




UNIVERSITY OF WYOMING

WORKING FOR WYOMING & THE WORLD

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**Date:** 26 August 2016

**To:** Kate Miller, Provost and Vice President of Academic Affairs  
Anne Alexander, Associate Vice President of Academic Affairs

**From:** Michael V. Pishko   
Dean, College of Engineering & Applied Science

**RE:** Energy Systems Engineering Program Review

As per instructions from Academic Affairs, the Energy Systems Engineering B.S. program has been reviewed. This degree program is administered by the Department of Mechanical & Energy Systems Engineering. Pursuant to UW guidelines for program review, I recommend the program mentioned above be eliminated because of consistently low enrollment since the inception of the program. Last academic year, the department was tasked with growing enrollment in this program. Despite the department's efforts to promote the program, student demand has not increased. The department is better served by focusing its attention on Mechanical Engineering, by far the most popular engineering major in the college.

Please note that no faculty or staff positions are impacted by this recommendation. All faculty in energy systems engineering are also faculty in mechanical engineering. At over 450 students and a critical part of the college's Tier 1 vision, mechanical engineering is in need of additional instructors and researchers.

cc: Carl Frick, Steve Barrett, Megan Barber, File

**Academic Program Review**  
Report Template  
University of Wyoming  
Office of Academic Affairs  
March 2016

(adapted from SDSU)

Deans and Directors who administer an authorized major or course of study approved by action of the Board of Trustees will be responsible for conducting program reviews. Four key elements should be addressed in each academic program review: (1) Program Demand, (2) Program Quality, (3) Mission Centrality, and (4) Cost.

For each program that is reviewed, a recommendation will be made by the Academic Dean to the Vice President of Academic Affairs.

*Instructions: Please provide the following information:*

**Title of Program/Specialization:** *Energy Systems Engineering*

**Indicate whether undergraduate or graduate program/specialization:** *Undergraduate*

**Department and College:** *Mechanical Engineering, College of Engineering and Applied Sciences*

**Department Head Name and contact information (phone, email):** *Carl Frick, 307.766.4068, cfrick@uwyo.edu*

### **Part 1 – Program Review**

*Instructions: Please answer each of the following questions. Items listed under each question have been provided to help guide your response. If an item is not applicable, simply indicate “N/A”.*

#### **1. Program Demand\*:**

*(Note: If degrees granted exceeds cutoff, delay review until next round.)*

a. Number of graduates over 5-year period:

*We had 40 students graduating in the past 5 years.*

b. Enrollment in major/specialization over 5-year period:

*We had 188 students enrolled in the past 5 years.*

\* Cutoffs for “Low Demand” Designation -- *Degrees Granted*

- Bachelor’s Programs: Average – 5 per year; 5-year total: 25
- Master’s Programs: Average – 3 per year; 5-year total: 15
- Ph.D. Programs: Average – 1 per year; 5-year total: 5

(See APPENDIX A for the types of programs that will be excluded from review.)

#### **2. Program Quality: Is the program of high quality?**

a. Program accreditation

i. For programs currently accredited include:

1. Name of accrediting body/organization: *Accreditation Board for Engineering and Technology (ABET)*
  2. Date most recently accredited: *2012*
  3. Next reaccreditation date: *2018*
  4. List recommendations from most recent visit and progress to date.
    - 1) *Reword program objectives to distinguish from outcomes—focus on objectives ~3 years post-graduation*
    - 2) *Assessment of student outcomes combined for ME and ESE—more separation for individual program assessment.*
    - 3) *Document more clearly all design considerations and constraints for ESE capstone (senior design) projects.*
    - 4) *Increase funding for student laboratory to keep functional and up-to-date.*
- ii. For programs seeking accreditation include:
1. Name of accrediting body/organization
  2. Timeline for seeking accreditation
- iii. For all other programs include:
1. Date of most recent Academic Program Review (APR)
  2. List of recommendations from the most recent APR and progress to date.

*(Note: For first-time reviews, include N/A in response.)*

b. Credentials of faculty

- i. Include a list of all faculty by name, highest degree and discipline of highest degree. *Data as of February 2016*
  1. *Dilpuneet S. Aidhy, Ph.D. Materials Science and Engineering*
  2. *Erica L. Belmont, Ph.D. Mechanical Engineering*
  3. *Jian Cai, Ph.D. Mechanical Engineering*
  4. *Dennis N. Coon, Ph.D. Ceramic Science*
  5. *Paul A. Dellenback, Ph.D. Mechanical Engineering*
  6. *Ray S. Fertig III, Ph.D. Materials Science and Engineering*
  7. *Carl P. Frick, Ph.D. Mechanical Engineering*
  8. *Mark R. Garnich, Ph.D. Mechanical Engineering*
  9. *Chung-Souk Han, Dr.-Ing. Civil Engineering/Computational Mechanics*
  10. *Kevin Kilty, Ph.D. Geophysics*
  11. *Dimitri J. Mavriplis, Ph.D. Mechanical and Aerospace Engineering*
  12. *Jonathan W. Naughton, Ph.D. Mechanical Engineering*
  13. *Nancy Peck (1/2 time), Ph.D. Mechanical Engineering*
  14. *Michael Stoellinger, Ph.D. Mathematics*
- ii. Also, include a breakdown by gender and ethnicity.  
*Male: 12 Female: 2*  
*White: 11 Asian: 3*

- iii. Grants awarded to academic personnel: Previous 5 years  
*69 grants awarded totaling \$6.7M (external + internal) over the past 5 years (2010-2015). Source for iii-v: Faculty CV's submitted for performance evaluation in February 2016.*
  - iv. Grants submitted by academic personnel: Previous 5 years  
*92 grants submitted but not accepted in the past 5 years*
  - v. Publications/presentations by academic personnel  
*113 peer reviewed journal papers, 192 conference papers or proceedings, 171 conference presentations and invited talks over the past 5 years*
  - vi. National/international awards:
    - *Dr. Carl P. Frick, NSF CAREER Award Winner*
    - *Dr. Chung-Souk Han, NSF CAREER Award Winner*
  - vii. Other
    - *Dimitri Mavriplis: Max Castagne Professorship, Co-author of the highly influential NASA Technical Report, "NASA Vision 2030 CFD Code"*
    - *Jonathan Naughton, Director of UW'S Wind Energy Research Center*
    - *Dennis Coon, H.T. Person Professorship in Engineering Education in the College of Engineering and Applied Science*
- c. Program reputation
- i. If program is ranked, include rank and by what organization.  
*No ranking.*
  - ii. Include a brief description of any other indicators of program reputation such as demand (e.g. waiting lists or over enrollment) for admission into program, employer data/feedback, etc.  
*Because the ESE program was the first of its kind and was only accredited 4 years ago, this data is extremely limited. Job placement rate is consistent with the college average of approximately 80%.*
- d. Curriculum of major or specialization
- i. Include a list of courses by prefix, number, title required in the major or specialization (do not include general education course unless required as part of the major requirements.)
 

