Weber State University
Biennial Report on Assessment of Student Learning

Cover Page

Department/Program: Mechanical Engineering / Mechanical Engineering
Academic Year of Report: 2019/20 (covering Summer 2018 through Fall 2020)
Date Submitted: 1-8-2021
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We have updated the Institutional Effectiveness website, which includes an update for each program page. All Biennial Assessment and Program Review reports will now be available on a single page. Please review your page for completeness and accuracy, and indicate on the list below the changes that need to be made. Access your program page from the top-level results **page. Select the appropriate college and then your program from the subsequent page.**

Mechanical Engineering
The WSU Mechanical Engineering (ME) program completed its initial accreditation by the Engineering Accreditation Commission (EAC) of ABET. ABET accredits engineering programs on a six year cycle. The ME draft report indicates an accredited ME program. ABET's Final report will be disseminated this July 2021. Per the agreement between EAST and the Office of Institutional Effectiveness, the ABET self-study report and the ABET on-site evaluation will constitute the Mechanical Engineering program review.

A. Mission Statement

___ Information is current; no changes required.

Update if not current:

Educate and prepare Mechanical Engineering students for successful careers. This is accomplished by the program educational objectives.

B. Student Learning Outcomes

___ Information is current; no changes required.

Update if not current:

Graduates of the WSU Mechanical Engineering Program will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

3. An ability to communicate effectively with a range of audiences.

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

A. Curriculum (please note, we are using Google Sheets for this section so that updates are easier to make)

___ Information is current; no changes required.

Update if not current (you may have access to the Google Sheet if that is easiest, or we can make the updates):

Table 1. Curriculum Map that Assesses Student Performance to Student Learning Outcomes.

Matrix of ME courses and student outcomes	ME Student Outcomes 1 - 7						
ME CLASSES	1	2	3	4	5	6	7
ENGR 1000 Introduction to Engineering	M	M		M	M		
ENGR 2300 Thermodynamics	H						M
ENGR 2210 Circuits for Non - EE Majors	M					H	M
ENGR 2010 Statics	H						M
ENGR 2080 Dynamics	H						M
ENGR 2140 Mechanics of Materials	H						M
ENGR 2160 Materials Science & Engineering		M		H	M	H	
ME 3350 Engineering Computing			M				M
ME 3040 Dynamic System Modeling	H		M				M
ME 3300 Fluid Mechanics	H					H	M
ME 3050 Machine Design	H						M
ME 3500 Numerical Methods for Engineers	H						H
ME 4000 Heat Transfer	H					H	
ME 3060 Sensors, Instrumentation & Control Systems	M				H	H	
ME 4100 Senior Project 1	H	H	H	M	H		H
ME 4200 Senior Project 2	M	H	H	H	H		
ME 4990 Seminar in Mechanical Engineering			H	H			H
Blank = Low Applicability							
M = medium applicability							
H = high applicability							

For each course in the curriculum, a level of applicability for each student outcome was assigned. The levels of applicability are *low*, *medium* and *high*, designated by a blank, M and H, respectively, in the matrix. Table 1 is the matrix of courses and student outcomes.

After each semester, faculty prepare a rubric for each ME course they taught by assigning a level of achievement to each PI for the student outcomes in the rubric. The levels of achievement are (1) unsatisfactory, (2) developing, (3) satisfactory and (4) exemplary. An example of a course rubric is shown below in Table 2.

