SAINT LOUIS UNIVERSITY

Program-Level Assessment: Annual Report

Program Name (no acronyms): BS Mechanical Engineering

Department: Aerospace & Mechanical Engineering

Degree or Certificate Level: Bachelor of Science

College/School: School of Science & Engineering

Date (Month/Year): May 2023

Assessment Contact: Sridhar Condoor/Ray LeBeau

In what year was the data upon which this report is based collected? 2021-2022

In what year was the program's assessment plan most recently reviewed/updated? 2020

Is this program accredited by an external program/disciplinary/specialized accrediting organization or subject to state/licensure requirements? Yes

If yes, please share how this affects the program's assessment process (e.g., number of learning outcomes assessed, mandated exams or other assessment methods, schedule or timing of assessment, etc.): ABET EAC – review every six years. The next full review report is due June 2024, the review in 2024-2025. Thus, while the assessment of HLC LO1 is presented here consistent with the 2020 plan, the full assessment program approach was reviewed and restructured in 2022-2023. These updates will be presented as part of the 2022-23 report.

1. Student Learning Outcomes

Which of the program's student learning outcomes were assessed in this annual assessment cycle? (Please provide the complete list of the program's learning outcome statements and **bold** the SLOs assessed in this cycle.)

Based on the 2020 plan, students should be able

1. **To practice the principles of engineering in aerospace or allied organizations**
2. To pursue further learning in aerospace engineering or in allied disciplines
3. To function as effective engineers with professional knowledge, skills, and values

2. Assessment Methods: Artifacts of Student Learning

Which artifacts of student learning were used to determine if students achieved the outcome(s)? Please describe the artifacts in detail, identify the course(s) in which they were collected, and if they are from program majors/graduates and/or other students. Clarify if any such courses were offered a) online, b) at the Madrid campus, or c) at any other off-campus location.

The assessment of this outcome is tied to the artifacts collected for ABET LO1 – Students should have an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. The specific artifacts were:

1) ESCI 2100 Statics: A set of multiple-choice final exam questions based on the Fundamentals of Engineering (FE) exam. The FE exam is a test required to become an Engineer-In-Training (EIT), a step on the path to becoming certified as a Professional Engineer. It is usually taken in the year before or a few years after completing an undergraduate degree. Aerospace, mechanical, and civil engineering students are required to take the class, but only aerospace engineering major data is used here. Course typically taken in second year.
2) MENG 2300 Applied Thermodynamics: Homework problem on performance of simple and regenerative gas turbines to determine two different optimal pressure ratios: one for maximum specific power and one for maximum thermal efficiency. Course typically taken in second year although some majors take it later. Class is typically only ME majors.

Classes were in-person or hybrid. Most students were generally in-person although due to COVID a few students were largely online. ESCI 2100 and MENG 2300 were offered in Madrid in this time frame, but these were not included in this review.

Additional materials for each class are included as appendices as appropriate/available.

3. Assessment Methods: Evaluation Process

What process was used to evaluate the artifacts of student learning, and by whom? Please identify the tools(s) (e.g., a rubric) used in the process and **include them in/with this report document** (please do not just refer to the assessment plan).

In all cases, performance was initially assessed by the instructor based on evaluating the assignments. The results of these assessments were presented to the full departmental faculty in an assessment review meeting and discussed. This discussion concluded with a proposed course of action approved by the faculty.

ESCI 2100 were multiple choice problems, so the answer was either correct or incorrect. A score of 70% or above was considered as meeting expectations (70% is the nominal passing grade for the FE exam). The overall goal was at least 75% of students meeting expectations.

MENG 2300 was a homework problem that was evaluated using a rubric of 1-5:
A score of 3.0 and above on a scale of 5.0 (5-Outstanding, 4-Excellent, 3-Good, 2-Satisfactory, 1-Poor)

5 - use of programming to produce efficiency versus power graphs, and comments related to selecting different engines for different applications.

4 - formulation of all the equations correctly, sketch shape of efficiency versus power graphs, but there are a few numerical errors in the calculations

3 - formulation of the equations for calculating thermal efficient and specific power correctly, with a few errors setting up the calculation for fuel cost, but no programming or graph

2 - reasonable formulation of problem equations, with a few errors

1 - inability to formulate the equations required to solve the problem

A score of 3 or higher was considered as meeting expectations. The overall goal was at least 70% of students meeting expectations.

4. Data/Results

What were the results of the assessment of the learning outcome(s)? Please be specific. Does achievement differ by teaching modality (e.g., online vs. face-to-face) or on-ground location (e.g., STL campus, Madrid campus, other off-campus site)?