<i>MATH 2200</i>	<i>Calculus I</i>
<i>MATH 2205</i>	<i>Calculus II</i>
<i>MATH 2210</i>	<i>Calculus III</i>
<i>MATH 2310</i>	<i>Applied Differential Equations</i>
<i>CHEM 1020</i>	<i>General Chemistry I</i>
<i>LIFE 1010</i>	<i>Biology I</i>
<i>PHYS 1220</i>	<i>Engineering Physics II</i>
<i>ATSC 2100</i>	<i>Atmospheric Change</i>
<i>ES 1060</i>	<i>Intro to Engineering Problem Solving</i>
<i>ES 2110</i>	<i>Statics</i>
<i>ES 2120</i>	<i>Dynamics</i>
<i>ES 2210</i>	<i>Electric Circuit Analysis</i>
<i>ES 2310</i>	<i>Thermodynamics</i>
<i>ES 2330</i>	<i>Fluid Dynamics</i>
<i>ES 2410</i>	<i>Mechanics of Materials</i>

<i>ME/ESE 3005</i>	<i>Engineering Experimentation</i>
<i>ME/ESE 3020</i>	<i>System Dynamics</i>
<i>ME/ESE 3040</i>	<i>Thermodynamics II</i>
<i>ME/ESE 3060</i>	<i>Numerical Methods</i>
<i>ME/ESE 3160</i>	<i>Thermo/Fluids Laboratory</i>
<i>ME/ESE 3360</i>	<i>Fundamentals of Transport Phenomena</i>
<i>ME/ESE 4060</i>	<i>Systems Design I</i>
<i>ME/ESE 4070</i>	<i>Systems Design II</i>
<i>PHIL 2330/2345</i>	<i>Env. Ethics OR Natural Resource Ethics</i>
<i>ENR 3000</i>	<i>ENR Problem Solving</i>
<i>ENR 4900</i>	<i>ENR Assessment Prac.</i>

- e. Distance delivery of program/major
  - i. Note if the program is offered online and/or at one of the off-campus attendance centers (e.g., UW-Casper)  
*Not offered online or off-campus.*
- f. Quality of Assessment Plan/data
  - i. Include a brief description of the program assessment plan and how the data are used to inform decisions related to program quality and student learning.  
*Please see Attachment A for Assessment details.*
- g. Strategic Plan
  - i. Include a brief description of any plans for the program or specialization that appear in the college/department strategic plan (i.e., facilities upgrades, curriculum changes, on-line or off-campus delivery, enrichment learning opportunities, etc.)  
*As the ESE program is relatively unique, and focuses on Engineering aspects of the Energy Industry, it has the potential to broadly attract students from across the nation and beyond. We believe the program simply needs time to develop a reputation, and marketing to make potential students aware of the program.*  
*All laboratories associated with the ME and ESE curriculum has recently undergone a significant ~\$90k upgrade in available equipment.*
- h. Other: *None.*

**3. Mission Centrality: Does the program advance the mission of UW including institutional strategy?**

- a. Describe how the program supports the mission, vision and strategic goals of UW.

*The ESE program is well-aligned with the mission, vision, and strategic goals of UW. In particular, the ESE program aims to prepare graduates with a technically rigorous background to address issues in energy development and energy policy with a view towards critical environmental concerns. Both the focus on energy and environment (natural resources) address the initiatives at UW to focus on issues relevant to the State (energy production) as well as the missional goal of responsible stewardship of natural resources. The significant scholarly output of the faculty in terms of publications and the recruitment of external funds is evidence of rigorous scholarship by the faculty in the program.*

*In addition to the close alignment with UW and State goals, the ESE program has served to diversify the undergraduate student base in the department. As ESE is a program within the Mechanical Engineering (ME) department, it's 32% female student ratio significantly boosts female involvement in the department, which, without ESE, has only a 14% female student ratio.*

- b. Describe how the program contributes to other programs across campus (i.e., general education courses, minor or support courses, interdisciplinary program, etc.)

*Because the ESE program has an energy policy focus, our students interact with closely with the Environment and Natural Resources (ENR) program via several required courses and electives.*

- c. Include placement data for graduates and indicate if graduates are working in the field or not.

*Job placement rate is consistent with the college average of approximately 80%.*

- d. Describe the uniqueness or duplication of this program across the UW.

*The ESE program was introduced in 2009 and was the first program of its kind in the country. Today a handful of other universities have followed suit and introduced their own ESE programs, including the University of Michigan and Oregon State University. As the flagship program in this area, it is extremely unique and strongly tied to state energy resource interests.*

- e. Other: *None.*

**4. Cost: Is the program financially viable?**

- a. Ratio of student credit hours per FTE: *313.2*

- b. Direct instructional expenditures:

i. Per student credit hour: *\$720*

ii. Per total degrees awarded: *\$48,020*

iii. Non-personnel expenditures per total academic FTE: *\$14,121*

- c. Course enrollment (*past 2 years*)

i. Number of classes falling under University minimums: *None*

ii. Lower-division courses falling under University minimums: *None*

- d. Other instructional cost drivers, such as:

i. Section fill rates: *N/A*

ii. Course completion rates: *N/A*

iii. Curricular complexity: *N/A*

iv. Faculty course load:

*The standard faculty course load is 5 courses per semester, which can be reduced according to specific research and administrative metrics.*

- e. Research expenditures per tenured/tenure-track FTE (and other academic personnel, where appropriate): *\$114,170*
- f. Compare your data to national benchmarks (Delaware data):

	<i>Dir. Instr. Expend: Per student credit hour</i>	<i>Dir. Instr. Expend: Per total academic FTE</i>	<i>Research expenditures per tenured/tenure-track FTE</i>
<i>Peers AY 2013</i>	<i>\$384</i>	<i>\$10,450</i>	<i>\$141,264</i>
<i>UW-ME AY 2013</i>	<i>\$682</i>	<i>\$15,602</i>	<i>\$110,612</i>
<i>UW-ME AY 2014</i>	<i>\$720</i>	<i>\$17,415</i>	<i>\$114,170</i>

- g. Other:

*The ESE program resides in within the Mechanical Engineering (ME) department. The courses required for the ESE program are a subset of ME courses with additional courses outside of the department and college. **No additional resources are required for the ESE degree beyond perhaps an additional section in one or two courses to accommodate the additional ~30 students in the ESE program, as well as some additional accreditation effort every six years.***

## **Part II - Recommendations**

*Instructions: After the review is completed, the Dean in consultation with the Department Head will select one of the following recommendations. In the justification, address each of the items associated with the recommendation.*

### **1) Retain Due to Critical Need**

- a) A college may recommend that a degree program be retained due to its ability to fulfill a critical workforce need or shortage area for the state.
- b) Justification for retaining due to critical need must include:
  - i) Explanation of why the program is important to the University/State/region
  - ii) Description of specific steps (already taken and/or planned) to increase enrollment and graduate production;
  - iii) Preliminary outcomes of steps taken.

### **2) Retain with Further Review Required**

- a) A college may request that a program be retained for further review for those degree programs that serve a specific function central to the mission of the college or university.
- b) Justification for retain due to further review must include:
  - i) Explanation for how the program is central to the university's mission and the benefit to the system;
  - ii) Description of specific steps (already taken and/or planned) to increase enrollment and graduate production;
  - iii) Preliminary outcomes of steps taken.

### **3) Consolidate with Another Program within College**

- a) A college may request that a program be consolidated with a similar program on campus that achieves similar degree requirements.
- b) Justification to consolidate with another program on campus must include:
  - i) Explanation for how the degree requirements for the two programs warrant consolidation;
  - ii) Evidence that the consolidation will meet graduate production thresholds, or specific steps to increase enrollment to meet production thresholds;
  - iii) Preliminary outcomes of steps taken.

