OREGON INSTITUTE OF TECHNOLOGY
Mechanical Engineering Program

Mechanical Engineering Assessment Report 2008-09

September 7, 2009

INTRODUCTION

This report documents the assessment done within the Mechanical Engineering (ME) program at Oregon Institute of Technology during the 2008-09 school year.

The ME program is using a three year assessment cycle. In this, each outcome is assessed at least once every three years. The document "Mechanical Engineering Program Assessment Plan" documents this plan over the three year cycle. The outcomes being assessed within the 2008-09 school year are summarized here, both the assessment being done and results of these assessments. For the overall three year cycle the reader is referred to the program's assessment plan.

PROGRAM MISSION STATEMENT AND EDUCATIONAL OBJECTIVES

The mission statement of the ME Program is in line with and built upon the mission statements of the Institution and the Department. The ME program's Mission Statement and Program Educational Objectives are stated as:

Mechanical Engineering Program Mission Statement

The Mechanical Engineering Program at Oregon Institute of Technology is an applied engineering program. Its mission is to provide graduates the skills and knowledge for successful careers in mechanical engineering.

Mechanical Engineering Program Educational Objectives

Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. The Program Educational Objectives of OIT's mechanical engineering program are to produce alumni who:

- *are able to analyze, design and improve practical thermal and mechanical systems.*
- *communicate effectively and work well on team-based engineering projects.*
- *succeed in entry-level mechanical engineering positions regionally and nationally.*
- *pursue continued professional development, including professional registration if desired.*
- *have the skills and knowledge to pursue engineering graduate studies and research, if desired.*

EDUCATIONAL OUTCOMES

The ME program's Student Learning Outcomes are aligned with ABET EAC outcomes. These are stated as:

(a) an ability to analyze and model physical systems or components using (apply knowledge of) mathematics (including multi-variable calculus and differential equations), basic science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design and realize a physical 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
(m1) Graduates will be able to work professionally in the area of thermal systems
(m2) Graduates will be able to work professionally in the area of mechanical systems.

These outcomes mirror those of the EAC of ABET. Outcomes (a) and (c) have been slightly modified to better represent ABET's Mechanical Engineering program specific criteria. Also, outcomes (m1) and (m2) have been added also to address ABET's Mechanical Engineering program specific criteria.

ASSESSMENT CYCLE

Assessment within the MMET Department is done on a three-year cycle. Each outcome is assessed at least once every three years. The schedule for assessment activities for the ME Program is shown in Table I.

TABLE 1 : Assessment Cycle

Educational Outcome	*2008-09*	*2009-10*	*2010-11*	*TAC*
Review Program Mission and Educational Objectives	x			
Assess Program Educational Objectives		x		
a) Graduates will have the ability to analyze and model physical systems or components using (apply knowledge of) mathematics (including multi-variable calculus and differential equations), basic science and engineering	x			b
b) Graduates will have the ability to design and conduct experiments, as well as to analyze and interpret data.			x	c
c) Graduates will be able to design and realize a physical system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	x			d
d) Graduates will be able to function on multi-disciplinary teams.		x		e
e) Graduates will be able to identify, formulate, and solve engineering problems. Graduates will be able to analyze and model physical systems or components using principles of engineering, basic science and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems or components.	x			f
f) Graduates will have an understanding of professional and ethical responsibility.		x		i
g) Graduates will have the ability to communicate effectively.			x	g
h) Graduates will have the broad education necessary to		x		j

Educational Outcome	*2008-09*	*2009-10*	*2010-11*	*TAC*
understand the impact of engineering solutions in a global, economic, environmental, and social context.				
i) Graduates will recognize the need for, and have the ability to engage in life-long learning.			x	h
j) Graduates will have a knowledge of contemporary issues			x	j
k) Graduates will be able to use the techniques, skills, and modern engineering tools necessary for engineering practice.			x	a
m1) Graduates will be able to work professionally in the area of thermal systems.	x			
m2) Graduates will be able to work professionally in the area of mechanical systems.	x			

Note that ME Program Mission and Program Educational Objectives are to be assessed along with program Student Learning Outcomes.

The MMET Department consists of both engineering and engineering technology programs. The ABET outcomes for engineering and engineering technology are quite similar. The engineering technology outcomes (a-k) are listed in Table I for reference.

MISSION STATEMENT AND PROGRAM EDUCATIONAL OBJECTIVES REVIEW

The ME Program Mission Statement and Program Educational Objectives are reviewed and updated through the assessment process. At the beginning of each assessment cycle the faculty and select constituents will review and, as necessary, revise them. If revised, the revisions will be reviewed by a broader constituency.

