Academic Program Review
MS Mechanical Engineering

Table of Contents

APRC Recommendation to Faculty Senate
MS Mechanical Engineering

The Academic Program Review Committee (APRC) affirms that the Department of Mechanical Engineering has completed program review as per policy, including self-study, external review, internal review, and action plan submission for the MS Mechanical Engineering. APRC recommends that the next program review be scheduled for six years from Faculty Senate approval; or, should the College of Engineering and Computer Science decide to schedule a college-wide program review, the next program review will occur at that time.

APRC Chair: Jeffrey Brodd, Professor of Humanities and Religious Studies

Mechanical Engineering (ME) Graduate Program Self-Study Report

Fall 2022

California State University, Sacramento

Academic Year 2021-22

Date of Last Review 2010

Contents

Date: December 29, 2022

Date of Last Review: 2010

Academic Unit: Department of Mechanical Engineering

Element One: Mission and Context

University, college, and academic unit missions, visions, and values

University Mission: As California's capital university, Sacramento State transforms lives by preparing students to lead, serve, and succeed.

University Vision: To be a welcoming, caring, and inclusive leader in education, innovation, and engagement.

Engineering and Computer Science (ECS) College Mission: Through contemporary curricula, engaging pedagogy, scholarship and applied research, we produce career-ready graduates prepared for a lifetime of professional achievement and intellectual growth.

ECS Vision: We strive to be a valued community of scholars in which students are engaged in diverse learning experiences with faculty and staff who are devoted to student success and technical achievement.

ECS Values: We value student success, academic excellence, scholarship, innovation, a balance of theory and practice, diversity, opportunity, community engagement, integrity, and accountability.

Department of Mechanical Engineering (ME) Mission: The mission of the ME program is to provide an outstanding, practice-oriented education in mechanical engineering that will prepare graduates for professional employment and/or graduate study.

ME Goal: The goal of the program is to provide students with a well-rounded education based on fundamental math, science and engineering principles with an understanding of the global and societal impact of engineering decisions.

Degrees offered by Department of Mechanical Engineering

- BS in Mechanical Engineering

https://catalog.csus.edu/colleges/engineering-computer-science/engineering-mechanical/bs-in-mechanical-engineering/

- Blended BS/MS in Mechanical Engineering

https://catalog.csus.edu/colleges/engineering-computer-science/engineering-mechanical/blended-bs-ms-in-mechanical-engineering-program/

- MS in Mechanical Engineering

https://catalog.csus.edu/colleges/engineering-computer-science/engineering-mechanical/ms-in-mechanical-engineering/

- Minor in Engineering

https://catalog.csus.edu/colleges/engineering-computer-science/engineering/minor-in-engineering/

External educational partnerships

Student Clubs and Organizations

The following student clubs and organizations within the Department of Mechanical Engineering are active and officially registered with Sac State's Student Organization & Leadership program. These clubs organize many events, tours, and activities to engage our students and industry.

- American Society of Mechanical Engineers
    - Advisor: Akihiko Kumagai
    - President: Trent Porter
- American Society of Heating, Refrigeration, and Air Conditioning Engineers
    - Advisor: Farshid Zabihian
    - President: Garrett Bordenave
- Hornet Racing - Formula SAE
    - Advisor: Rustin Vogt
    - President: John Kim
- Material Advantage Club
    - Advisor: Troy Topping
    - President: Marius Santos

Other educational partnerships

Formal educational partnerships for the program have been entered previously, but the current status is unknown due to lack of continuity from their inception through the years of the COVID 19 pandemic. For example, an MOU was developed with NTUT (Taiwan) in 2014, but there is no current activity under this MOU.

Informal partnerships have existed and continue to exist between CSUS and programs such as UC Davis and Engineering and Colorado State University. Typically these partnerships involve handshake and email agreements promoting graduate programs that offer Ph.D.s after the Master's earned at CSUS. Occasionally, some coursework (up to 12 units) from the CSUS Master's can count toward the Ph.D. The Department intends to do more work in formalizing these types of agreements.