### **4) Consolidate with Program(s) between Colleges/campuses (e.g., UW/C)**

- a) Two or more colleges may request that similar degree programs be consolidated to maintain equivalent degree programs.
- b) Justification for retaining due to cross-college consolidation must include:
  - i) Explanation for how the consolidated programs will collaborate (e.g., sharing of required courses, shared faculty, etc.) to maintain graduate production thresholds;



- ii) Evidence that multi-college collaboration will meet graduate production thresholds, or specific steps to increase enrollment if merging programs fails to meet production thresholds;
- iii) Preliminary outcomes of collaboration between colleges.

**5) Terminate**

- a) A college may request that a program be terminated due to limited graduate production, lack of student interest, shifts in a given field of study, or continued declines in major enrollments.
- b) If the exigency for termination results from the program productivity review process then a brief justification to terminate a program should be included. Such a justification must include:
  - i) Explanation for the decline in graduate production in the degree program;
  - ii) Intended timeframe for submitting a program termination request to the Board of Trustees for their consideration;
  - iii) Expected timeline to meet teach-out requirements established through the regional accrediting body.

## APPENDIX A

### “Low Productivity” Programs Excluded from Review Process

- 1) **Major Program Modifications**
  - a) Degree programs that have undergone recent program modifications that adversely impact graduate production for a college.
  - b) Modifications traditionally include programs that have undergone recent name changes during the reporting window that result in two equivalent degree programs.
- 2) **Program/Major Specializations**
  - a) Degree programs that have one or more specializations which reduce the total number of graduates.
  - b) The exclusion may apply only for those specializations where the combination results in graduate production that meets the established threshold for the degree.
- 3) **Terminated Programs**
  - a) Degree programs that have been inactivated during the reporting period, but still depict graduates that fall below the established thresholds.
  - b) Terminated programs will remain on the Program Productivity Report until inactive programs have completely cycled through the established reporting period.
- 4) **New Programs**
  - a) Degree programs that have been activated within the past 7 years resulting in limited graduate production due to program implementation.
  - b) Institutional review may be requested prior to the 7<sup>th</sup> year if graduate production is not scaling to the required thresholds for the degree level.

## TIER 1 ASSESSMENT OF STUDENT LEARNING OUTCOMES REPORTING FOR 2015-2016 ACADEMIC YEAR

### Directions

Programs that attained Tier 1 status based on feedback from last year's annual report (2014-15) will complete the following reflective report on assessment.

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#### **Report Expectations:**

Completed reports should be 3 to 4 pages in length. Appendices are welcome, but not required. While the report should be concise, it should provide enough information so that external audiences understand the nature of assessment within your department.

The University Assessment Coordinators will review these reports during the summer and department heads/chairs will receive feedback by September. Please consult the rubric for the criteria used to assess this report (available on the Assessment of Student Learning website).

#### **Why This Report is Important:**

The annual assessment report is the main way in which UW systematically collects information about how well the university is doing in developing and implementing effective assessment of student learning processes. As such, please recognize that UW will use these reports part of the university's body of evidence for continued accreditation by the Higher Learning Commission (HLC). Parts or all of these reports could be read and reviewed by external audiences.

#### **Advice and Assistance:**

The University Assessment Coordinators have posted resources for you on the [Assessment of Student Learning Website](#).

We encourage the writers of this section of the report to dedicate adequate time to the task. You will not be successful if you try to write this report a few days before the deadline! You should begin working on it during spring semester.

We also recommend that you consult your college assessment coordinator first, OR alternatively Mark Lyford as soon as possible for assistance.

[Click here for your college assessment coordinator](#)

Mark Lyford, [Mahler@uwyo.edu](mailto:Mahler@uwyo.edu) 766-2897

## Tier 1–Assessment of Student Learning Report

**Note:** Academic Affairs recognizes the tremendous amount of preparation required for the ABET Self Studies, the onsite visit in October 2015, and the post-visit reporting requirements. To help manage the additional reporting requirements, Tier 1 undergraduate programs may complete the modified Tier 1–Assessment of Student Learning Report.

Department or program name: Mechanical Engineering

Name of degree/program assessed: BS-Energy Systems Engineering Degree Program

Program Level (check one):

Undergraduate

Masters

Doctorate

Submitted by: Prof. Denny Coon and Prof. Carl Frick, Mechanical Engineering

Date submitted: July 15, 2016

**1. Please reflect on your program’s assessment process and feedback provided by the University Assessment Coordinators Committee last year.**

The primary concern raised in last year’s report was the format and lack of sufficient details to permit full review by the University Assessment Coordinators Committee. The Department has made a significant attempt this year to follow the requested format closely.

**Provide one example of your program's assessment successes and one example of an assessment challenge.**

**Assessment success:** One of the student outcomes of the BS-ESE degree program is related to ethics:

Student Outcome (f): an understanding of professional and ethical responsibility

The Department has struggled to demonstrate attainment of this outcome in the engineering capstone design course in both AY13-14 and AY 14-15. The assessment tool used during this period was required discussion in the capstone design final report, see Appendix 1. In AY13-14, only 10% of the students in the capstone design course provided adequate demonstration of this student outcome. The Department modified the report requirements to provide additional motivation for demonstrating this student outcome in AY 14-15. However, only 11% of the students provided adequate demonstration of this student outcome even with the modifications implemented by the Department. The Department reviewed the assessment, discussed this student outcome with students enrolled in the capstone design course, and identified a new assessment tool, see Appendix 2. The change in the assessment tool provided a means to demonstrate this student outcome in a manner that was readily accepted by the students. In AY15-16, 90% of the student had provided adequate or excellent demonstration of this student outcome. Identification of an appropriate assessment tool was the success in this case.

**Assessment Challenge:** The Mechanical Engineering Department submitted a Self-Study Accreditation Report to Engineering Accreditation Commission of ABET (Accreditation Board for Engineering and Technology) on June 30, 2015. ABET is a nonprofit, non-governmental organization recognized by the Council for Higher Education Accreditation (CHEA), and the Engineering Accreditation Commission is primary accrediting body of engineering degree programs.

The accreditation process focuses on 9 criteria, and the details of these criteria are provided in Appendix 3. ABET reviewed the program's success in achieving ABET student outcomes 3(a) through 3(k), and reviewed the program's continuous improvement processes. ABET provided detailed feedback to the Mechanical Engineering Department, and that feedback is provided in Appendix 4. The main challenge was the feedback relative to Criterion 4 (Continuous Improvement):

"Currently the process for assessment of student outcomes evaluates both energy systems engineering and mechanical engineering program students on a combined basis. The combined results are then used for the evaluation process. Since assessed courses include students from

both programs, the validity of the assessment for each individual program is difficult to determine.”

Resolving this issue required that the Department develop a methodology to fully separate the assessment data for the two degree program administered by the Department. While this was a challenging task, it has been completed. The details are given in Appendix 5.

