr>
<td>PCE 371</td>
<td>Introduction to Plastics Materials and Processes</td>
<td>X</td>
</tr>
<tr>
<td>PCE 372</td>
<td>Introduction to Composites Materials and Processes</td>
<td>X</td>
</tr>
<tr>
<td>MFGE 341</td>
<td>Quality Assurance</td>
<td>X</td>
</tr>
<tr>
<td>MFGE 342</td>
<td>Data Analysis and Design of Experiments</td>
<td>X</td>
</tr>
<tr>
<td>EE 351</td>
<td>Electronics for Engineering</td>
<td>X</td>
</tr>
<tr>
<td>EE 352</td>
<td>Introduction to Automation and Controls</td>
<td>X</td>
</tr>
<tr>
<td>MFGE/PCE 491</td>
<td>Project Research, Planning and Ethics</td>
<td>X</td>
</tr>
<tr>
<td>PCE 331</td>
<td>Injection Molding</td>
<td>X</td>
</tr>
<tr>
<td>PCE 431</td>
<td>Advanced Materials and Processing</td>
<td>X</td>
</tr>
<tr>
<td>PCE 461</td>
<td>Tooling for Plastics Processes</td>
<td>X</td>
</tr>
<tr>
<td>PCE 471</td>
<td>Advanced Materials &amp; Characterization</td>
<td>X</td>
</tr>
<tr>
<td>PCE 472</td>
<td>Advanced Composites</td>
<td>X</td>
</tr>
<tr>
<td>PCE 492</td>
<td>Plastics Project Definition</td>
<td>X</td>
</tr>
<tr>
<td>PCE 493</td>
<td>Plastics Project Implementation</td>
<td>X</td>
</tr>
<tr>
<td>CHEM 308</td>
<td>Polymer Chemistry</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 4.1 PCE Major Course Review Schedule

4. Summaries of Evaluation and Analysis of Attainment of Outcomes

The following are brief written summaries of the tabulated information in Table 5.a.2 and Appendix E, for each a-k outcome.

a. **an ability to apply knowledge of mathematics, science, and engineering to solving problems**
   - Goal: 80% of the students in the class achieve satisfactory or exceeding on three of the five performance indicators
   - Mastery data collected in PCE 472.
   - Met: Data shows that students met three of five performance indicators at a level of 80% or higher satisfying or exceeding the set goal. (see appendix E3)

b. **an ability to design and conduct experiments and to analyze and interpret data**
   - Goal: 80% of the students in the class achieve satisfactory or exceeding on three of the four performance indicators.
   - Mastery data collected in PCE 431.
   - Met: Data shows 100% students met this goal on all four
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
   • Goal: 80% of the students in the class achieve satisfactory or exceeding on three of the five performance indicators.
   • Mastery data collected in PCE 492.
   • Met: Data shows 80% or more of students achieved a level of satisfactory or exceeding the target in three of five performance indicators (see appendix E3)

d. an ability to function on multidisciplinary teams
   • Goal: 80% of the students in the class achieve satisfactory or exceeding on three of the four performance indicators.
   • Mastery data collected in PCE 461.
   • Met: Data shows 100% students met this target on four performance indicators (see appendix E3)

e. an ability to identify, formulate, and solve engineering problems
   • Goal: 80% of the students in the class achieve satisfactory or exceeding on three of the four performance indicators.
   • Mastery data collected in PCE 493.
   • Met: Data shows 80% or more of students achieved a level of satisfactory or exceeding the target in all four performance indicators (see appendix E3)

f. an understanding of professional and ethical responsibilities
   • Goal: 80% of the students in the class achieve satisfactory or exceeding on each of the two performance indicators.
   • Mastery data collected in PCE 491.
   • Not Met: Data shows that 73% of students successfully achieved a level of satisfactory or exceeding the target on performance indicator one, and 100% of the students achieved satisfactory of exceeding the target on performance indicator two. The materials for this course were reviewed as part of the 3 year review cycle (see example later in this section).