Major structural changes in academic unit since last review (new, moved, or discontinued degrees, concentrations, minors, etc.)

In 2013, the Department proposed a change to the catalog that introduced a Blended Masters program, enabling students to extend their academic careers a minimum of one year to attain a masters degree. The program allows "extra" units taken during the undergraduate program to be deferred for use in the Master's degree. Students are still required to have the appropriate number of units, currently 120, and required courses for the undergraduate degree. Elective units are chosen based on future graduate status and course needs in the graduate program. If the student chooses to "opt out" of the program, those courses can be used as electives in the undergraduate degree if needed. In 2020, the catalog was updated for this program to align with CSUS Coded Memorandum AA-2-12-01, clarifying the required total units to be 150, since the ME undergraduate BS degree requires 122, by exception from the CSU system.

In 2014, based on the addition of faculty in the area of Materials Science and Engineering, the approved specializations in the major were changed. A new specialization – Manufacturing and Materials Engineering – was added to the list of specializations available to students. All specializations have been updated periodically to increase the number of courses available for students to use in their chosen field.

Starting in Spring 2019, a new format for Master's Exit Seminars was added on a trial basis. Instead of having talks spanning 30 minutes for each student in various venues (classes, ballrooms, and labs), the Department initiated Exit Seminar Poster sessions. The poster session was scheduled during the regular department meeting time (Wednesday's at noon) in the last week before theses submissions. Students present posters and faculty evaluate them individually. Food is provided and the highest scoring poster receives a prize. This new format has taken hold and continues. Faculty engagement has increased dramatically and the students and attendees are more exposed to a research-oriented format for the presentations. During the

pandemic, sessions were held on zoom with attendees and presenters participating internationally.

Elements Two: Learning Outcomes

MS Mechanical Engineering Program Learning Outcomes (PLO)

PLO 1: Disciplinary knowledge: Identify and formulate technical requirements and use engineering, scientific, and mathematical tools to analyze, test, and solve problems.

PLO 2: Critical thinking and creativity: Apply critical thinking and creativity to identify needs for improvements in a real-world environment and operationalize these needs.

PLO 3: Communication: Write effectively for a range of audiences with specifying clear contributions, explanations, and conclusions following standard professional formats and present technical work for a targeted audience with effective oral communication and visual aids.

PLO 4: Professionalism: Follow professional and ethical practices, apply them in engineering situations, and make informed judgments with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

PLO 5: Information literacy: Demonstrate the ability to obtain, assess, and analyze information from a myriad of sources to address engineering problems.

PLO 6: Research: Conduct independent research resulting in an original contribution to knowledge in engineering in general and Mechanical engineering in particular.

Assessment Plan

The ME graduate program uses course level direct assessments and program level indirect assessments to measure the program success and to maintain and improve the program.

Course Level Direct Assessments

Course level direct assessments can provide immediate and rich sources of information on student learning for both instructors and students, which can be used to identify areas where improvements are required and/or possible. The following process is employed for course level assessments.

First, it is determined which Program Learning Outcome(s) should be measured in each individual course. The instructor in coordination with the graduate coordinator and the department chair makes this determination. The list of ME graduate courses and PLOs that measured in each course are presented in Table 1. If applicable, each PLO is broken down to

several criteria. Then, the instructor selects an appropriate assessment tool(s) that measures students' performance for each criterion e.g. an exam question, a project report, a presentation, etc. (Table 2). The instructor also selects a range of grade for the selected assessment tool that represents the four levels of students' achievement (Initial, Emerging, Developed, and Highly Developed). The number of students who achieve the four levels of achievement defined in the previous step is counted and their percentages are calculated. The graduate coordinator creates a templated Excel file for each course and send it to the course instructor. The instructor uploads the completed Excel files to the folder "ME Graduate Program Assessment" which is shared in OneDrive.

Currently, the assessment process ends here. But the plan for the future is:

1. To determine a formula to convert the abovementioned percentages to a single number.
2. To determine a threshold/benchmark for the number determined in the previous step that is acceptable for each PLO in the course.
3. To compare the numbers determined in the previous steps to determine if the course meets the benchmarks or not.
4. To create a listed of few actions/strategies to improve the course based on the finding of the assessment (including ways to measure the effectiveness of each action/strategy).
5. To assess courses every other year to measure student learning through years and evaluate the effectiveness of each action/strategy from the previous item.