The ME program underwent its initial ABET visit during the fall of 2008. It was determined during that visit that the ME program's Educational Objectives needed revision. With this realization the Mission and Objectives were reviewed by the faculty. It was felt the ME Mission Statement still represented the ME program's overall focus. New Program Educational Objectives were drafted by the faculty. The Mission and Objectives were then sent to the Industrial Advisory Committee (IAC) for review. The IAC is composed of industrial members, alumni and educational professionals giving a reasonable cross section of our constituents. They felt, as the faculty did, that the Mission Statement was still appropriate but several changes to the draft Objectives resulted. After IAC review the Mission and final draft of the new Objectives were sent to a broader cross section of constituents for review. Upon receiving and reviewing these comments, the new Objectives were adopted.

The revised, and now current, Mission Statement and Program Educational Objectives for the ME program are presented above.

SUMMARY OF 2008-09 ASSESSMENT ACTIVITIES

As seen in the above assessment cycle, outcomes a, c, e, m1 and m2 were assessed during the 2008-09 school year. This being the first year of the three year cycle, the program's Mission Statement and

Program Educational Objectives were also reviewed. Each Student Learning Outcome is broken down into several Performance Criteria to be assessed individually.

Following are the assessment results for the SLOs addressed during 2008-09.

OUTCOME (a): Mathematics, Science & Core Engineering

Graduates will have the ability to analyze and model physical systems or components using (apply knowledge of) mathematics (including multi-variable calculus and differential equations), basic science and engineering.

The Performance Criteria to consider in assessing this outcome are:

1. Apply math principles to obtain analytical or numerical solution(s) to an engineering problem
2. Apply scientific principles that govern the performance of a given process or system in engineering problem(s)
3. Apply engineering principles that govern the performance of a given process or system in engineering problem(s)
4. Apply appropriate technology tools (software, equipment, CAD, CNC, instrumentation, etc.) for a given process or system to an engineering problem

Assessment Method: Pre-Exams

Faculty of the ME program administer “Pre-Exams” in selected junior level mechanical engineering courses. These pre-exams evaluate a cross section of the prerequisite mathematics, science and core engineering knowledge needed in the ME program. They will indicate to the instructor and students what prerequisite material, if any, needs review and in general indicate how effective the mathematic, science and core engineering courses are. These entry exams were given in the following courses.

Course	*Performance Criteria*
MECH 312 Advanced Dynamics	4
MECH 315 Machine Design I	1, 3
MECH 318 Fluid Mechanics I	1, 2

Each set of pre-exams were reviewed by the faculty member giving that exam using an analytic rubric.

Tables 3, 4 and 5 show the results from pre-exams in MECH 312, MECH 315 and MECH 318 respectively.

Table 3 shows results from a spring 2009 MECH 312 Advanced Dynamics class. This evaluation represents a Pre-Exam assessment of 7 students.

Table 4 shows results from a winter 2009 MECH 315 Machine Design I class. This evaluation represents a Pre-Exam assessment of 23 juniors within the Mechanical Engineering program.

Table 5 presents results from a fall 2009 MECH 318 Fluid Mechanics class. This evaluation represents a Pre-Exam assessment of 11 juniors within the Mechanical Engineering program.

Table 3. Assessment Results for SLO a, spring term 2009, MECH 312, 7 juniors

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Apply math principles to an engineering problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	86%
Apply scientific principles in engineering problem(s)	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	71%
Apply engineering principles in engineering problem(s)	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	86%
Apply appropriate engineering tools to an engineering problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%

Table 4. Assessment Results for SLO a, winter term 2009, MECH 315, 23 juniors

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Apply math principles to an engineering problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Apply scientific principles in engineering problem(s)	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Apply engineering principles in engineering problem(s)	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	74%
Apply appropriate engineering tools to an engineering problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%

Table 5. Assessment Results for SLO a, fall term 2008, MECH 318, 11 juniors

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Apply math principles to an engineering problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	73%
Apply scientific principles in engineering problem(s)	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	27%
Apply engineering principles in engineering problem(s)	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	55%
Apply appropriate engineering tools to an engineering problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	N/A

The graded Pre-Exams and faculty rubric evaluations have been retained in electronic form. They are kept on a shared drive at OIT and available to OIT faculty and staff.