**2. How has assessment led to process, curricular, or programmatic change or affirmations within your program? Provide at least two concrete examples of process, curricular, or programmatic changes or affirmations made to your curriculum or program that will improve student learning.**

Based on feedback from ABET, the Mechanical Engineering Department thoroughly reviewed its assessment process, continuous improvement process, and curriculum requirements including assignments in key courses. Two examples of specific changes include:

**Change 1 – Curricular modification:** One of the cornerstones of engineering education is integration of multiple, realistic, and often conflicting objectives in solutions to engineering problems, and is identified as a student outcome for the BS-ESE degree program:

Student Outcome (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.

Feedback from ABET indicated issues with documentation of this student outcome. To address this feedback, the Department implemented a new assignment in ME/ESE 4070 – Systems Design II. Details of this change are given in Appendix 6.

**Change 2 – Programmatic Change:** One of the accreditation criteria for ABET requires appropriate laboratory facilities and equipment to attain student outcomes. During the accreditation visit, ABET questioned whether the Department had adequately fulfilled this requirement:

“Students interviewed during the visit expressed their concerns over the state of some of the equipment in the fluids laboratory, used for ME 3160, in terms of its age and its consistent functionality. While this equipment was functioning properly at the time of the visit, and the criterion is currently satisfied, without appropriate and adequately maintained laboratory equipment there is potential that the equipment could deteriorate so that this criterion may not be satisfied in the future.”

As a result of this concern, the Department completed a thorough review of its laboratory facilities and courses. Based on this review, several improvements were initiated. The details are given in Appendix 7.

**3. What are your department's/program's assessment plans for next year? (For ex, what system or structures do you have in place to keep your assessment process moving forward and sustainable?)**

The Mechanical Engineering Department assesses demonstration of Student Outcomes every academic year during the spring semester in select courses: ESE 3005, ESE 3360, and ESE 4070. Assessment tasks are scheduled with the appropriate instructor at the beginning of the spring semester by the Department's Assessment Coordinator. Assessment tools include student work, self-assessment by students, and assessment by judges of the capstone design symposium.

In addition, the national Fundamentals of Engineering Exam results are used for assessment of select student outcomes. The Department's Assessment Coordinator receives these exam results from the Dean's Office in the College of Engineering and Applied Science. The Dean's Office also provides the results of the Graduate Survey for use in Departmental assessment of student outcomes.

The Department's assessment process has continued without interruption in an annual cycle since 2002. Specific assessments scheduled for spring 2017 include:





**Table 3. Assessment tools used to assess achievement of Student Outcomes using self-assessment by students.**

	SO a	SO b	SO c	SO d	SO e	SO f	SO g	SO h	SO i	SO j	SO k
<b>Self-Assessment</b>											
Exit Survey - App Math	X										
Exit Survey - App Sci	X										
ESE 3360 First Day Assess - Diff Eq	X										
Exit Survey - Exper		X									
Exit Survey - Teams				X							
ESE 4070 Team Eval - Teams - Peers				X							
ESE 4070 Team Eval - Teams - Self				X							
Exit Survey - Engineering Prob. Solving					X						
Exit Survey - Prof & Ethics						X					
Exit Survey - Com Skills							X				
Exit Survey - Soc Context								X			
Exit Survey - Ind Learning									X		
Exit Survey - Contemp Issues										X	
Exit Survey - Comp Skills											X
ESE 3360 First Day Assess - Analysis Tools											X

Specific rubrics exist for each of the assessment tools list above. However, those rubrics have been omitted from this status report for the sake of brevity.

## Appendix 1 – Former Assessment Tool for Student Outcome (f) in Capstone Design

### ME/ESE 4070 – Final Report – Performance Rubric

#### SO (a) - Application of Science and Engineering

- Performance Level 2 – All applicable physics and engineering principles clearly identified
- Performance Level 1 – At least 75% of physics and engineering principles clearly identified
- Performance Level 0 – Less than 75% of physics and engineering principles clearly identified

#### SO (b) - Experimental Data

- Performance Level 2 – all unknowns experimentally determined
- Performance Level 1 – at least 75% of unknowns experimentally determined
- Performance Level 0 – fewer than 75% of unknowns experimentally determined

#### SO (c) – Safety, Economics, and Manufacturability

- Performance Level 2 – discussion of safety and economic and manufacturability.
- Performance Level 1 – discussion of two of the following three: safety, economics, and manufacturability.
- Performance Level 0 – discussion of fewer than two of the following three: safety, economics, and manufacturability.

#### SO (e) - Problem Formulation

- Performance Level 2 – all known characteristics of problem identified
- Performance Level 1 – at least 75% of known characteristics of problem identified
- Performance Level 0 – less than 75% of known characteristics of problem identified

#### SO (f) - Ethics

- Performance Level 2 – complete discussion of ethical issues in project
- Performance Level 1 – some discussion of ethical issues in project
- Performance Level 0 – little or no discussion of ethical issues in project

#### SO (g) - Communication

- Performance Level 2 – report format and writing to professional standards

- Performance Level 1 – few issue with format or writing
- Performance Level 0 – many issues with format or writing

**SO (h)** - ME 4070 – Final Report – Societal Impact of Engineering Solution

- Performance Level 2 – significant discussion of appropriate issues like environmental, societal, legal, and political impact of the engineering project
- Performance Level 1 - some discussion of appropriate issues like environmental, societal, legal, and political impact of the engineering project
- Performance Level 0 – little to no discussion of appropriate issues like environmental, societal, legal, and political impact of the engineering project

**SO (i)** - ME 4070 – Final Report – Independent Learning

- Performance Level 2 – clear extension beyond topics in ME curriculum as appropriate to specific problem
- Performance Level 1 – some extension beyond topics in ME curriculum as appropriate to specific problem
- Performance Level 0 – little to no extension beyond topics in ME curriculum

**SO (k)** - ME 4070 – Final Report – use of computer tools to generate engineering information

- Performance Level 2 – 100% of sketches, plots, and tables generated with an appropriate computer tool
- Performance Level 1 – at least 75% of sketches, plots, and tables generated with an appropriate computer tool
- Performance Level 0 – fewer than 75% of sketches, plots, and tables generated with an appropriate computer tool

## Appendix 2 – Current Assessment Tool for Student Outcome (f) in Capstone Design

### ME/ESE 4070

#### Ethics Assessment

The following questions are based on the National Society of Professional Engineers Code of Ethics. Please answer the questions based on your experience/activities/accomplishments in ME/ESE 4060 last fall, and then return the form to your instructor.

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#### Question related to your academic major:

1. My academic major is  ME  ESE  Dual ME and ESE
- 

#### Question related to your project:

2. Were safety, health, and welfare of the users of your design and/or public considered during the design process?
- Always
- Sometimes, but not always
- Rarely
- Never
- 

#### Questions related to you and your actions:

3. If your instructor asks about the status of your project, what is your approach in answering the question?
- 100% objective and truthful (give them the good, the bad, and the ugly)

- generally objective and truthful (give them the good, the bad, and the ugly; but stress the good)
- Give them the good, and only acknowledge the bad and ugly if pushed
- Give them the good, and refuse to acknowledge the bad and ugly.