Table 2. Course rubric example

Mechanical Engineering Course Rubric								
COURSE	**ME 4000 Heat Transfer**							
SEMESTER	**Spring**							
YEAR	**2020**						S = 1 or 2: action initiated by instructor	
INSTRUCTOR	**Hagen**						S = 3 or 4: no action initiated by instructor	
Performance Indicator (PI)	Student Outcomes	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Exemplary	Score (S)	Initiate action by instructor ?	Action to be initiated
Identifies operative heat transfer modes in an analysis and uses applicable equations or empirical correlations.	1	Cannot identify which heat transfer modes are operative in a given system.	Can identify operative heat transfer modes but uses incorrect equations or empirical correlations.	Can identify operative heat transfer modes and uses correct equations or empircal correlations to obtain correct results.	Can identify operative heat transfer modes, uses correct equations or empirical correlations, and draws meaningful conclusions about results.	**3**	no	
Identifies when radiation should be used in a problem involving external convection and uses applicable equations.	1	Cannot identify when radiation should be included with external convection.	Recognizes that radiation should be included but fails to use the correct radiation relations.	Recognizes that radiation should be included and uses the correct radiation relations.	Recognizes that radiation should be included, uses the correct radiation relations, and calculates the relative contributions of convection and radiation.	2	yes	Incorporate additional examples to show the relative impact of radiation in a convection problem.
Uses and applies good assumptions in a heat transfer analysis.	1	Uses bad assumptions or makes no assumtions at all.	States good assumtions but does not apply them properly.	Uses good assumptions and correctly applies them in the analysis.	Uses good assumptions, correctly applies them, and contrasts results if different assumptions are used.	3	no	
Identifies dimensionality (1-D, 2-D or 3-D) of a system and correctly analyzes the system.	1	Cannot identify dimensionality of a system.	Identifies dimensionality of the system but uses incorrect anlaytical approach.	Identifies dimesionality of the system and uses correct analytical approach to solve the problem.	Identifies dimensionality of the system, uses correct analytical approach, and provides alternative solution based on a lower dimension assumption.	3	no	
Solves the steady conduction equation and applies corrrect boundary conditions.	1	Cannot solve the steady conduction equation, even for a 1-D problem.	Solves the 1-D steady conduction equation but uses the wrong boundary conditions.	Solves the 1-D steady conduction equation using the correct boundary conditions.	Solves the 1-D and 2-D steady conduction equation using the correct boundary conditions.	**2**	yes	Provide supplemental material outside of text for solving 1-D conduction equation for a variety of problems.
Identifies when a transient conduction system is lumped.	1	Cannot identify when a transient conduction systgem is lumped.	Identifies when a transient conduction system is lumped but uses incorrect analytical approach.	Identifies when a transient conduction system is lumped and uses correct analytical approach.	Identifies when a transient conduction system is lumped, uses the correct analytical approach, and solves the problem including spatial effects for a contrast.	**3**	no	
Identifies the type of convection problem (forced/natural, external/internal)	1	Cannot identify the type of convection problem.	Identifies the type of convection problem but applies incorrect equations or empirical correlations.	Identifies the type of convection problem and applies correct equations or empiricall correlations.	Identifies the type of convection problem, applies correct equations or correlations, and uses alternative correlation for a contrast.	3	no	
Performs a correct analysis of a heat exchanger	1	Cannot even start a heat exchanger anlaysis.	Can perform a log-mean-temperature difference analysis only.	Can perform both a log-mean-temperature difference and an effectiveness NTU analysis.	Can perform both a log-mean-temperature difference and an effectiveness NTU analysis and contrasts results.	3	no	
Can effectively use temperature, pressure and flow sensors and interpret the data	6	Cannot take temperature, presssure or flow measurements.	Can take measurements but cannot correctly interpret the data.	Can take measurements and correctly interpret the data.	Can take measurements, correctly interpret the data, and conduct an error analysis.	3	no	
					Average Score for Course =	**2.7**		
					(Transfer this number to course continuous improvement record kept by dept. chair)			

C. Program and Contact Information

___ Information is current; no changes required.
Update if not current:

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D. Assessment Plan (please see our website for details on how to develop a program assessment plan)

___ Information is current; no changes required.

Update if not current: (this update can be via a Google Sheet if that iss easiest; we can then embed the Google Sheet on your program web page, as we do with the curriculum grid).

The ME program uses four assessment instruments for student learning.