These results show a large discrepancy in assessments. Two assessments show the students mathematical skills at this stage proficient or highly proficient while the third evaluation put this at 73%, below the aspired to 80%. Assessment of using scientific principles showed an even larger discrepancy. The evaluations here were 73%, 100% and 27%. Two assessments fell below the desired 80%, one of these by a wide margin. Assessment of the students' application of core engineering principles had a large spread but not as wide as in scientific principles. In core engineering principles two evaluations fell below 80%, at 73% and 55% with the third at 86%. Two assessments showed all students with high proficiency in using engineering tools, the third assessment found the assignment was not appropriate for this evaluation.

Assessment Method: MMET Senior Survey

As part of the ME capstone course students were asked to complete a senior survey. This was done through Survey Monkey. Sixteen ME students responded to the survey, 75% graduating this spring term and another 19% graduating summer or fall 2009. 88% reported a GPA above 3.0 with 50% reporting GPA above 3.5. 62% are planning to obtain a mathematics minor. Only 25% participated in a MECOP internship. 60% felt their education prepared them to take the FE Exam, however the survey did not attempt to break this down further. Each respondent was asked to judge how well their education prepared them in each SLO.

40% of the responding students transferred in 9 or less credits. 56% started mathematics at algebra or trigonometry while 25% started in differential calculus or above. For this particular SLO, "mathematics, science, and core engineering", 75% felt highly prepared and 25% felt prepared. No respondents reported feeling inadequately prepared.

Assessment Method: Fundamentals of Engineering Exam

The Fundamentals of Engineering Exam is taken by all ME students the term before graduation. The results from the spring 2009 exam will not be known until summer 2009. Thus results from the prior year's exam, spring 2008, are used here. This data is sketchy as only three graduates sat for the exam that year. All three passed the FE Exam.

Results from the FE Exam are broken down into disciplines. Those relevant to math, science and core engineering are tabulated in Table 6.

FE Exam results in mathematics, science and core engineering are all in general slightly above the national average but generally on par. It should be remembered that only three students are represented in this data.

Table 6. FE Exam Results from spring 2008, 3 participants

Discipline	***OIT ME***	***National Avg.***	**National Std. Dev.**
Mathematics	74%	75%	15%
Prob. & Statistics	79%	68%	21%
Chemistry	73%	71%	18%
Computers	83%	85%	16%
Eng. Mechanics	87%	73%	17%
Strength of Materials	75%	65%	18%
Material Properties	71%	77%	18%
Fluid Mechanics	75%	73%	20%
Electricity & Mag.	76%	69%	21%
Thermodynamics	62%	63%	20%

OUTCOME (c): Design a System, Component or Process within Realistic Constraints

> *Graduates will be able to design and realize a physical system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.*

The Performance Criteria to consider in assessing this outcome are:

1. Identify an appropriate set of realistic constraints and performance criteria.
2. Generate one or more creative solutions to meet the criteria and constraints.
3. Create a detailed design to meet the criteria within the realistic constraints.
4. Plan and manage a small technical project.

Assessment Method: Review Project Reports

Project Final Reports were reviewed by the faculty member(s) giving the assignment. Project reports in Machine Design II, Fluid Mechanics I, and Senior Projects were assessed. An analytic rubric was used in each case to assess the students' ability to meet the Performance Criteria.

Tables 7, 8 and 9 show the results from project report review in MECH 316, MECH 318 and Senior Projects respectively.

Table 7 shows assessment results from MECH 316 taught in the spring term 2009. The assignment was a final report of a term long design project. There were 17 juniors in the class.

Table 8 lists the assessment results from MECH 318, Fluid Mechanics taught fall term of 2008. The assignment assessed was a final report of a term long design project. There were 11 mechanical engineering juniors in the class.

Assessment results from MECH 492, Senior Projects taught spring term of 2009, are shown in Table 9. The assignment assessed was the final report developed for this three term sequence. As the project teams are a mix of Mechanical Engineering, Mechanical Engineering Technology and Manufacturing Technology the results are not purely ME related but the information is none the less useful. There were 11 senior projects in 2008-09 of which 8 were assessed.

Table 7. Assessment Results for SLO c, spring term 2009, MECH 316, 17 juniors

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Identify an appropriate set of realistic constraints and performance criteria.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	80%
Generate one or more creative solutions.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	73%
Create a detailed design within realistic constraints.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	40%
Plan and manage a small technical project.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	60%

Table 8. Assessment Results for SLO c, fall term 2008, MECH 318, 11 juniors

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Identify an appropriate set of realistic constraints and performance criteria.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Generate one or more creative solutions.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Create a detailed design within realistic constraints.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	73%
Plan and manage a small technical project.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%

Table 9. Assessment Results for SLO c, spring term 2009, MECH 492, 8 project teams

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Identify an appropriate set of realistic constraints and performance criteria.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	88%
Generate one or more creative solutions.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Create a detailed design within realistic constraints.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Plan and manage a small technical project.	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	88%

In the eight senior projects none were judged to be unacceptable.