Table 1: Mapping of Program Learning Outcomes with program courses

Coursework	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6
ENGR 201: Engineering Analysis I*	×	×				
ENGR 202: Engineering Analysis II*	×	×				
ME 209: Research Methodology*	×	×	×	×	×	
ME 233: Intelligent Product Design and Manufacturing**	×		×		×	
ME 237: Digital Control of Manufacturing Processes**	×					
ME 238: Automated Inspection**	×		×		×	
ME 240: Mechanical Design & Failure Analysis**	×	×		×	×	
ME 241: Optimum Mechanical Design**	×	×				
ME 243: Accident Biomechanics Reconstruction**	×			×	×	
ME 253: Advanced Fluid Mechanics**	×					
ME 258: Advanced Thermodynamics**	×	×	×			
ME 272: Finite Element Modeling in Computer-Aided Design**	×					
ME 274: Introduction to Flight Dynamics**	×					
ME 275: Analysis of Aircraft Structures**	×					
ME 280: Advanced Mechanical Properties of Materials**	×					
ME 285: Material for Extreme Environment	×	×	×		×	
ME 296M: Space Mission Design and Analyses**	×	×	×	×	×	
ME 296S: Advanced CAD for Aerospace Applications**	×		×			
ME 295: Fieldwork**	×			×		
ME 500: Master's Thesis	×	×	×	×	×	×

*Core course

**Concentration/elective course

Table 2: Lines of evidence used for each PLO

		Lines of Evidence	
Institutional Graduate-Goal	PLO	Direct	Indirect
Disciplinary knowledge	PLO 1	• Assignments in core and elective courses • Completion of thesis	Survey
Communication	PLO 3	• Assignments in ME 209 • Thesis proposal • Writing thesis • Exit seminar	Survey
Critical thinking/analysis	PLO 2	• Assignments in core and elective courses • Completion of thesis	Survey
Information literacy	PLO 5	• Assignments in ME 209 • Completion of thesis	Survey
Professionalism	PLO 4	• Assignments in ME 209 • Completion of thesis	Survey
Intercultural/Global Perspectives	PLO 4	• Assignments in ME 209 • Completion of thesis	Survey
Research	PLO 6	• Completion of thesis	

Program Level Indirect Assessments

Graduate Alumni Survey

While the department is currently using Alumni Survey as an assessment tool at the undergraduate level, Alumni Survey has not been used for this purpose at the graduate level. The department is in the process of developing such survey for the graduate program and is planning to employ them from Fall 2023 semester.

1.1.1. Other Program Level Assessment Tools

The program is also considering other potential tools such as employment after graduation, Professional Engineering licensure passage rates, PhD program acceptance rates, internships, etc. to measure and improve the program success. The Department has reformed its Industrial Advisory Committee and will solicit feedback from this important group.

Summary of data for each learning outcome (Course Level Direct Assessments)

Program Learning Outcome 1

Disciplinary knowledge: Identify and formulate technical requirements and use engineering, scientific, and mathematical tools to analyze, test, and solve problems.

Table 3: Course assessment data for PLO 1

Course	Fa 22 (%)				Sp 23 (%)				Fa 23 (%)				Sp 24 (%)			
	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
ENGR 201																
ENGR 202																
ME 209																
ME 233	36	64	0	0												
ME 237																
ME 238	50	50	0	0												
ME 240																
ME 241																
ME 243																
ME 253																
ME 258																
ME 272																
ME 274																
ME 275	73	23	4	0												
ME 280																
ME 285																
ME 296M																
ME 296S	13	63	25	0												
ME 295																
ME 500																

Program Learning Outcome 2

Critical thinking and creativity: Apply critical thinking and creativity to identify needs for improvements in a real-world environment and operationalize these needs.