· Course rubrics
· Graduate survey
· Industrial Advisory Board recommendations
· Senior Assessment Exam

Course Rubrics
When the ME program was first established in 2018, the faculty spent a great deal of effort defining a matrix of courses and student outcomes. For each course in the curriculum, a level of applicability for each student outcome was assigned. The levels of applicability are *low*, *medium* and *high*, designated by a blank, M and H, respectively, in the matrix. Table 1 is the matrix of courses and student outcomes. Only the student outcomes that ranked *high* in the matrix were assigned a performance indicator (PI) in the course rubric. Levels of applicability were assigned to courses outside the ME program as well, but none of them ranked higher than *medium*, so they were not connected to a PI and are therefore not shown in Table 1.

Table 1. Matrix of ME courses and student outcomes.

Matrix of ME courses and student outcomes	ME Student Outcomes 1 - 7						
ME CLASSES	1	2	3	4	5	6	7
ENGR 1000 Introduction to Engineering	M	M		M	M		
ENGR 2300 Thermodynamics	H						M
ENGR 2210 Circuits for Non - EE Majors	M					H	M
ENGR 2010 Statics	H						M
ENGR 2080 Dynamics	H						M
ENGR 2140 Mechanics of Materials	H						M
ENGR 2160 Materials Science & Engineering		M		H	M	H	
ME 3350 Engineering Computing			M				M
ME 3040 Dynamic System Modeling	H		M				M
ME 3300 Fluid Mechanics	H					H	M
ME 3050 Machine Design	H						M
ME 3500 Numerical Methods for Engineers	H						H
ME 4000 Heat Transfer	H					H	
ME 3060 Sensors, Instrumentation & Control Systems	M				H	H	
ME 4100 Senior Project 1	H	H	H	M	H		H
ME 4200 Senior Project 2	M	H	H	H	H		
ME 4990 Seminar in Mechanical Engineering			H	H			H
Blank = Low Applicability							
M = medium applicability							
H = high applicability							

After each semester, faculty prepare a rubric for each ME course they taught by assigning a level of achievement to each PI for the student outcomes in the rubric. The levels of achievement are (1) unsatisfactory, (2) developing, (3) satisfactory and (4) exemplary. A recent example of a course rubric is shown below in Table 2.

Table 2. Course rubric example for ME Heat Transfer. [(1)]