Assessment Method: MMET Senior Survey

As part of the ME capstone course students were asked to complete a senior survey. The process and general results are briefly explained in Outcome (a) above.

For this outcome, "Design a System, Component or Process within Realistic Constraints", 56% felt they were highly prepared and 44% felt prepared. No respondents reported feeling inadequately prepared.

OUTCOME (e): Identify, Formulate and Solve Engineering Problems

> *Graduates will be able to identify, formulate, and solve engineering problems. Graduates will be able to analyze and model physical systems or components using principles of engineering, basic science and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems or components.*

The Performance Criteria to consider in assessing this outcome are:

1. Identify an engineering problem.
2. Make appropriate assumptions.
3. Formulate a plan which will lead to a solution.
4. Apply engineering principles to analyze the problem.
5. Document results in an appropriate format.

These performance criteria are taught throughout the ME curriculum including all MECH courses. A review of lab reports was used for assessment. In addition, surveys of graduating seniors was used.

Assessment Method: Review Lab Reports

Selected Lab Reports were reviewed by the faculty member(s) giving the assignment. Reports from Finite Element Analysis (MECH 351), Fluid Mechanics II (MECH 318), Heat Transfer II (MECH 437) and Vibrations (MECH 480) were to be assessed. Collection of assignments from MECH 351 were missed, so no results from these assignments are included. An analytic rubric was used to assess the students' ability to meet the Performance Criteria.

Tables 10, 11 and 12 show the results from assessment in MECH 417, MECH 437 and MECH 480 respectively. An analytical rubric was used in each case.

Table 10 indicates the results from MECH 417 Fluid Mechanics II. The assessment included 17 mechanical engineering juniors and a laboratory report was used.

Table 11 shows results from MECH 437 Heat Transfer Laboratory. 18 mechanical engineering juniors were included in the sample. Again, a laboratory report was used as the assessed assignment.

Assessment results from MECH 437 Heat Transfer Laboratory are given in Table 12. 17 mechanical engineering juniors were included in the sample. A laboratory report was used as the assessed assignment.

Table 10. Assessment Results for SLO c, winter term 2009, MECH 417, 17 juniors

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Identify an Engineering Problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Make appropriate assumptions	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Formulate a plan which will lead to a solution	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Apply engineering principles to analyze the problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	N/A
Document results in an appropriate format	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%

Table 11. Assessment Results for SLO c, winter term 2009, MECH 437, 18 juniors

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Identify an Engineering Problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Make appropriate assumptions	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Formulate a plan which will lead to a solution	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Apply engineering principles to analyze the problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Document results in an appropriate format	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	72%

All assessors agreed the students were able to “Identify an engineering problem,” “Make appropriate assumptions” and “Formulate a plan which will lead to a solution”. Results here were all over the 80% threshold. Results regarding “Apply engineering principles to analyze the problem” indicate students are doing well with two reviewers rating 100% and 94% of the students proficient or highly proficient. One of the three reviewers felt the assignment used was not applicable to this performance criteria. In the last performance criteria, “Document results in an appropriate format”, two evaluations showed all, 100%, of students were able to document their results proficiently while the third assessment fell slightly short of the threshold at 72%.

Table 12. Assessment Results for SLO c, winter term 2009, MECH 480, 17 juniors

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Identify an Engineering Problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Make appropriate assumptions	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	94%
Formulate a plan which will lead to a solution	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	88%
Apply engineering principles to analyze the problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	94%
Document results in an appropriate format	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%

Assessment Method: MMET Undergraduate Exit Survey

As part of the ME capstone course students were asked to complete a senior survey. The process and general results are briefly explained in Outcome (a) above.

For this outcome, "Identify, Formulate and Solve Engineering Problem," 87% felt they were highly prepared and 13% felt prepared. No respondents reported feeling inadequately prepared.

OUTCOME (me1): Thermal Systems

Graduates will be able to work professionally in the area of thermal systems.

The Performance Criteria, and assessment tools, used in Outcome E will be used here to assess student abilities related to thermal systems. Those performance criteria are then:

1. Identify an engineering problem.
2. Make appropriate assumptions.
3. Formulate a plan which will lead to a solution.
4. Apply engineering principles to analyze the problem.
5. Document results in an appropriate format.