Table 4: Course assessment data for PLO 2

Course	Fa 22 (%)				Sp 23 (%)				Fa 23 (%)				Sp 24 (%)			
	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
ENGR 201																
ENGR 202																

ME 209																
ME 240																
ME 241																
ME 258																
ME 285																
ME 296M																
ME 500																

Program Learning Outcome 3

Communication: Write effectively for a range of audiences with specifying clear contributions, explanations, and conclusions following standard professional formats and present technical work for a targeted audience with effective oral communication and visual aids.

Table 5: Course assessment data for PLO 3

Course	Fa 22 (%)				Sp 23 (%)				Fa 23 (%)				Sp 24 (%)			
	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
ME 209																
ME 233	100	0	0	0												
ME 238	100	0	0	0												
ME 258																
ME 285																
ME 296M																
ME 296S	25	25	50	0												
ME 500																

Program Learning Outcome 4

Professionalism: Follow professional and ethical practices, apply them in engineering situations, and make informed judgments with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Table 6: Course assessment data for PLO 4

Course	Fa 22 (%)				Sp 23 (%)				Fa 23 (%)				Sp 24 (%)			
	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
ME 209																
ME 240																

ME 243																
ME 296M																
ME 295																
ME 500																

Program Learning Outcome 5

Information literacy: Demonstrate the ability to obtain, assess, and analyze information from a myriad of sources to address engineering problems.

Table 7: Course assessment data for PLO 5

Course	Fa 22 (%)				Sp 23 (%)				Fa 23 (%)				Sp 24 (%)			
	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
ME 209																
ME 233	100	0	0	0												
ME 238	100	0	0	0												
ME 240																
ME 243																
ME 285																
ME 296M																
ME 500																

Program Learning Outcome 6

Research: Conduct independent research resulting in an original contribution to knowledge in engineering in general and Mechanical engineering in particular.

Table 8: Course assessment data for PLO 6

Course	Fa 22 (%)				Sp 23 (%)				Fa 23 (%)				Sp 24 (%)			
	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
ME 500																

Analysis for each learning outcome

Currently, the Department has data for ME 233, ME 238, ME 275, ME 296S and ME 500 in a shared drive for ME faculty. This data can be made available to reviewers on request.

Element Three: Student Success, and Assessment to Maintain Success and Engage in Continuous Improvement

Program Admission Data

The following diagrams illustrate the admission data for the ME graduate program between Fall 2019 and Fall 2022. The data for the diagrams are provided by the Office of Institutional Research, Effectiveness, and Planning (https://www.csus.edu/president/institutional-research-effectiveness-planning/dashboards/admissions.html).

Figure 1 shows the number of applicants and admitted applicants during the period. While the numbers dropped from Spring 2020 to Spring 2021, primarily due to the pandemic, they bounced back stronger in the subsequent semesters.