4. Did you perform tasks/services only in areas in which you are competent?

- Always
- Sometimes, but not always
- Rarely
- Never

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Questions related to your teammates and their actions:

*(Different teammates may have demonstrated different levels of ethical conduct. Please answers these questions based on the "typical" of "average" teammate on your project. There will be a team evaluation later in the course where you have the opportunity to distinguish between individual teammates.)*

5. If you ask a team member about the status of their portion of the project, how would they answer?

- 100% objective and truthful (give you the good, the bad, and the ugly)
- generally objective and truthful (give you the good, the bad, and the ugly; but stress the good)
- give you the good, and only acknowledge the bad and ugly if pushed
- give you the good, and refuse to acknowledge the bad and ugly.

6. Did your teammates perform tasks/services only in areas in which they were competent?

Always

Sometimes, but not always

Rarely

Never

## **Appendix 3 – Accreditation Criteria for Mechanical Engineering**

Mechanical Engineering is reviewed and accredited based on nine criteria:

### Criterion 1. Students

Student performance must be evaluated. Student progress must be monitored to foster success in attaining student outcomes.

### Criterion 2. Program Educational Objectives

The program must have published program educational objectives that are consistent with the mission of the institution, the needs of the program's various constituencies, and these criteria

### Criterion 3. Student Outcomes

The program must have documented student outcomes that prepare graduates to attain the program educational objectives. Student outcomes are outcomes (a) through (k):

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

- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

#### Criterion 4. Continuous Improvement

The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the continuous improvement of the program.

#### Criterion 5. Curriculum

- (1) one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline.
- (2) one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study.
- (3) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.

#### Criterion 6. Faculty

The program must demonstrate that the faculty members are of sufficient number and they have the competencies to cover all of the curricular areas of the program.

#### Criterion 7. Facilities

Classrooms, offices, laboratories, and associated equipment must be adequate to support attainment of the student outcomes and to provide an atmosphere conducive to learning.

#### Criterion 8. Institutional Support

Institutional support and leadership must be adequate to ensure the quality and continuity of the program.

#### Criterion 9 – Specific Energy Systems Engineering Criteria



None.

## **Appendix 4 – Detailed feedback from ABET**

### Criterion 1 – Students:

No issues noted and no feedback provided

### Criterion 2 – Program Educational Objectives

Program educational objectives are defined as broad statements that describe what graduates are expected to attain within a few years of graduation. Some of the program's educational objectives are rewordings of student outcomes describing graduate's capabilities and qualities at the time of graduation rather than what they are expected to attain within a few years after graduation.

### Criterion 3 – Student Outcomes

No issues noted and no feedback provided

### Criterion 4

Currently the process for assessment of student outcomes evaluates both energy systems engineering and mechanical engineering program students on a combined basis. The combined results are then used for the evaluation process. Since assessed courses include students from both programs, the validity of the assessment for each individual program is difficult to determine.

### Criterion 5 – Curriculum

A review of several major design projects revealed that some students had incorporated engineering standards and multiple constraints while others did not consider them at all. Without incorporation of appropriate engineering standards and multiple constraints consistently through all major design projects, the expectations of the major design projects are not fully met.

### Criterion 6 – Faculty

No issues noted and no feedback provided

#### Criterion 7 – Facilities

Students interviewed during the visit expressed their concerns over the state of some of the equipment in the fluids laboratory, used for ME/ESE 3160, in terms of its age and its consistent functionality. While this equipment was functioning properly at the time of the visit, and the criterion is currently satisfied, without appropriate and adequately maintained laboratory equipment there is potential that the equipment could deteriorate so that this criterion may not be satisfied in the future.

#### Criterion 8 – Institutional Leadership

No issues noted and no feedback provided

#### Criterion 9 – specific Energy Systems Engineering Criteria

N/A

## Appendix 5 – Example of Resolving Challenge in Assessment Process

### Program Weakness – Criterion 4 – Continuous Improvement

**ABET Feedback - “Currently the process for assessment of student outcomes evaluates both energy systems engineering and mechanical engineering program students on a combined basis. The combined results are then used for the evaluation process. Since assessed courses include students from both programs, the validity of the assessment for each individual program is difficult to determine.”**

Department Response – The Mechanical Engineering Department acknowledges the issue identified by ABET. The Department has identified and implemented a plan to fully separate the BS-ME and BS-ESE assessment results by discipline:

#### **A. Assessment of Student Work by Faculty**

1. ME/ESE 3005– Format Laboratory Report
  - a. Assesses Student Outcomes a, e, g, and k
  - b. Both Mechanical Engineering and Energy Systems Engineering majors register for this course.
  - c. Laboratory Reports are submitted by individuals
    - i. Separate reports by discipline and assess using the existing performance rubric
    - ii. Some students are dual majors in both Mechanical Engineering and Energy Systems Engineering. The assessment results for these students will be included in both Mechanical Engineering and Energy Systems Engineering data sets.
  - d. IMPLEMENTED Spring 2016 – COMPLETE
2. ME 3170 – Design Project
  - a. Assesses Student Outcomes c and e
  - b. Only Mechanical Engineering majors enroll in this course
  - c. No changes are necessary in the assessment plan for this course.
3. ME/ESE 3360 – Design Project
  - a. Assesses Student Outcomes a, c, d, and j
  - b. Students from Mechanical Engineering, Energy Systems Engineering, Architectural Engineering, and Chemical Engineering enroll in this course.

- c. Design projects will be separated by discipline and assessed using the existing performance rubric
    - i. Design projects for Architectural Engineering and Chemical Engineering majors will not be assessed.
  - d. IMPLEMENTED Spring 2016 – COMPLETE
4. ME/ESE 4070 – Final Design Report
- a. Assesses Student Outcomes a, b, c, e, f, h, I, and k
  - b. Both Mechanical Engineering and Energy Systems Engineering majors register for this course.
  - c. Final Design reports are team efforts with several contributing authors
  - d. Each design report will be assessed using the existing performance rubric
    - i. Assessment results will be weighted by the discipline of the authors, e.g. the assessment outcome for an individual report with 1 ESE and 3 ME authors will be included once in the ESE results and three times in the ME results.
  - e. IMPLEMENTED Spring 2016 – COMPLETE
5. ME/ESE 4070 – Final Design Presentation
- a. Assesses Student Outcome g
  - b. Both Mechanical Engineering and Energy Systems Engineering majors register for this course.
  - c. Presentations are team efforts with several contributing presenters
  - d. Each presentation will be assessed using the existing performance rubric
    - i. Assessment results will be weighted by the discipline of the presenters, e.g. the assessment outcome for an individual presentation with 1 ESE and 3 ME presenters will be included one in the ESE results and three times in the ME results.
  - e. IMPLEMENTED Spring 2016 – COMPLETE

## **B. Self-Assessment by Students**

6. ME/ESE 3360 – First day self-assessment of preparedness
- a. Assesses Student Outcomes a, d, and k
  - b. Students from Mechanical Engineering, Energy Systems Engineering, Architectural Engineering, and Chemical Engineering enroll in this course.
  - c. Extra information required on form completed by students: ME, ESE, dual ME/ESE, ARE, or CHE? (circle your discipline)
  - d. Separate forms by discipline and assess using the existing performance rubric
    - i. Self-assessment forms for Architectural Engineering and Chemical Engineering majors will not be assessed.
  - e. IMPLEMENTED Spring 2016 – COMPLETE