Assessment Method: Review Lab Reports

Selected Lab Reports were reviewed by the faculty member(s) assigning those labs. Reports from Fluid Mechanics II (417 MECH) and Heat Transfer II (MECH 437) were assessed. An analytic rubric was used to assess the students' ability to meet these Performance Criteria. This was the same rubric used in Outcome (e) above.

Tables 13 and 14 show the results from assessment in MECH 417 and MECH 437 respectively.

Table 13 lists the assessment results from MECH 417, Fluid Mechanics II, taught winter term of 2009. The assignment assessed was a laboratory report. There were 17 mechanical engineering juniors in the class.

Table 13. Assessment Results for SLO c, winter term 2009, MECH 417, 17 juniors

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Identify and Engineering Problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Make appropriate assumptions	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Formulate a plan which will lead to a solution	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Apply engineering principles to analyze the problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	N/A
Document results in an appropriate format	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%

Table 14 lists the assessment results from MECH 437, Heat Transfer Laboratory, taught winter term of 2009. The assignment assessed was a laboratory report. There were 18 mechanical engineering juniors in the class.

Table 14. Assessment Results for SLO c, winter term 2009, MECH 437, 18 juniors

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Identify and Engineering Problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Make appropriate assumptions	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Formulate a plan which will lead to a solution	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Apply engineering principles to analyze the problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Document results in an appropriate format	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	72%

As with Outcome (e) the assessments show all students, 100%, were able to adequately “Identify an engineering problem,” “Make appropriate assumptions” and “Formulate a plan which will lead to a solution” related to thermal systems. As for student ability to “Apply engineering principles to analyze the problem” one reviewer judged 100% of the students performed with proficiency or high proficiency. The second reviewer didn't feel the assignment assessed was adequate to judge this performance.

Assessment related to students' ability to "Document results in an appropriate format" showed some inconsistency. Here one assessment found all students proficient or highly proficient while the other found 72% of students in this category.

Assessment Method: Fundamentals of Engineering Exam

The Fundamentals of Engineering Exam is taken by all ME students the term before graduation. The results from the spring 2009 exam will not be known until summer 2009. Thus results from the prior years exam, spring 2008, is used here. This data is sketchy as only three graduates sat for the exam that year. All three passed the FE Exam.

Results from the FE Exam are broken down into disciplines. Those relevant to thermal sciences are tabulated in Table 15.

Table 15. FE Exam Results from spring 2008, 3 participants

Discipline	***OIT ME***	***National Avg.***	***National Std. Dev.***
Thermo. & Energy Conversion	44%	44%	19%
Fluid Mechanics & Fluid Machinery	52%	58%	20%
Heat Transfer	67%	47%	23%
Refrigeration & HVAC	56%	48%	22%

Results from the FE Exam related to thermal systems are near the national averages, and above the average in Heat Transfer and Refrigeration & HVAC. It should be remembered that only three students are represented in this data.

Assessment Method: MMET Senior Survey

As part of the ME capstone course students were asked to complete a senior survey. The process and general results are briefly explained in Outcome (a) above.

For this outcome, "thermal systems", 44% felt they were highly prepared and 15% felt prepared. 6%, one respondent, reported feeling inadequately prepared.

OUTCOME (me2): Mechanical Systems

Graduates will be able to work professionally in the area of mechanical systems.

The Performance Criteria, and assessment tools, used in Outcome E will be used here to assess student abilities related to mechanical systems. Those performance criteria are then:

1. Identify an engineering problem.
2. Make appropriate assumptions.
3. Formulate a plan which will lead to a solution.
4. Apply engineering principles to analyze the problem.
5. Document results in an appropriate format.

Assessment Method: Review Lab Reports

Selected Lab Reports were reviewed by the faculty member(s) assigning those labs. Reports from Finite Element Analysis and Vibrations were to be assessed. The collection of assignments in MECH 351 were missed fall term; these will be collected fall term 2009. An analytic rubric was used to assess the students' ability to meet the Performance Criteria. This was the same rubric used in Outcome (e) above.

Tables 16 show the results from assessment in MECH 480. This involved reviewing one lab report and completing an analytic rubric.

Table 16. Assessment Results for SLO c, winter term 2009, MECH 480, 17 juniors

Performance Criteria	Assessment Method	Measurement Scale	Minimum Acceptable Performance	Results
Identify and Engineering Problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%
Make appropriate assumptions	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	94%
Formulate a plan which will lead to a solution	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	88%
Apply engineering principles to analyze the problem	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	94%
Document results in an appropriate format	Rubric-graded project	1-4 proficiency scale	80% score 3 or 4	100%

This assessment in MECH 480 showed good performance in all areas.