g. an ability to communicate effectively
   • Goal: 80% of the students in the class achieve satisfactory or exceeding on three of the four performance indicators.
   • Mastery data to be collected in PCE 493.
   • Met: Data shows 80% or more of students achieved a level of satisfactory or exceeding the target in all three performance indicators (see appendix E3)
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
   • Goal: 80% of the students in the class achieve satisfactory or exceeding on two of the three performance indicators.
   • Mastery data collected in PCE 491.
   • Met: Data shows that students achieved a level of satisfactory or exceeding the target in two of three performance indicators. Although the target was met, the rubric was still reviewed as part of the 3 year review cycle. (see example later in this section)

i. a recognition of the need for, and an ability to engage in life-long learning
   • Goal: 80% of the students in the class achieve satisfactory or exceeding on two of the three performance indicators.
   • Mastery data collected in PCE 492.
   • Met: Data shows that more than 80% students achieved a level of satisfactory or exceeding the target in two of three performance indicators. (see appendix E3)

j. a knowledge of contemporary issues
   • Goal: 80% of the students in the class achieve satisfactory or exceeding on three of the four performance indicators.
   • Mastery data collected in PCE 491.
   • Not Met: Data shows that 87.5% of students successfully achieved a level of satisfactory or exceeding the target in performance indicators one and two but failed to meet the 80% threshold in performance indicators three and four (75% and 62.5% respectively). The materials for this course were reviewed as part of the 3 year review cycle (see example later in this section).

k. an ability to use and practical experience with the techniques, skills, and modern engineering tools necessary for engineering practice
   • Goal: 80% of the students in the class achieve satisfactory or exceeding on three of the four performance indicators.
   • Mastery data collected in PCE 472.
   • Met: Data shows that 80% of students met or exceeded the target for three of four performance indicators. (see appendix E3)

B. Continuous Improvement

A thorough example of how this process is used is described below. Additional examples can be seen in Appendix E4.

PCE 491 – Project Research, Planning, and Ethics

This course is the first in a series of 3 and is part of the senior capstone project. It was developed to aid the students in gaining the necessary project planning, design, and ethics
tools they will need to complete their senior project. This review is of the first time the course had been offered. The actual PowerPoint review used and remedy documentation can be seen in Appendix E4.

**Problems.** Since this course had never been disseminated before, there were several logistical and content issues that arose which led to several of the performance indicator levels being lower than expected. The results are shown below:

**Student Learning Outcomes:**

Student learning outcome f was assessed using and ethics presentation assignment (Available in the Display Materials for PCE 491) (PI1), and in-class discussion (PI2). The goal is for 80% or more of the students to achieve satisfactory or exceeding the target for each performance indicator.

<table>
<thead>
<tr>
<th>f</th>
<th>Performance Indicator (Student has the ability to …..)</th>
<th>72.7%</th>
<th>Of students achieved satisfactory or exemplary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>identify important information in an ethical dilemma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>meaningfully participates in In-Class Discussions and Exercises on Ethics and Professionalism</td>
<td>100.0%</td>
<td>Of students achieved satisfactory or exemplary</td>
</tr>
</tbody>
</table>

Student learning outcome (h) was assessed using a contemporary issue assignment (Available in the Display Materials for PCE 491) (PI1), in-class discussion (PI2), and student GPA in GUR courses (PI3). The goal is for 80% or more of the students to achieve satisfactory or exceeding the target for two of the three performance indicators.

<table>
<thead>
<tr>
<th>h</th>
<th>Performance Indicator (Student has the ability to …..)</th>
<th>50.0%</th>
<th>Of students achieved satisfactory or exemplary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Analyze an engineering solution to determine the global, societal, economic, and environmental impact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Student Participates in In-Class Discussions and Exercises on the impact of engineering solutions in a global, economic, environmental, and societal context</td>
<td>100.0%</td>
<td>Of students achieved satisfactory or exemplary</td>
</tr>
</tbody>
</table>
Perform well in humanity, social sciences and comparative gender and multicultural studies courses to satisfy the general university requirements (based on GPA)  

100.0%  
Of students achieved satisfactory or exemplary  

Student learning outcome j was assessed using the ethics presentation assignment (Available in Display Materials for PCE 491) (PI1-4). The goal is for 80% or more of the students to achieve satisfactory or exceeding the target for three of four performance indicators.