7. ME/ESE 4070 – Self and peer assessment of teamwork
  - a. Assesses Student Outcome d
  - b. Both Mechanical Engineering and Energy Systems Engineering majors register for this course.
  - c. Extra information required on form completed by students: ME, ESE, or dual ME/ESE? (circle your discipline)
  - d. Separate forms by discipline and assess using the existing performance rubric
  - e. IMPLEMENTED Spring 2016 – COMPLETE
  
8. Graduating Senior Survey
  - a. Assesses a, b, d, f, g, h, i, j, and k
  - b. This survey is administered by the Dean's Office. The Department has worked closely with the Dean's Office to separate data from online survey
  - c. IMPLEMENTED Spring 2016 – COMPLETE

### C. Assessment by External Entities

9. FE Exam
  - a. Assesses Student Outcomes a, b, d, f, and k
  - b. Currently separated on the FE Exam performance report.
  - c. Separate forms by discipline and assess using the existing performance rubric
  - d. IMPLEMENTED Spring 2016 – COMPLETE
  
10. ME/ESE 4070 – Assessment by Design Symposium Judges
  - a. Assesses Student Outcomes b, d, e, g, and h
  - b. Both Mechanical Engineering and Energy Systems Engineering majors register for this course.
  - c. Presentations are team efforts with several contributing presenters
  - d. Each presentation will be assessed using the existing performance rubric
    - i. Assessment results will be weighted by the discipline of the presenters, e.g. the assessment outcome for an individual presentation with 1 ESE and 3 ME presenters will be included one in the ESE results and three times in the ME results.
  - e. IMPLEMENTED Spring 2016 – COMPLETE

### Evidence of Separated ME and ESE Assessment Results

Of the 10 elements of the plan outlined above, 2 elements are fully implemented as of March 1, 2016, and 8 elements will be fully implemented by May 2016. One of the elements that have been separated by discipline is the ME/ESE 3360 first day self-assessment of preparedness. The original data for Spring 2015 and Spring 2016 were available, and the separated data are shown in red in the tables below. Both Student Outcomes a and k are partially assessed by this tool:

<b>BS-ESE SO a</b>				<b>Performance Level (%)</b>		
Type	Item	Timeline	Num Observations	1	2	3
Self-Assessment	ME/ESE 3360 - Diff Eq	current year	6	0	84	16
		prior year	4	0	50	50
		two years prior	36	6	41	53

<b>BS-ME SO a</b>				<b>Performance Level (%)</b>		
Type	Item	Timeline	Num Observations	1	2	3
Self-Assessment	ME/ESE 3360 - Diff Eq	current year	45	7	62	31
		prior year	32	10	56	34
		two years prior	35	11	52	37

<b>BS-ESE SO k</b>				<b>Performance Level (%)</b>		
Type	Item	Timeline	Num Observations	1	2	3
Self-Assessment	ME 3360 - Analysis Tools	current year	6	0	50	50
		prior year	4	0	25	75
		two years prior	36	18	57	25

<b>BS-ME SO k</b>				<b>Performance Level (%)</b>		
Type	Item	Timeline	Num Observations	1	2	3
Self-Assessment	ME/ESE 3360 - Analysis Tool	current year	45	7	58	35
		prior year	32	0	59	41
		two years prior	35	14	54	32

The second element that has been separated by discipline is the FE results. The FE performance report results have always been separated in the performance reports supplied to the Department, and the results from October 2010 through October 2015 are given below as evidence of separation of assessment results:

**SO (a) – FE Exam – Fluids (BOTH BS-ME and BS-ESE)**

- Performance Level 3 – UW average  $\geq 1.2$ (national average)
- Performance Level 2 –  $0.9$ (national average)  $\leq$  UW average  $< 1.2$ (national average)
- Performance Level 1 – UW average  $< 0.9$ (national average)

<b>BS-ME</b>		<b>SO(a) - FE - Fluids</b>			<b>BS-ESE</b>		<b>SO(a) - FE - Fluids</b>		
		Performance Level					Performance Level		
<b>Date</b>	<b>n</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>Date</b>	<b>n</b>	<b>1</b>	<b>2</b>	<b>3</b>
Oct 2010	34	0%	0%	100%	Oct 2010	1	0%	100%	0%
Apr 2011	8	0%	100%	0%	Apr 2011	1	0%	0%	100%
Oct 2011	18	0%	100%	0%	Oct 2011	5	0%	100%	0%
Apr 2012	9	100%	0%	0%	Apr 2012	2	100%	0%	0%
Oct 2012	32	0%	100%	0%	Oct 2012	5	0%	100%	0%
Apr 2013	16	0%	100%	0%	Apr 2013	4	0%	100%	0%
Oct 2013	34	0%	100%	0%	Oct 2013	8	0%	0%	100%
Apr 2014	6	0%	100%	0%	Apr 2014	2	0%	100%	0%
Oct 2014	16	0%	100%	0%	Oct 2014	2	0%	100%	0%
Apr 2015	26	0%	100%	0%	Apr 2015	1	0%	100%	0%
Oct 2015	15	0%	100%	0%	Oct 2015	1	0%	100%	0%

**SO (a) – FE Exam – Thermodynamics (BOTH BS-ME and BS-ESE)**

- Performance Level 3 – UW average  $\geq 1.2$ (national average)
- Performance Level 2 –  $0.9$ (national average)  $\leq$  UW average  $< 1.2$ (national average)
- Performance Level 1 – UW average  $< 0.9$ (national average)



<b>BS-ME</b>		<b>SO(a) - FE - Thermo</b>			<b>BS-ESE</b>		<b>SO(a) - FE - Thermo</b>		
		Performance Level					Performance Level		
Date	n	1	2	3	Date	n	1	2	3
Oct 2010	34	0%	100%	0%	Oct 2010	1	0%	0%	100%
Apr 2011	8	0%	100%	0%	Apr 2011	1	100%	0%	0%
Oct 2011	18	0%	100%	0%	Oct 2011	5	0%	0%	100%
Apr 2012	9	0%	100%	0%	Apr 2012	2	0%	0%	100%
Oct 2012	32	0%	0%	100%	Oct 2012	5	0%	100%	0%
Apr 2013	16	0%	100%	0%	Apr 2013	4	0%	100%	0%
Oct 2013	34	0%	100%	0%	Oct 2013	8	0%	0%	100%
Apr 2014	6	0%	100%	0%	Apr 2014	2	0%	100%	0%
Oct 2014	16	0%	100%	0%	Oct 2014	2	100%	0%	0%
Apr 2015	26	0%	100%	0%	Apr 2015	1	0%	100%	0%
Oct 2015	15	0%	100%	0%	Oct 2015	1	0%	0%	100%

**SO (a) – FE Exam – Machine Design (BS-ME only)**

- Performance Level 3 – UW average  $\geq 1.2$ (national average)
- Performance Level 2 –  $0.9$ (national average)  $\leq$  UW average  $< 1.2$ (national average)
- Performance Level 1 – UW average  $< 0.9$ (national average)

<b>BS-ME</b>		<b>SO(a) - FE - Machine Design</b>		
		Performance Level		
Date	n	1	2	3
Oct 2010	34	0%	100%	0%
Apr 2011	8	0%	100%	0%
Oct 2011	18	0%	100%	0%
Apr 2012	9	100%	0%	0%
Oct 2012	32	0%	100%	0%
Apr 2013	16	100%	0%	0%
Oct 2013	34	0%	100%	0%
Apr 2014	6	0%	100%	0%
Oct 2014	16	0%	100%	0%
Apr 2015	26	0%	100%	0%
Oct 2015	15	0%	100%	0%