Assessment Method: Fundamentals of Engineering Exam

The Fundamentals of Engineering Exam is taken by all ME students the term before graduation. The results from the spring 2009 exam will not be known until summer 2009. Thus results from the prior years exam, spring 2008, is used here. This data is sketchy as only three graduates sat for the exam that year. All three passed the FE Exam.

Results from the FE Exam are broken down into disciplines. Those relevant to thermal sciences are tabulated in Table 17.

Table 17. FE Exam Results from spring 2008, 3 participants

Discipline	***OIT ME***	***National Avg.***	***National Std. Dev.***
Mechanical Design & Analysis	30%	35%	18%
Kinematics, Dynamics & Vibrations	85%	68%	18%
Materials & Processing	72%	46%	20%
Measurement, Instrumentation & Controls	56%	46%	22%

Results from the FE Exam related to mechanical systems show good results. While slightly below average in Mechanical Design & Analysis the other categories are notably above average. It should be remembered that only three students are represented in this data though.

Assessment Method: MMET Senior Survey

As part of the ME capstone course students were asked to complete a senior survey. The process and general results are briefly explained in Outcome (a) above.

For this outcome, "mechanical systems", 94% felt they were highly prepared and 6% felt prepared. No respondents reported feeling inadequately prepared.

SUMMARY OF STUDENT LEARNING OUTCOMES & ACTIONS TAKEN

An MMET Department meeting was held June 5, 2009 where assessment results related to the ME Program were discussed and considered. These discussions and resulting actions are documented in this section.

OUTCOME (a): Mathematics, Science & Core Engineering

- Mathematics – Rubric assessment was scattered while FE Exam results showed performance at or above the national average.
- Science – Rubric assessments showed a wide variation in results. The FE Exam has few basic science questions but those reviewed, chemistry, showed performance above the national average.
- Core Engineering – Rubric assessment was scattered while FE Exam results showed performance generally above national averages.
- Students felt they were well prepared in this Outcome

The conclusion of the faculty was that the outcome is being met. The most objective assessment by far is student performance on the nationally normed FE Exam. Review from this exam show performance generally above the national average. Surveys also indicated students felt well prepared related to this outcome.

There was discussion regarding the assignments used for our internal assessment via a rubric. It was recommended that the particular assignments used be reviewed before the next assessment cycle is undertaken for this outcome.

OUTCOME (c): Design a System, Component or Process within Realistic Constraints

- Assessment results from Fluid Mechanics and Machine Design showed room for improvement, particularly in "creating a detailed design within realistic constraints".
- Assessments from senior projects showed at least acceptable performance in all cases.
- Students felt they were adequately prepared.

Assessment results here are encouraging. Recommendations were made and curriculum modifications adopted in 2007-08 related to this outcome. At that time formal projects were added to Machine Design II and Fluid Mechanics I. Being their first major design experience performance is not expected to be exemplary and this is seen in the data. However, these projects lead into the senior projects cap stone sequence. Performance in senior projects seems to have improved since 2007-08 apparently due to this change.

The faculty noted this improvement and recommended no action be taken at this time.

OUTCOME (e): Identify, Formulate and Solve Engineering Problems

- Identifying an engineering problem – No difficulties noted
- Make appropriate assumptions – No difficulties noted
- Formulate a plan which will lead to a solution – No difficulties noted
- Apply engineering principles to analyze the problem – One reviewer felt the assignment used was not adequate to evaluate this performance criteria
- Document results in an appropriate format – One of three rubric reviews fell below our 80% threshold. There was some discrepancy between the evaluations.
- Students felt they were prepared.

The faculty felt this outcome is generally being met. No obvious area of improvement was noted.

The faculty did recommend a review of the assignments used for assessment through rubrics be reviewed before the next assessment cycle. Otherwise no actions were deemed necessary.

OUTCOME (me1): Thermal Systems

- Identifying an engineering problem – No difficulties noted
- Make appropriate assumptions – No difficulties noted
- Formulate a plan which will lead to a solution – No difficulties noted
- Apply engineering principles to analyze the problem – One of the two reviewer felt the assignment used was not adequate to evaluate this performance criteria
- Document results in an appropriate format – One, of two, rubric reviews fell below our 80% threshold. There was some discrepancy between the evaluations.
- Results from the FE Exam showed performance at or above national averages.