<table>
<thead>
<tr>
<th>j</th>
<th>Performance Indicator (Student has the ability to …..)</th>
<th>87.5%</th>
<th>Of students achieved satisfactory or exemplary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>identifies valid contemporary issues</td>
<td>87.5%</td>
<td>Of students achieved satisfactory or exemplary</td>
</tr>
<tr>
<td>2</td>
<td>seeks multiple sources of information on the issue</td>
<td>87.5%</td>
<td>Of students achieved satisfactory or exemplary</td>
</tr>
<tr>
<td>3</td>
<td>discerns the credibility of the resources</td>
<td>75.0%</td>
<td>Of students achieved satisfactory or exemplary</td>
</tr>
<tr>
<td>4</td>
<td>integrates the information into a nuanced argument</td>
<td>62.5%</td>
<td>Of students achieved satisfactory or exemplary</td>
</tr>
</tbody>
</table>

Content Issues
- The rubrics were not clearly stated or given to the students so the assignments were confusing.
- Student were also unclear of the difference between the contemporary issues and ethics assignments.
- Students seem to continue to struggle with determining the appropriate constraints and specifications (also called objectives/functions/constraints) in the assignment.
- Inadequate time was developed to project management lectures.
- The Action Memo assignment requires the completion of the project plan. Unfortunately students do not complete the full project plan until PCE 492 so this assignment should be removed from PCE 491.
Logistical Issues

This course was combined with MFGE 491 and, therefore, had 3 professors for most of the course. Students were confused with grading, naming conventions, expectations, and which professor was in charge of what.

Solution.

Program faculty from both the MFGE and PCE programs reviewed the course during W16. From that discussion, the following changes have been made to the course. This table can also be found in Appendix E.4.

Table 4.2 – closing the loop

<table>
<thead>
<tr>
<th>Type of Change</th>
<th>SLOs Targeted for Improvement</th>
<th>Description of Program Improvement</th>
<th>Rationale</th>
<th>Evidence that will demonstrate if this change improves student learning.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curricular PCE 491</td>
<td>All PCE with PCE instructor and MFGE with MFGE instructor</td>
<td>students register for and start with and finish with an instructor from their program regardless of their project (don’t know their project until 3rd week, no joint assignments during 491), grading doesn’t need to be negotiated with other program (would require creating grading rubrics that are agreed to by all instructors), consistent terminology for assignments (i.e., O/f/C), could have only one instructor in the room for feedback on presentations</td>
<td>More consistent grades and reports</td>
<td></td>
</tr>
<tr>
<td>Curricular PCE 491</td>
<td>h</td>
<td>Make two contemporary issues assignments in series with room for feedback. Assess both times and</td>
<td>Students were to analyze 3 in a row without feedback in between so the results did not improve.</td>
<td>Improvement to SLO h to PI 1 from the first to the second analysis</td>
</tr>
<tr>
<td>Curricular PCE 491</td>
<td>Course outcome</td>
<td>Creating better project management PowerPoints to address risk and critical paths</td>
<td>Current plans are not well versed in critical path and risk analysis.</td>
<td>Improved critical paths and risk analysis to project plan in PCE 492</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Curricular PCE 491</td>
<td>Course outcome</td>
<td>Strategy for improving student’s understanding of constraints/specifications</td>
<td>Students continue to struggle with identifying objectives/functions/constraints (O/F/C) and how to quantify and justify them</td>
<td>Improved grade for identification and justification for O/F/C’s portion of the background assignment</td>
</tr>
<tr>
<td>Curricular PCE 491</td>
<td>f, h, j</td>
<td>Post rubrics so students know how instructors are assessing their work</td>
<td>Students did not understand what instructors were looking for</td>
<td>Improvement to SLO f PI 1-2 and outcome j PI 1-4. Improvement to outcome h PI 1</td>
</tr>
<tr>
<td>Curricular PCE 491</td>
<td>f, h, j</td>
<td>Ensure that the ethics presentation and contemporary issues assignments are clearly delineated.</td>
<td>Students were very confused as to the difference between the two assignments</td>
<td>Improvement to SLO f PI 1 and outcome j PI 1-4. Improvement to outcome h PI 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>calculate improvement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>