Mechanical Engineering Course Rubric								
COURSE	**ME 4000 Heat Transfer**							
SEMESTER	**Spring**							
YEAR	**2020**						S = 1 or 2: action initiated by instructor	
INSTRUCTOR	**Hagen**						S = 3 or 4: no action initiated by instructor	
Performance Indicator (PI)	Student Outcomes	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Exemplary	Score (S)	Initiate action by instructor ?	Action to be initiated
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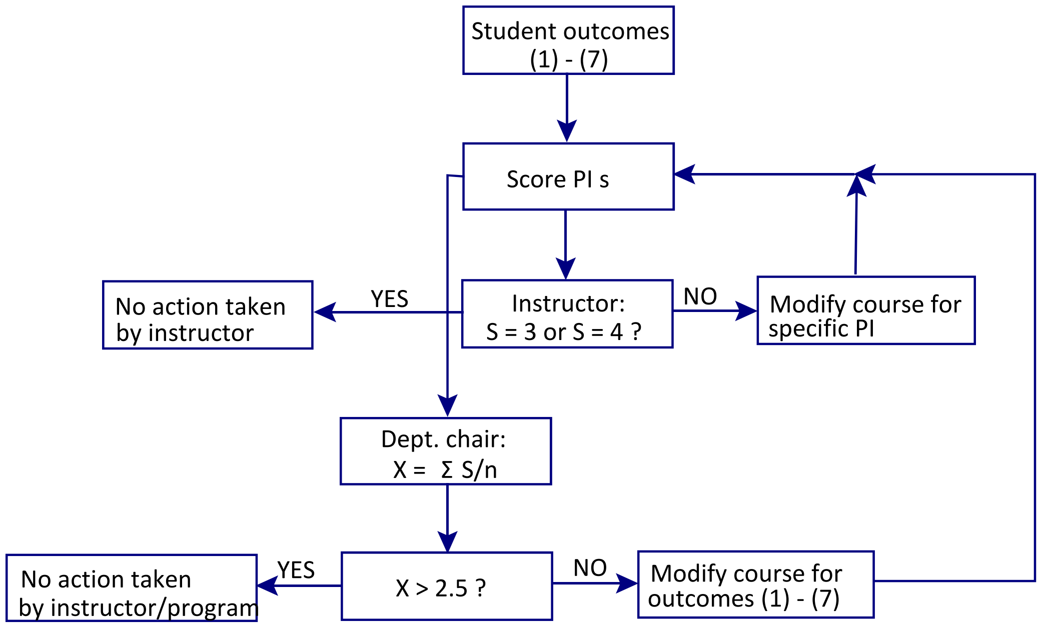
Identifies when radiation should be used in a problem involving external convection and uses applicable equations.	1	Cannot identify when radiation should be included with external convection.	Recognizes that radiation should be included but fails to use the correct radiation relations.	Recognizes that radiation should be included and uses the correct radiation relations.	Recognizes that radiation should be included, uses the correct radiation relations, and calculates the relative contributions of convection and radiation.	2	yes	Incorporate additional examples to show the relative impact of radiation in a convection problem.
Uses and applies good assumptions in a heat transfer analysis.	1	Uses bad assumptions or makes no assumtions at all.	States good assumtions but does not apply them properly.	Uses good assumptions and correctly applies them in the analysis.	Uses good assumptions, correctly applies them, and contrasts results if different assumptions are used.	3	no	
Identifies dimensionality (1-D, 2-D or 3-D) of a system and correctly analyzes the system.	1	Cannot identify dimensionality of a system.	Identifies dimensionality of the system but uses incorrect anlaytical approach.	Identifies dimesionality of the system and uses correct analytical approach to solve the problem.	Identifies dimensionality of the system, uses correct analytical approach, and provides alternative solution based on a lower dimension assumption.	3	no	
Solves the steady conduction equation and applies corrrect boundary conditions.	1	Cannot solve the steady conduction equation, even for a 1-D problem.	Solves the 1-D steady conduction equation but uses the wrong boundary conditions.	Solves the 1-D steady conduction equation using the correct boundary conditions.	Solves the 1-D and 2-D steady conduction equation using the correct boundary conditions.	**2**	yes	Provide supplemental material outside of text for solving 1-D conduction equation for a variety of problems.
Identifies when a transient conduction system is lumped.	1	Cannot identify when a transient conduction systgem is lumped.	Identifies when a transient conduction system is lumped but uses incorrect analytical approach.	Identifies when a transient conduction system is lumped and uses correct analytical approach.	Identifies when a transient conduction system is lumped, uses the correct analytical approach, and solves the problem including spatial effects for a contrast.	**3**	no	
Identifies the type of convection problem (forced/natural, external/internal)	1	Cannot identify the type of convection problem.	Identifies the type of convection problem but applies incorrect equations or empirical correlations.	Identifies the type of convection problem and applies correct equations or empiricall correlations.	Identifies the type of convection problem, applies correct equations or correlations, and uses alternative correlation for a contrast.	3	no	
Performs a correct analysis of a heat exchanger	1	Cannot even start a heat exchanger anlaysis.	Can perform a log-mean-temperature difference analysis only.	Can perform both a log-mean-temperature difference and an effectiveness NTU analysis.	Can perform both a log-mean-temperature difference and an effectiveness NTU analysis and contrasts results.	3	no	
Can effectively use temperature, pressure and flow sensors and interpret the data	6	Cannot take temperature, presssure or flow measurements.	Can take measurements but cannot correctly interpret the data.	Can take measurements and correctly interpret the data.	Can take measurements, correctly interpret the data, and conduct an error analysis.	3	no	
					Average Score for Course =	**2.7**		
					(Transfer this number to course continuous improvement record kept by dept. chair)			

1. The faculty will make improvements in the program utilizing this assessment instrument upon larger sample sizes that have some statistical significance affecting the continuous improvement of the program.

The process for using the rubrics to improve courses is illustrated in Figure 1. The continuous improvement process for courses occurs on two levels - the course level and the program level. At the course level, the instructor makes independent improvements to the course. When the score, S, for a given PI is 3 or greater, no action is taken by the instructor to improve the course. When S falls below 3, the instructor identifies corrective actions to implement the next time that he/she teaches the course.