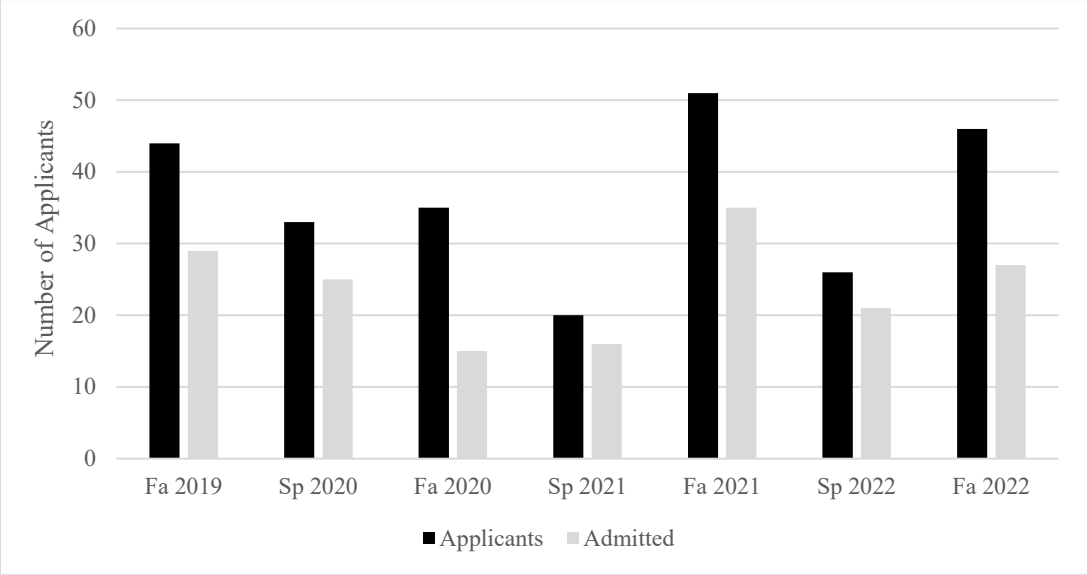

Figure 1: The number of applicants and admitted applicants between Fall 2019 and Fall 2022

Figure 2 shows the number of resident and non-resident applicants between Fall 2019 and Fall 2022. Similarly, Figure 3 shows the number of domestic and international applicants in the same period. The diagram Figure 3 indicates that the program has made major progress in attracting international applicants, from 16 applicants in Fall 2019 to 27 applicants in Fall 2022 (from 36% in Fall 2019 to 59% in Fall 2022). A similar pattern can be observed in Figure 2. However, this

increase came at the expense of resident applicants, from our own undergraduate program. Considering that these two demographics are totally independent, this trend indicates that we need to increase the outreach to our undergraduate ME student population and improve our massaging and advertisement approach.

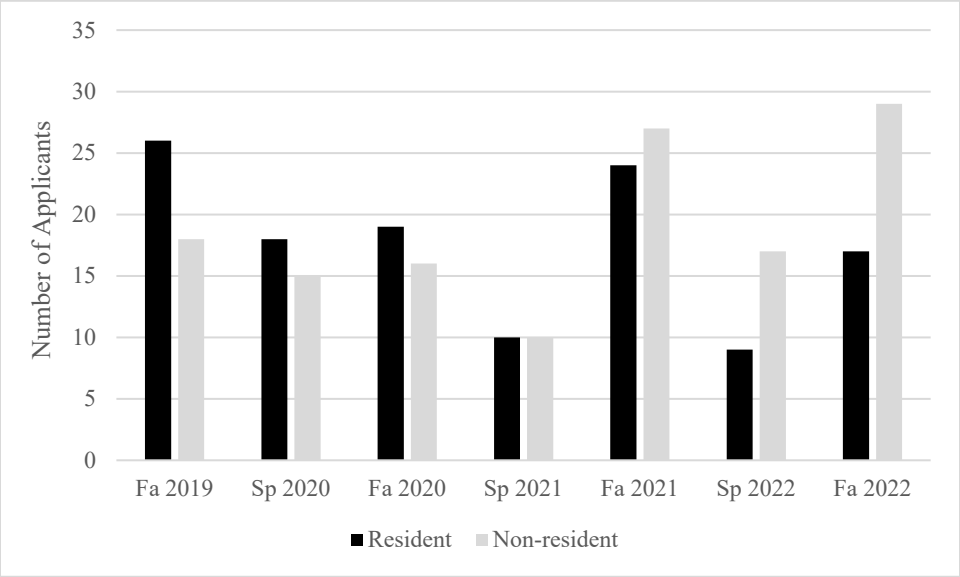

Figure 2: The number of resident and non-resident applicants between Fall 2019 and Fall 2022