Assessment of this outcome through application of a rubric to selected assignment show very good results. A better assessment of this outcome is the nationally normed FE Exam. This showed performance in all areas on par or above national averages, in some cases above by a significant margin. The faculty felt no action was necessary.

OUTCOME (me2): Mechanical Systems

- Identifying an engineering problem – No difficulties noted
- Make appropriate assumptions – No difficulties noted
- Formulate a plan which will lead to a solution – No difficulties noted
- Apply engineering principles to analyze the problem – No difficulties noted
- Document results in an appropriate format – No difficulties noted
- Results from the FE Exam showed performance at or above national averages but for mechanical design and analysis. (The number of participants was very small)
- Students felt they were highly prepared regarding this Outcome.

Assessment results, both rubric assessment of assignments and review of FE Exam results showed excellent performance on this outcome. The faculty recommended no action.

RELATED CHANGES DUE TO PRIOR ASSESSMENTS

The recommendation, resulting from the 2007-08 assessment effort, suggested a review of Pre-Exams. The purpose was to bring more consistency across the department. Although an effort was made, results from the 2008-09 assessment shows improvements can still be made.

A concern was noted in the 2007-08 assessment in student ability to plan and manage an engineering project. Several small, but formal, term-long design projects were placed into the curriculum to give students additional experience before arriving at the capstone course, senior projects. These projects were implemented in MET 111-112, MECH 316 and MECH 318. It is felt that it is too early to judge the effectiveness of these changes but early indications are that they are helping.

The machine design sequence was reviewed for content applicable to the FE Exam. All material needed for the FE Exam was found to be taught in MECH 315 and MECH 316.

APPENDIX I
Student Learning Outcomes - Curriculum Maps

The curriculum maps below show the courses in which each SLO is introduced, emphasized or reinforced. This is a continuum as most SLOs are considered in all courses. However, the maps presented indicate the courses most instrumental in obtaining each SLO.

OUTCOME (a): Mathematics, Science & Core Engineering

	Freshman		*Sophomore*		*Junior*		*Senior*	
Fall	CHE 221	E	MATH 252	E	MATH 253N	E	MECH 323	R
	MET 111	I	MET 242	E	MFG 314		MECH 351	R
	WRI 121		PHY 221	E	MECH 318	R	MECH 490	R
	Hum/Soc Sci		WRI 227		MECH 363	E	WRI 321	
			Econ Elec		MET 375	E	MECH Elec	R
							Hum/Soc Sci	
Winter	CHE 222	E	ENGR 211	E	ENGR 212	E	MECH 417	R
	MET 112	I	MATH 254N	E	ENGR 355	E	MECH 436	R
	MFG 103		MATH 361	E	MECH 315	R	MECH 437	R
	WRI 122		PHY 222	E	MECH 360	R	MECH 491	R
					MET 326		WRI 322	
					SPE 321		PHIL 331	
							WRI 322	
Spring	MATH 251	E	ENGR 266	E	HUM 125		IMGT 345	
	MFG 120		ENGR 213	E	MATH 451	E	ENGR 485	
	MET 160	E	ENGR 236	E	MECH 312	R	MECH 480	R
	MET 241	E	MATH 321	E	MECH 313	R	MECH 492	R
	SPE 111		PHY 223	E	MECH 316	R	WRI 323	
							MECH Elec	R
							Hum/Soc Sci	

I = Introduced
R = Reinforced
E = Emphasized

OUTCOME (c): Design a System, Component or Process within Realistic Constraints

	Freshman		*Sophomore*		*Junior*		*Senior*	
Fall	CHE 221		MATH 252		MATH 253N		MECH 323	R
	MET 111	E	MET 242	R	MFG 314		MECH 351	R
	WRI 121		PHY 221		MECH 318	E	MECH 490	E
	Hum/Soc Sci		WRI 227		MECH 363	R	WRI 321	
			Econ Elec		MET 375	R	MECH Elec	R
							Hum/Soc Sci	
Winter	CHE 222		ENGR 211		ENGR 212	R	MECH 417	R
	MET 112	E	MATH 254N		ENGR 355	R	MECH 436	R
	MFG 103		MATH 361		MECH 315	R	MECH 437	R
	WRI 122		PHY 222		MECH 360		MECH 491	E
					MET 326		WRI 322	
					SPE 321		PHIL 331	
							WRI 322	
Spring	MATH 251		ENGR 266		HUM 125		IMGT 345	
	MFG 120		ENGR 213	R	MATH 451	R	ENGR 485	
	MET 160		ENGR 236		MECH 312	R	MECH 480	R
	MET 241	R	MATH 321		MECH 313	R	MECH 492	E
	SPE 111		PHY 223		MECH 316	E	WRI 323	
							MECH Elec	R
							Hum/Soc Sci	