At the program level, the instructor, with input from department faculty, makes improvements to the course. If the mean score for a given course is 2.5 or greater, no action is taken to improve the course, but a mean score of less than 2.5 suggests deficiencies in the course that require discussion and correction by the instructor and/or program faculty. For the rubric shown in Table 3, the action is to be initiated by the instructor for two PIs, but no program level action is required.



Definitions: PI = Performance Indicator for a specific student learning outcome

S = PI score

$X = \Sigma S/n$ (mean PI score for the course)

Figure 1. Course rubric application for closing the loop in continuous improvement.

We have been using course rubrics as a student outcome assessment instrument since the fall semester of 2019. When a course-level trigger occurs, it is the responsibility of the faculty member to initiate action and implement improvement in that particular course.

Graduate Survey

The graduate survey is a ten-question survey instrument administered to seniors at graduation. Each question asks graduates to indicate the degree to which the student learning outcome was achieved in their program. The responses are given on the following five-point Likert scale: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree. The trigger point was set by faculty at 3.5.

Industrial Advisory Board recommendations

The Industrial Advisory Board (IAB) consists of program faculty and staff members, engineering managers and engineers from local engineering companies and at least one senior ME student. The primary role of the IAB is to periodically evaluate the ME programs and make recommendations for improvement. Board members sometimes represent the companies with whom our graduates are employed, so they have a unique and direct impact on the direction and educational objectives of the program.

The IAB typically convenes once per year in the fall semester. Topics and issues discussed by this board include, but are not necessarily limited to, the following:

1. Review of program educational objectives
2. Program structure
3. Content of courses
4. Declared majors and course enrollments
5. Graduate projections
6. Internship opportunities
7. Full-time hiring projections
8. Trends in the advancement of technology

Senior Assessment Exam
The engineering faculty decided that we needed an instrument to directly and globally assess the technical knowledge of our senior students. We discussed using the Fundamentals of Engineering (FE) examination administered by the National Council of Examiners for Engineering and Surveying (NCEES). However, we did not want to be constrained by the lack of detailed score reporting, cost, and timing of the FE examination, so we designed an internal exam that resembles the FE exam. Questions similar or identical to those in old FE review manuals were chosen to build the exam.

The exam covers the following 12 topics:

Statics	Mechanics of Materials	Dynamics
Material Science	Machine Design	Thermodynamics
Fluid Mechanics	Heat Transfer	
Control Systems	Dynamic System Modeling	
Diversity	Ethics & Professionalism	

The exam consists of 84 questions that students work through. It is an open book, open notes and no time limit. Students can have two attempts where their best score is recorded. The exam counts as 40% of their grade in the senior seminar class.

New: High Impact Educational Experiences in the Curriculum
In response to the recent USHE requirement that all students have at least 1 HIEE in the first 30 credit hours and 1 HIEE in the major or minor we are asking programs to map HIEEs to curriculum using a traditional curriculum grid. This helps demonstrate how and where these goals are accomplished.

	Department/Program use of High Impact Educational Experiences				
Courses	HIEE 1	HIEE 2	HIEE 3		
ENGR 1000	Project Based Learning	Team Based Learning			
ME 4200 Senior Project II	Project Based Learning	Team Based Learning	Research		

HIEEs include capstone courses or experiences, community-engaged learning, evidence-based teaching practices, internships, project-based learning, study abroad/away, supplemental instruction, team-based learning, undergraduate research, pre-professional/career development experiences.

F. Report of assessment results since the last report:

Course rubrics

There are 123 performance indicators associated in the course rubrics to assess student-learning outcomes. The course rubric application (Fig.1) in the assessment plan for closing the loop in continuous improvement has been triggered 17 times. The faculty teaching these courses have initiated action to improve the performance indicators that have been triggered, closing the loop for assessment and student learning.