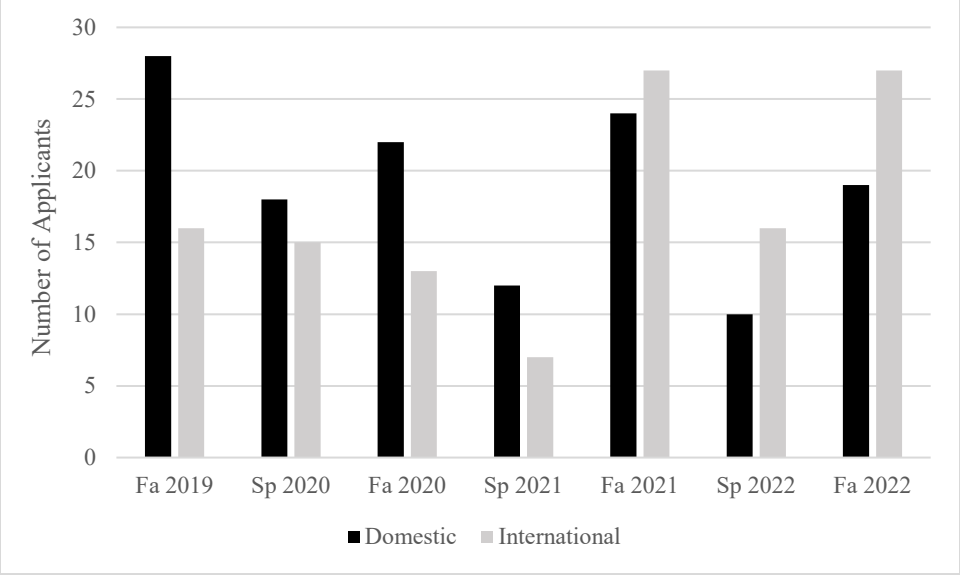

Figure 3: The number of domestic and international applicants between Fall 2019 and Fall 2022

The diagrams presented in Figure 4 to 6 illustrate the equity gap among the ME graduate program applicants: underrepresented minority vs. non-underrepresented minority applicants (Figure 4), female vs. male applicants (Figure 5), and first generation vs. non-first generation applicants (Figure 6). As the diagrams indicate, there are unacceptably large ethnic and gender gaps among applicants. While unfortunate and unacceptable, these large gaps are neither surprising nor uncommon in STEM programs in general and engineering programs in particular. Perhaps addressing these major issues can be a part of the agenda for the newly formed Diversity Equity Inclusion (DEI) Committee in the ECS college.

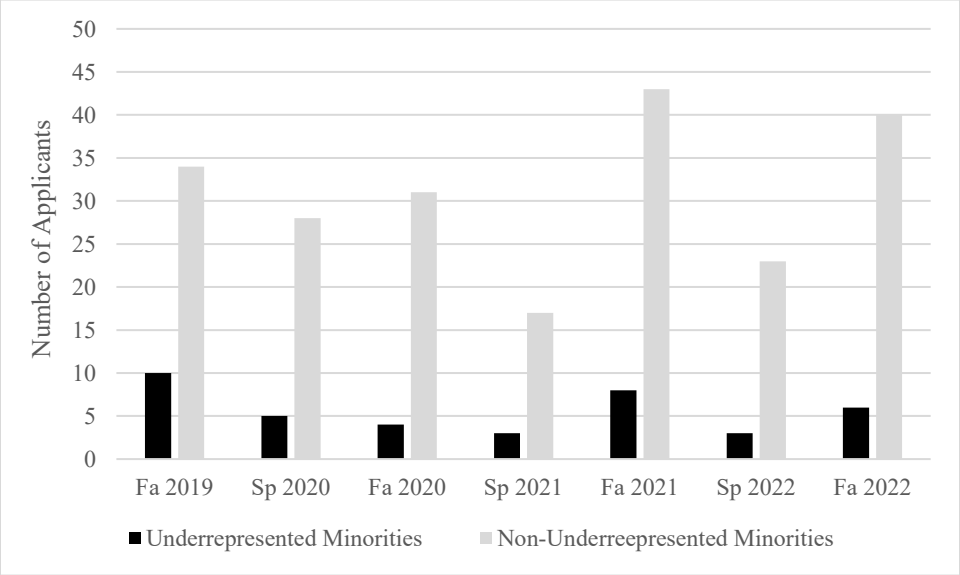

Figure 4: The number of underrepresented minority and non-underrepresented minority applicants between Fall 2019 and Fall 2022