ESCI 2100 (Fall 2021): 4 of 11 mechanical students (36%) scored 70% or above on 30 multiple choice problems.
ESCI 2100 (Spring 2022): 3 of 4 mechanical students (75%) scored 70% or above on 20 multiple choice problems.
MENG 2300 (Spring 2022): 19 of 24 students (79%) scored a 3 or higher. Score distribution was 2 fives, 15 fours, 2 threes, and 5 twos or lower.

Additional information is provided in the appendices.

5. Findings: Interpretations & Conclusions

What have you learned from these results? What does the data tell you? Address both a) learning gaps and possible curricular or pedagogical remedies, and b) strengths of curriculum and pedagogy.

While progress was made on free body diagrams, mathematical issues in trigonometry and geometry were present in ESCI 2100 among the ME students. The shift from 30 multiple choice questions to 20 such questions and two open-ended problems showed higher scores but in a small sample pool.

Performance in MENG 2300 was improved through a review of fundamentals particularly related to energy and entropy balances. Some of the difficulties were attributed to COVID causing students to demand greater flexibility and more variable participation and dedication to assignments.

6. Closing the Loop: Dissemination and Use of Current Assessment Findings

A. When and how did your program faculty share and discuss the results and findings from this cycle of assessment?

As noted previously, the full faculty of the department held an assessment review meeting in Fall 2022.

B. How specifically have you decided to use these findings to improve teaching and learning in your program? For example, perhaps you've initiated one or more of the following:

Changes to the Curriculum or Pedagogies	• Course content • Teaching techniques • Improvements in technology • Prerequisites	• Course sequence • New courses • Deletion of courses • Changes in frequency or scheduling of course offerings
Changes to the Assessment Plan	• Student learning outcomes • Artifacts of student learning • Evaluation process	• Evaluation tools (e.g., rubrics) • Data collection methods • Frequency of data collection

Please describe the actions you are taking as a result of these findings.

One action was to expand on reviewing geometry in ESCI 2100, building on an effort started in Spring 2022 that seemed to help. A related action was to continue working on pre-req expectations being met consistently as part of future assessment discussions.

The other major action was to restructure the assessment plan. This was driven by a changing curriculum, shifting assessment review in courses that were consistently taught by regular AEME faculty, and achieving better alignment with ABET. The new courses for this outcome will be MENG 2150 Dynamics, MENG 3200 Fluid Dynamics, and MENG 4300 Heat Transfer. The full plan will be updated as part of the 2022-23 assessment cycle.

If no changes are being made, please explain why.

7. Closing the Loop: Review of Previous Assessment Findings and Changes

A. What is at least one change your program has implemented in recent years **as a result of previous assessment data**?

Based on previous data, additional emphasis was placed on teaching Free Body Diagrams (FBD) in ESCI 2100

B. How has the change/have these changes identified in 7A been assessed?

The effect of this change was considered in the review of the final exam problems and other results, particularly in Fall 2021.

C. What were the findings of the assessment?

An improvement in performance for problems requiring FBD's was noted.

D. How do you plan to (continue to) use this information moving forward?

This additional emphasis will continue to be applied.

IMPORTANT: Please submit any assessment tools (e.g., artifact prompts, rubrics) with this report as separate attachments or copied and pasted/appended into this Word document. Please do not just refer to the assessment plan; the report should serve as a stand-alone document. Thank you.

Learning Outcome:	**1 (Solve Problems using SEM)**	2 (Design in Global Context)	3 (Effective Communication)
[select 1]	4 (Ethics in Global Context)	5 (Functional Teamwork)	6 (Experiment and Draw Conclusions)
	7 (Lifelong Learning)		

Course: ESCI 2100 (Statics)

Location in Program: Early Middle End

Method: Comprehensive final exam – 30 FE type questions. The results are:
The class average is 72%.
ME students average is 66%.
36% of ME student achieved 70% proficiency. Note FE exam pass score is 70%.

Rubric:
1. 70% average for the class
2. 70% of students achieving it

Desired result: 75% of students will meet expectations of 70% or more

Student performance: 36% of students met expectations

Observations: The previous deficiency of free-body diagram was addressed. The students lacked the pre-req knowledge (geometry). Multiple students were given "care and concern" due to issues which affected their performance in the finals. Comparing to the previous years, this semester looks like an anomaly – We will do further analysis and keep an eye on next semester. The students who didn't demonstrate proficiency performed well in Tests 1, 2 and 3.

