SAINT LOUIS UNIVERSITY.

Program-Level Assessment: Annual Report

Program Name (no acronyms): BS Aerospace 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: 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) AENG 3220 Aerodynamics: Three exam problems, one from the second exam, the other two from the final.
    a. Determination of lift and drag for a 3D wing from 2D airfoil data (Final Exam)
    b. Lifting-Line Theory (LLT) analysis given series coefficients (Exam 2)
    c. Incompressible Thin-Airfoil Theory analysis (Final Exam)

   These three problems cover a range of material including 2D and 3D aerodynamics, lift and drag, compressibility effects, and series-based potential flow solutions. Only aerospace majors were in this course.

Course is typically taken in the third year and was hybrid in Spring 2021, with half the class attending in-person one day, the other half the next day.

3) AENG 4110 Flight Vehicle Structures: Composite assessment based on all assignments. Only aerospace majors were in this course. Course is typically taken in the fourth year.

Classes were in-person or hybrid. Most students were generally in-person although due to COVID a few students were largely online. ESCI 2100 was offered in Madrid in this time frame, but that was 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.

AENG 3220 problems were broken down into a series of subparts that were evaluated, scored, and summed for a final result. Partial credit could be awarded in each subsection for partially correct work. A score of above 70% was considered as meeting expectations. The score for each of the three problems as well as the average of the three scores were considered in this evaluation. The overall goal was at least 70% of students meeting expectations.

AENG 4111 was a composite average for the full course for each student, with a score of 70% or above 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): 6 of 7 aerospace students (86%) scored 70% or above on 30 multiple choice problems.
ESCI 2100 (Spring 2022): 33 of 33 aerospace students (100%) scored 70% or above on 20 multiple choice problems.
AENG 3220 (Spring 2021): 22 of 35 students (63%) scored above 70% on the lift-drag problem (with 3 students scoring 70); 33 of 35 students (94%) on the LLT problem; 24 of 30 (80%) on the Thin Airfoil Theory problem (students could choose 2 of 3 problems in this part of the final – 5 students did not choose this problem). Combined average, 30 of 35 (86%) scored above 70%.
AENG 4111 (Fall 2021): 100% of aerospace students scored 70% or above for their final class average.

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.

Aerospace students exhibited strong performances in these artifacts, with the artifact evidencing the largest issue being the lift-drag problem in Aerodynamics, although in this case 8 of the 13 students scoring 70% or below were between 65 and 70%. Students scored particularly highly on the LLT problem in Aerodynamic, which is the most advanced problem considered here but also a shorter problem on a midterm exam. Mathematical errors (polynomial integration, algebra, trigonometry, computation) occurred on more than 50% of the Aerodynamics problems graded. The aerodynamics exams were all timed online open book/note exams due to COVID restrictions. The students who performed most poorly on each of the three Aerodynamics problems tended to change from problem to problem, such that the averaged scores saw only 2 students scoring below 70%.

Mathematical issues in trigonometry and geometry were also present in ESCI 2100, but these were more prominently visible in the scores of non-AE students. The shift from 30 multiple choice questions to 20 such questions and two open-ended problems did not appear to affect aerospace results significantly.

Performance in AENG 4111 was thought to have benefited from the return to fully in-person classes. Improvement was also credited to improved Solid Mechanics and Finite-Element Method (FEM) knowledge from prior classes.

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, AENG 3150 Astrodynamics, and AENG 4400 Stability and Control. 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%.
AE students average is 74%.
85% of AE 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: 85% of students met expectations

Observations: A large fraction of the missed expectations were due to their inability to handle multiple choice questions under time pressure. The previous deficiency of free-body diagram was addressed.

Program Assessment:
A question bank was provided. The students lacked the pre-req knowledge (geometry).

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: ESCI 2100 (Statics)

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%.

AE students average is 88.6%.

100% of AE 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: 100% 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: AENG 3220 (Aerodynamics)

Location in Program: Early **Middle** End

Method: Evaluation of three problems by the instructor:

1) Determination of lift and drag for a 3D wing from 2D airfoil data (Final Exam)
2) Lifting-Line Theory (LLT) analysis given series coefficients (Exam 2)
3) Incompressible Thin-Airfoil Theory analysis (Final Exam)

These three problems cover a range of material including 2D and 3D aerodynamics, lift and drag, compressibility effects, and series-based potential flow solutions.

Rubric: These three problems cover a range of material including 2D and 3D aerodynamics, lift and drag, compressibility effects, and series-based potential flow solutions. Scoring is based on standard grading, but the sources of error within each problem are also considered in the review process.

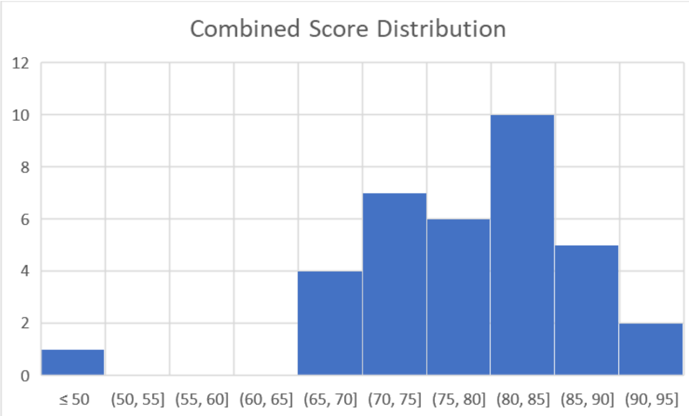
Desired result: Distribution of at least 70% of students achieving more than 70% on the combined average of these three problems (equal weighting) and ideally on each problem separately as well.