Graduate Survey

Table 3 is a summary of the graduate survey results. The numbers in the table are mean values for the graduating cohort. The survey also asks the graduate to provide feedback on the strengths, weaknesses and recommend changes of the ME program.

Table 3. Graduate survey results. (1)

		Student Outcome						
Year/Semester	Sample Size	1	2	3	4	5	6	7
2019/Fall	1	5	4	5	5	4	5	5
2020/Spring	4	4.5	4.75	4.5	4	4.5	4.75	4.5

1. The faculty will make improvements in the program utilizing this assessment instrument upon larger sample sizes that have some statistical significance affecting the continuous improvement of the program.

Industrial Advisory Board recommendations

The ME program educational objectives have been reviewed, but not revised, actionable recommendations of the IAB have been reviewed, and to the extent possible, implemented. Table 4 is a summary of ME IAB recommendations over these two years and corresponding actions taken.

Table 4. ME Industrial Advisory Board recommendations and actions taken.

Year	Recommendation	Action Taken
Fall 2018	1. Need to hire additional faculty to support program 2. Faculty with Aerospace background may be an asset to the ME department	1. New position requisition to hire a tenure track ME, Ph.D. 2. Noted and will open future requisitions to include aerospace engineering
Fall 2019	1. Current grads need better Excel skills 2. Grads need to improve technical writing skills 3. Need to improve or have a better understanding of GD&T	1. Noted under advisement 2. ME grads are required to take ENGL 3100 Professional & Technical Writing 3. Reinforce ASME Y14.5 GD&T in the PDD 1010 and ME 4990 classes

Senior Assessment Exam

The exam was administered to students in ME 4990 for the first time during the fall of 2019. Table 5 is a summary of the mean scores. The sample size was (1) in 2019 and (4) in 2020. Once again, we will be collecting ongoing data each year until we can statistically use this as a sustainable assessment measurement tool for continuous improvement.

Table 5. Senior assessment exam results (semester mean scores)

Semester/Year	Mean Score %	Sample Size
Fall 2019	89.2	1
Spring 2020	85.7	4

Appendix A

Most departments or programs receive a number of recommendations from their Five/Seven-Year Program Review processes. This page provides a means of updating progress towards the recommendations the department/program is enacting.

Appendix B

Please provide the following information about the full-time *and adjunct faculty* contracted by your department during the last academic year (summer through spring). Gathering this information each year will help with the headcount reporting that must be done for the final Five Year Program Review document that is shared with the State Board of Regents.

Faculty Headcount	2017-18	2018-19	2019-20
With Doctoral Degrees (Including MFA and other terminal degrees, as specified by the institution)			
Full-time Tenured	2	2	2
Full-time Non-Tenured (includes tenure-track)	2	2	2
Part-time and adjunct	1	1	1
With Master's Degrees			
Full-time Tenured	1	1	1
Full-time Non-Tenured	1	1	1
Part-time and adjunct		1	1
With Bachelor's Degrees			
Full-time Tenured			
Full-time Non-tenured			
Part-time and adjunct			
Other			
Full-time Tenured			
Full-time Non-tenured			
Part-time			
Total Headcount Faculty	7	8	8
Full-time Tenured	3	3	3
Full-time Non-tenured	4	3	3
Part-time		2	2

Please respond to the following questions.

1) First year student success is critical to WSU's retention and graduation efforts. We are interested in finding out how departments support their first-year students. Do you have mechanisms and processes in place to identify, meet with, and support first-year students? Please provide a brief narrative focusing on your program's support of new students:

   EAST advisors and program coordinators meet with students that need support.

   a. **Any** first-year students taking courses in your program(s) Yes

   b. Students declared in your program(s), whether or not they are taking courses in your program(s) Yes

2) A key component of sound assessment practice is the process of 'closing the loop' – that is, following up on changes implemented as a response to your assessment findings, to determine the impact of those changes/innovations. It is also an aspect of assessment on which we need to improve, as suggested in our NWCCU mid-cycle report. Please describe the processes your program has in place to 'close the loop'.

   This is addressed in Section D assessment plan, Figure 1, course rubric application for closing the loop in continuous improvement.