Program Assessment:
A question bank was provided.

Action: Add a module/review session on geometry.

Learning Outcome: **1 (Solve Problems using SEM)** 2 (Design in Global Context) 3 (Effective Communication)

[select 1] 4 (Ethics in Global Context) 5 (Functional Teamwork) 6 (Experiment and Draw Conclusions)

7 (Lifelong Learning)

Course: <u>ESCI 2100 (Statics)</u>

Location in Program: Early Middle End

Method: Comprehensive final exam – 20 FE type questions and two numerical problems. For evaluating outcome 1, only the FE type questions are considered. The results are:
The class average is 86.2%.
ME students average is 77.5%.
75% of ME student achieved 70% proficiency. Note FE exam pass score is 70%.

Rubric:
1. 70% average for the class
2. 70% of students achieving it

Desired result: 75% of students will meet expectations of 70% or more

Student performance: 75% of students met expectations

Observations: None

Program Assessment:
Pre-requisite knowledge of trigonometry and geometry was addressed at the beginning of the class

Action: Add a module/review session on geometry

ESCI 2100: STATICS
SPRING 2022
FINAL EXAM
TOTAL 50 POINTS

Instructions:

1. Please write clearly and legibly
2. You can use your calculator
3. No collaboration of any kind is permitted on this examination

NAME: ___________________________ DATE: ___________
(IN CAPITAL LETTERS)

Learning Outcome: **1 (Solve Problems using SEM)** 2 (Design in Global Context) 3 (Effective Communication)
[select 1] 4 (Ethics in Global Context) 5 (Functional Teamwork) 6 (Experiment and Draw Conclusions)
7 (Lifelong Learning)

Course: MENG 2300 (Applied Thermodynamics) spring 2022

Location in Program: Early **Middle** End

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

Method: Homework 7 problem 1 requires formulation of simple and regenerative gas turbine performance calculations with a view to plot graphs identifying two different optimum pressure ratios: one for maximum specific power and one for maximum thermal efficiencies for both the simple and regenerative gas turbine cycles. These are used to assess the performance of simple and regenerative cycles. Then the students are asked to pick engines suitable for two diverse applications. The simple cycle is suitable for a short-range helicopter engine. The regenerative engine is more suitable for a tugboat application.

Rubric: A score of 3.0 and above on a scale of 5.0 (5-Outstanding, 4-Excellent, 3-Good, 2-Satisfactory, 1-Poor)
5 - use of programming to produce efficiency versus power graphs, and comments related to selecting different engines for different applications.
4 - formulation of all the equations correctly, sketch shape of efficiency versus power graphs, but there are a few numerical errors in the calculations
3 - formulation of the equations for calculating thermal efficient and specific power correctly, with a few errors setting up the calculation for fuel cost, but no programming or graph
2 - reasonable formulation of problem equations, with a few errors
1 - inability to formulate the equations required to solve the problem

Desired result: 70% of students who have not withdrawn from the course will reach grade 3 or above

Student performance: 79.2% of students met expectations (average score 3.46)

Observations: We had 24 students registered the last few weeks of classes (2 had dropped earlier in the semester). Out of these 24, one student was taking this class for the 3rd time. He was unable to hand in this work, and was assigned grade 0 (6.3%). Of the 24 students, 2 were awarded grade 5 (8.3%); 15 were awarded grade 4 (62.5%); 2 were awarded grade 3 (8.3%); 3 were awarded grade 2 (12.5%); and 1 was awarded grade 1 (6.3%). Therefore, the class met expectations.

The class was not able to use energy and entropy balances at the beginning of the semester (this was required in the pre-requisite class ESCI 2300). We revised fundamentals, developed a very good understanding of these fundamentals, and then applied these with success in the analysis of modern energy conversion components and powerplants.

Program Assessment:
79.2% of the students in the class were able to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics.

Action: Continue emphasizing the importance of using fundamentals to formulate unfamiliar and complex problems in engineering.

Action agreed upon at program committee meeting:

Criterion 1: Assessment by the instructor:

Post COVID, student attitudes have changed. Expectations are that the course has to adjust to other important things in the student's lives, and I frequently felt this was not one class of 24 students, but 24 classes of one student (ok, 2 classes of 12 students each). Further, the students disengaged very fast on individual assignments (like this one) that were not straight out of a textbook with solutions published on Chegg. It was a challenge to keep them on track. The good news is that a good segment of the students continue to engage actively, seek new knowledge from several sources, connect it, and derive meaningful conclusions.

Respectfully submitted,

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