**SO (a) – FE Exam – Measurements and Instrumentation (BS-ME only)**

- Performance Level 3 – UW average  $\geq 1.2$ (national average)
- Performance Level 2 –  $0.9$ (national average)  $\leq$  UW average  $< 1.2$ (national average)
- Performance Level 1 – UW average  $< 0.9$ (national average)

<b>BS-ME</b>	<b>SO(b) - FE - Meas and Instr</b>			
		Performance Level		
<b>Date</b>	<b>n</b>	<b>1</b>	<b>2</b>	<b>3</b>
Oct 2010	34	0%	100%	0%
Apr 2011	8	0%	100%	0%
Oct 2011	18	0%	100%	0%
Apr 2012	9	100%	0%	0%
Oct 2012	32	0%	100%	0%
Apr 2013	16	0%	100%	0%
Oct 2013	34	0%	100%	0%
Apr 2014	6	0%	100%	0%
Oct 2014	16	0%	100%	0%
Apr 2015	26	0%	0%	100%
Oct 2015	15	0%	100%	0%

**SO (c) – FE Exam – Engineering Economics (BOTH BS-ME and BS-ESE)**

- Performance Level 3 – UW average  $\geq 1.2$ (national average)
- Performance Level 2 –  $0.9$ (national average)  $\leq$  UW average  $< 1.2$ (national average)
- Performance Level 1 – UW average  $< 0.9$ (national average)

<b>BS-ME</b>		<b>SO(c) - FE - Engr Econ</b>				<b>BS-ESE</b>		<b>SO(c) - FE - Engr Econ</b>			
		Performance Level						Performance Level			
Date	n	1	2	3	Date	n	1	2	3		
Oct 2010	34	0%	100%	0%	Oct 2010	1	0%	0%	100%		
Apr 2011	8	100%	0%	0%	Apr 2011	1	100%	0%	0%		
Oct 2011	18	0%	100%	0%	Oct 2011	5	100%	0%	0%		
Apr 2012	9	0%	100%	0%	Apr 2012	2	100%	0%	0%		
Oct 2012	32	0%	100%	0%	Oct 2012	5	0%	100%	0%		
Apr 2013	16	100%	0%	0%	Apr 2013	4	0%	100%	0%		
Oct 2013	34	0%	100%	0%	Oct 2013	8	0%	100%	0%		
Apr 2014	6	0%	0%	100%	Apr 2014	2	100%	0%	0%		
Oct 2014	16	0%	100%	0%	Oct 2014	2	0%	100%	0%		
Apr 2015	26	0%	100%	0%	Apr 2015	1	0%	0%	100%		
Oct 2015	15	0%	100%	0%	Oct 2015	1	100%	0%	0%		

**SO (f) – FE Exam – Ethics (BOTH BS-ME and BS-ESE)**

- Performance Level 3 – UW average  $\geq 1.2$ (national average)
- Performance Level 2 –  $0.9$ (national average)  $\leq$  UW average  $< 1.2$ (national average)
- Performance Level 1 – UW average  $< 0.9$ (national average)

<b>BS-ME</b>		<b>SO(f) - FE - Ethics</b>				<b>BS-ESE</b>		<b>SO(f) - FE - Ethics</b>			
		Performance Level						Performance Level			
Date	n	1	2	3	Date	n	1	2	3		
Oct 2010	34	100%	0%	0%	Oct 2010	1	100%	0%	0%		
Apr 2011	8	100%	0%	0%	Apr 2011	1	100%	0%	0%		
Oct 2011	18	0%	100%	0%	Oct 2011	5	0%	100%	0%		
Apr 2012	9	100%	0%	0%	Apr 2012	2	0%	100%	0%		
Oct 2012	32	0%	100%	0%	Oct 2012	5	100%	0%	0%		
Apr 2013	16	0%	100%	0%	Apr 2013	4	0%	100%	0%		
Oct 2013	34	0%	100%	0%	Oct 2013	8	0%	100%	0%		
Apr 2014	6	0%	100%	0%	Apr 2014	2	0%	0%	100%		
Oct 2014	16	0%	100%	0%	Oct 2014	2	100%	0%	0%		
Apr 2015	26	0%	100%	0%	Apr 2015	1	0%	100%	0%		
Oct 2015	15	0%	100%	0%	Oct 2015	1	100%	0%	0%		

**SO (k) – FE Exam – Computing Tools (BS-ME only)**

- Performance Level 3 – UW average  $\geq 1.2$ (national average)
- Performance Level 2 –  $0.9$ (national average)  $\leq$  UW average  $< 1.2$ (national average)
- Performance Level 1 – UW average  $< 0.9$ (national average)

<b>BS-ME</b>		<b>SO(k) - FE - Computing</b>		
		Performance Level		
<b>Date</b>	<b>n</b>	<b>1</b>	<b>2</b>	<b>3</b>
Oct 2010	34	0%	100%	0%
Apr 2011	8	100%	0%	0%
Oct 2011	18	0%	100%	0%
Apr 2012	9	0%	100%	0%
Oct 2012	32	0%	100%	0%
Apr 2013	16	0%	100%	0%
Oct 2013	34	0%	100%	0%
Apr 2014	6	0%	100%	0%
Oct 2014	16	0%	100%	0%
Apr 2015	26	0%	0%	100%
Oct 2015	15	0%	100%	0%

The information from the ME/ESE 3360 first day self-assessment of preparedness and the FE Exam results are offered as evidence of successful separation of assessment results by discipline as outlined in the Department's plan for separation of the results. The remaining elements are on schedule for separation with compilation of Spring 2016 assessment results.

## Appendix 6 – Example of Curriculum Modification as a result of the Assessment Process

### **Program Weakness – Criterion 5 – Curriculum**

**ABET Feedback - “A review of several major design projects revealed that some students had incorporated engineering standards and multiple constraints while others did not consider them at all. Without incorporation of appropriate engineering standards and multiple constraints consistently through all major design projects, the expectations of the major design projects are not fully met.”**

Department Response – Department faculty have reviewed the Spring 2015 capstone design final reports in question, and acknowledge that the information relative to design constraints and the impact of those constraints on design choices was more difficult than hoped to locate in the final reports. For the project entitled “Composite Skis” the purpose of this project was to design and fabricate a ski that was useful in multiple snow conditions and skiing styles, and would have definitely been the subject of multiple constraints. The information about those constraints was admittedly challenging to locate since it was spread throughout the report:

- Page 2 – authors defined general constraints which were difficult to quantify for use in design
- Page 3 – authors defined some quantifiable characteristics from the general constraints
- Page 4 – authors contrasted their design decisions to the approach used by commercial ski manufacturers.
- Page 33 – authors discussed the economic constraints on their design and provide an economic analysis.

The Department agrees that collection of the information into a single location near the front of the final design report would have been a significant improvement. A new assignment has been implemented in ME/ESE 4070 this spring to address this issue. Students have been asked to submit a list of constraints applicable to their design problem and a brief discussion of the impact of those constraints on their design choices. An example student submission for this assignment is attached (UW Mechanical Engineering Attachment 1). The purpose of this new assignment in ME/ESE 4070 was to provide an effective format for communicating constraint information and facilitate incorporation of that information into the final design report in a manner that directly addresses the issue identified by the ABET.