I = Introduced
R = Reinforced
E = Emphasized

OUTCOME (e): Identify, Formulate and Solve Engineering Problems

	Freshman		*Sophomore*		*Junior*		*Senior*	
Fall	CHE 221		MATH 252		MATH 253N		MECH 323	E
	MET 111	I	MET 242		MFG 314		MECH 351	E
	WRI 121		PHY 221		MECH 318	E	MECH 490	E
	Hum/Soc Sci		WRI 227		MECH 363	E	WRI 321	
			Econ Elec		MET 375		MECH Elec	E
							Hum/Soc Sci	
Winter	CHE 222		ENGR 211	E	ENGR 212	E	MECH 417	E
	MET 112	I	MATH 254N		ENGR 355	E	MECH 436	E
	MFG 103		MATH 361		MECH 315	E	MECH 437	E
	WRI 122		PHY 222		MECH 360	E	MECH 491	E
					MET 326		WRI 322	
					SPE 321		PHIL 331	
							WRI 322	
Spring	MATH 251		ENGR 266	E	HUM 125		IMGT 345	
	MFG 120		ENGR 213	E	MATH 451	E	ENGR 485	R
	MET 160	I	ENGR 236	E	MECH 312	E	MECH 480	E
	MET 241		MATH 321		MECH 313	E	MECH 492	E
	SPE 111		PHY 223		MECH 316	E	WRI 323	E
							MECH Elec	E
							Hum/Soc Sci	

I = Introduced
R = Reinforced
E = Emphasized

OUTCOME (me1): Thermal Systems

	Freshman		*Sophomore*		*Junior*		*Senior*	
Fall	CHE 221		MATH 252		MATH 253N		MECH 323	E
	MET 111		MET 242		MFG 314		MECH 351	
	WRI 121		PHY 221		MECH 318	E	MECH 490	R
	Hum/Soc Sci		WRI 227		MECH 363	E	WRI 321	
			Econ Elec		MET 375		MECH Elec	R
							Hum/Soc Sci	
Winter	CHE 222		ENGR 211		ENGR 212		MECH 417	E
	MET 112		MATH 254N		ENGR 355	E	MECH 436	
	MFG 103		MATH 361		MECH 315		MECH 437	E
	WRI 122		PHY 222	I	MECH 360		MECH 491	R
					MET 326		WRI 322	
					SPE 321		PHIL 331	
							WRI 322	
Spring	MATH 251		ENGR 266		HUM 125		IMGT 345	
	MFG 120		ENGR 213		MATH 451		ENGR 485	
	MET 160		ENGR 236		MECH 312		MECH 480	
	MET 241		MATH 321		MECH 313	E	MECH 492	R
	SPE 111		PHY 223		MECH 316		WRI 323	
							MECH Elec	R
							Hum/Soc Sci	

I = Introduced
R = Reinforced
E = Emphasized

OUTCOME (me2): Mechanical Systems

	Freshman		*Sophomore*		*Junior*		*Senior*	
Fall	CHE 221		MATH 252		MATH 253N		MECH 323	
	MET 111		MET 242		MFG 314		MECH 351	E
	WRI 121		PHY 221	I	MECH 318		MECH 490	R
	Hum/Soc Sci		WRI 227		MECH 363		WRI 321	
			Econ Elec		MET 375		MECH Elec	R
							Hum/Soc Sci	
Winter	CHE 222		ENGR 211	E	ENGR 212	E	MECH 417	
	MET 112		MATH 254N		ENGR 355		MECH 436	E
	MFG 103		MATH 361		MECH 315	E	MECH 437	
	WRI 122		PHY 222		MECH 360		MECH 491	R
					MET 326		WRI 322	
					SPE 321		PHIL 331	
							WRI 322	
Spring	MATH 251		ENGR 266		HUM 125		IMGT 345	
	MFG 120		ENGR 213	E	MATH 451		ENGR 485	
	MET 160		ENGR 236		MECH 312	E	MECH 480	E
	MET 241		MATH 321		MECH 313		MECH 492	R
	SPE 111		PHY 223		MECH 316	E	WRI 323	
							MECH Elec	R
							Hum/Soc Sci	

I = Introduced
R = Reinforced
E = Emphasized