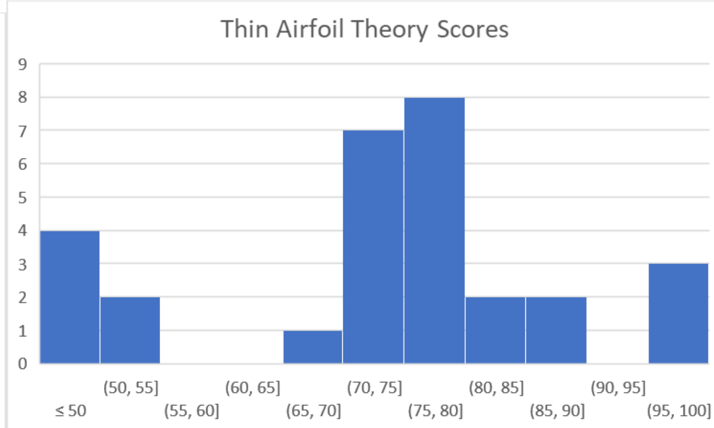
Student performance: 86% of students met expectations on the combined average, 63% on the lift-drag problem, 94% on LLT, 80% on TAT.

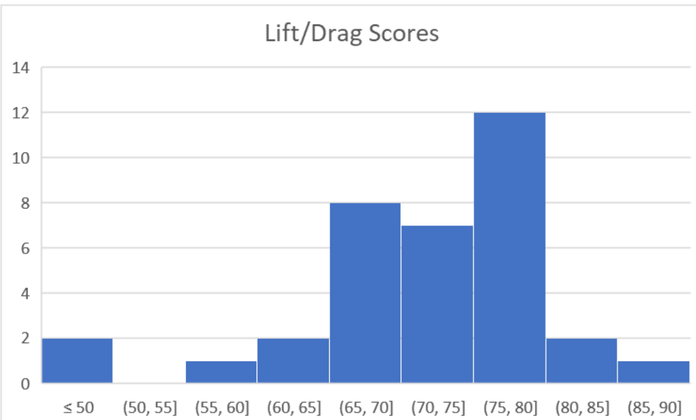
Observations: Compared to 2020, the exams while still online and open book/notes, were more strictly controlled and more tightly time limited. This appears to have driven scores downward on the TAT and, mostly notably, on the lift-drag problems. 8 of the 13 students who scored below 70% on the lift-drag problem scored between 65% and 70%, so the shift in performance is not as profound as it might appear. Frequent errors include failure to account for compressibility effects and to properly calculate the 3D lift slope in the lift-drag problem. There remained a variety of math errors as well for which a further assessment will hopefully be added.

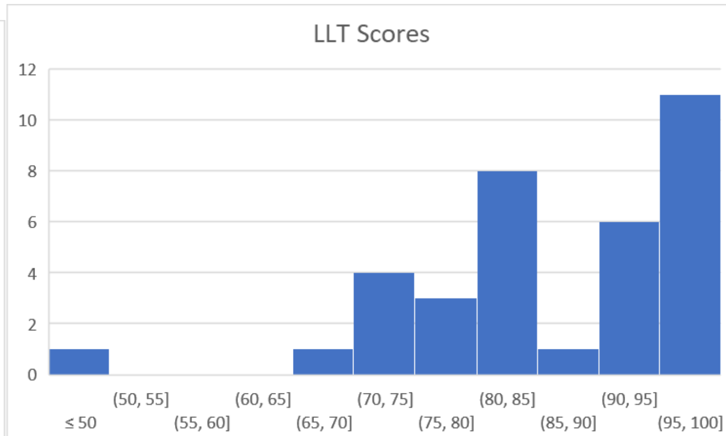
Program Assessment:
86% of students demonstrated a satisfactory degree of mastery of aerodynamics calculations and problem-solving across a range of expected outcome skills.

Proposed Action: Once COVID has passed, re-assess expected results with return to closed book/notes. Create a math-only rubric to isolate mathematical problems (hopefully to be added).







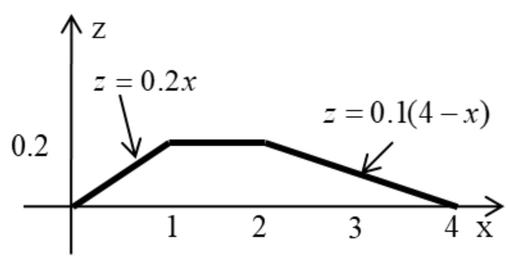


Example questions used for assessment. Please note that there were mulitple variations of each problem due to the remote test-taking due to COVID.

TAT problem:
Choice Problem 1

The mean camber line of a thin airfoil is given by the line shown below. The airfoil has a chord of 4 ft., the freestream velocity is 150 ft/s, the geometric angle of attack is 3°, and the air density is 0.00200 slug/ft^3. Using thin airfoil theory, determine:

The coefficient of lift for the airfoil. [a]
The 2D lift of the airfoil in lbf/ft. [b]
The absolute angle of attack for the airfoil in degrees [c]
The moment coefficient about the aerodynamic center [d]



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: AENG 4110 (FLIGHT VEHICLE STRUCTURES)

Location in Program: Early Middle End

Method: Composite score of homework, projects, mid-term exams and final exam
The class average is 82.45%.

Rubric: A score of 70% and above

Desired result: 70% of students will meet expectations

Student performance: 100% of students met expectations

Observations: Improvement in the concepts of Mechanics of Solids and knowledge of FEM software from last year. Having started the classes in-person has made a positive impact

---

Program Assessment:
100% of the students were able to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.
Action: Continue discussing with instructors of fundamental courses to stress the concepts of solid mechanics, area moments of inertia and centroids.