**UW-Mechanical Engineering Attachment 1:**

The following identification of multiple realistic design constraints was submitted by the ME/ESE 4070 E-Baja team in February 2016 as a new required assignment. This team is comprised of four BS-Mechanical Engineering students. This submission is offered as an example for consideration, but all design teams completed the assignment.

The challenge with the E-Baja is that because the vehicle is in a mostly complete working form, many of the design parameters that might otherwise be changed if we were designing the vehicle from scratch are set in stone and unavailable for us to change, given current time and budget constraints. As such, much of our design challenge is working around the existing constraints of physical space and current battery characteristics to create a vehicle power delivery and CAN Bust system that is aesthetic, user friendly and functional.

### Constraints and Design Choices

Item	Design Consideration	Constraint
Power connections	Capable of carrying amperage (125 Amps max).	Mating force under 20 lbs.
Battery tray size	Must fit within current confines of vehicle.	15" front to back. 10" height.
Dashboard	Does not cause injury to driver.  Ergonomic viewing of display.	All bottom edges must be rounded.  Display viewable from neutral seated position.
CAN Bus enclosure	Sized to fit aesthetically on vehicle.	¼ size of current enclosures, 2" X 2.5" X 1"
CAN Bus environmental resistance	Vibration resistance.  Water resistance.  Thermal resistance.	Circuitry must resist typical vibrations encountered in automotive environment.  No water enters enclosure under typical ATV use in wet conditions.  Selected I.C.'s must resist typical temperature range for ATV use, -40 to 85°C.
CAN Bus PCB	IC package size of 2" X 2" X 1"	EE Department must be able to build prototype board
CAN Bus trace width & cabling	Current handling capability	Must be able to operate with all accessories turned on (~ 3A load) indefinitely.
Accessories	Operation without noticeably shortening battery life of vehicle	Amperage of less than 10A for all accessories running simultaneously.
Headlights	Must be able to see 3 seconds distance at 30 mph (130 ft.)	Amperage draw with all accessories funning simultaneously less than 10A.
Running Lights	Must be seen clearly in daylight	Amperage draw with all accessories funning simultaneously less than 10A.
Horn	Must be heard clearly by surrounding	Amperage draw with all accessories

	vehicles (>100 dB)	funning simultaneously less than 10A.
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## Appendix 7 – Example of Programmatic Modification as a result of the Assessment Process

### Program Concern – Criterion 7 – Facilities

**ABET Draft Statement - “Students interviewed during the visit expressed their concerns over the state of some of the equipment in the fluids laboratory, used for ME 3160, in terms of its age and its consistent functionality. While this equipment was functioning properly at the time of the visit, and the criterion is currently satisfied, without appropriate and adequately maintained laboratory equipment there is potential that the equipment could deteriorate so that this criterion may not be satisfied in the future.”**

Department Response – The Department acknowledges that upgrade and maintenance of equipment in undergraduate teaching laboratories is both vital and challenging. Beginning in the summer of 2015, the Department initiated a revitalization of ME/ESE 3160, where most all the labs were updated both from a pedagogical and an equipment perspective. Support for this initiative totaled nearly \$50k. Dr. Kilty is one of the primary instructors of ME/ESE 3160 and taken the lead role in upgrades and modifications to the ME/ESE 3160 laboratory room. A report on his list of accomplishments is attached (UW-Mechanical Engineering Attachment 2).

#### **UW-Mechanical Engineering Attachment 2:**

Status Report – February 25, 2016

ME/ESE 3160 Upgrade and Modification

Dr. K. Kilty

A redesign of ME 2160, Fluids/thermal laboratory (renumbered to ME 3160) was initiated using funding approved by the UW Engineering Initiative for enhanced hands-on learning and by UW for upgrade and maintenance of equipment in undergraduate teaching laboratories. This document summarizes upgrades completed and upgrades that are scheduled but not yet complete.

#### **Completed Upgrades:**



This section summarizes improvements made to the ME2160 (now ME3160) laboratory course beginning in summer of 2015 and continuing to the present time. To this time we have:

- 1) Cleared obsolete, surplus, and non-functional equipment from room EN2064. We disposed of this in accordance with applicable University policies and State of Wyoming requirements.
- 2) Edited and expanded instructional materials for five introductory laboratories.
- 3) Made minor modifications of four introductory labs, including the production of sets of detents in exit ducts to help students place pitot tubes repeatably, added hot-wire anemometers into laboratory number 2 for comparison with measurements using-
- 4) pitot tubes, and completely overhauled two of the miniblowers/wind tunnels, providing a total of six of these apparatus in good repair.
- 5) Ran multiple experiments using the apparatus of Laboratory #1 modified by the addition of an automotive grade pressure transducer to better understand the isentropic expansion process. This also produced data that makes for an interesting example of a second-order pneumatic system for ME3020.
- 6) Completely redesigned the "fin" of experiment (#6) to incorporate closed loop control, make use of lower temperatures, and added data acquisition. This solved several problem with this very useful lab exercise including: eliminating unsafe temperatures, eliminating a vaporous substance hazard, eliminating student tedium in acquiring data, and making possible transient thermal analysis.
- 7) Greatly edited and expanded the instructional materials for Laboratory #6 to illustrate the solution of inverse problems in parameter estimation.
- 8) Modified the apparatus for Laboratory #6A (Lab #6 alternate) by adding data acquisition of pressure, current shunt, and temperature data. This is in preparation for putting this laboratory on the web to make it more available for students at arbitrary hours without having to open and staff EN2064.
- 9) Edited instructional materials for Laboratory #6A for consistency with the current apparatus. The materials prior to this edit were so out of date that they described equipment, such as an oil-filled manometer that was never a part of the apparatus.
- 10) Obtained new computers running Windows 7 that are used in the new data acquisition experiments. These have licenses to run hardware drivers from Measurement Computing Corp. and National Instruments (LabView).

- 11) Designed and conducted an open-ended laboratory exercise in all sections of ME3160 that required students to design, conduct and analyze data without extensive supervision by lab TAs or the instructor. This exercise is meant to demonstrate that students have absorbed and are prepared to apply knowledge gained in ME3160.
  
- 12) ME Senior Capstone Design course students developed a teaching wind tunnel and associated instrumentation. The wind tunnel will extend the capabilities of the laboratory course, and solve some additional problems with the present use of blowers to act as wind-tunnels. Item design complete and machine shop produced parts for, four copies of the apparatus of Experiment #6.

**Pending Upgrades:**

The following tasks are schedule for completion prior to the start of the Fall 2016 semester:

- 13) Automate an additional convective heat transfer experiment designed around various heat sinks in free and forced convection.
  
- 14) Prove the efficacy of scheduling unique equipment making use of automation on the web to make selected laboratory exercises more available. Launch one or more web interfaces to lab exercises.
  
- 15) Incorporate the new teaching wind tunnel into the course.
  
- 16) Purchase straight pitot tubes to replace the paired static/total pressure ports used in some exercises on the miniblowers, or design and construct such. Students have suggested such a replacement, and I agree that it will aid in their investigations of Bernoulli's Law.
  
- 17) Assemble and test four copies of the apparatus of Experiment #6.