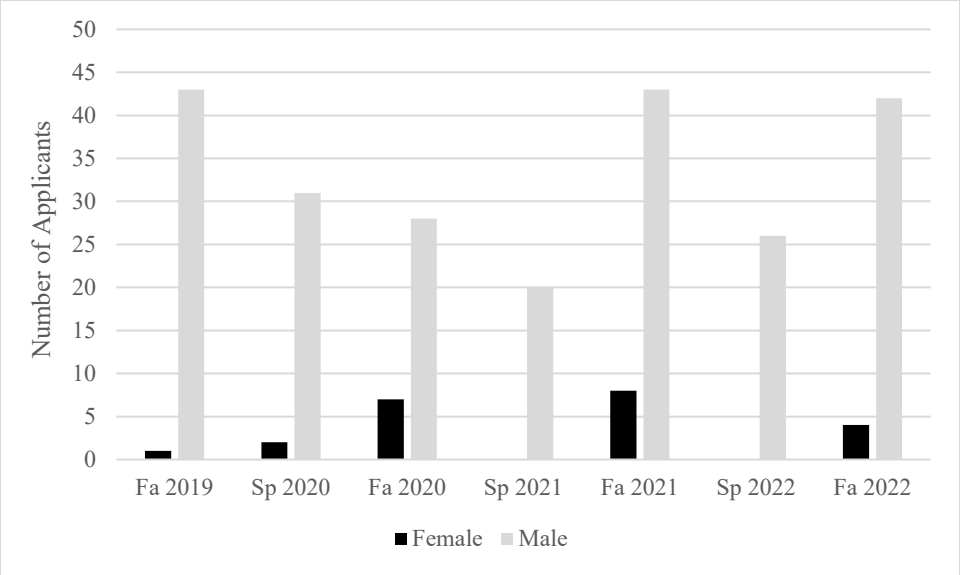

Figure 5: The number of female and male applicants between Fall 2019 and Fall 2022

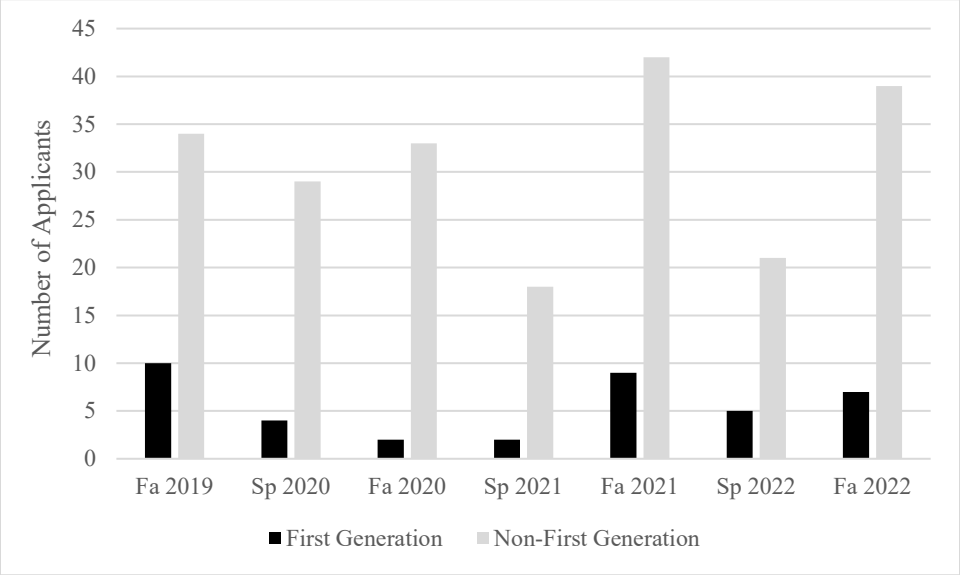

Figure 6: The number of first generation and non-first generation applicants between Fall 2019 and Fall 2022

Program Retention Data

Data specific to program retention are not available at this time, but data for enrollment are available. Data are plotted from Fall 2012 to Fall 2022 in Figure 7. Data show a trend of growth through 2021 with a dip in 2022. In Spring 2022, an unusually large number of students (22)

presented exit seminar posters as they intended to graduate by the end of spring or summer, which may have contributed to the dip.

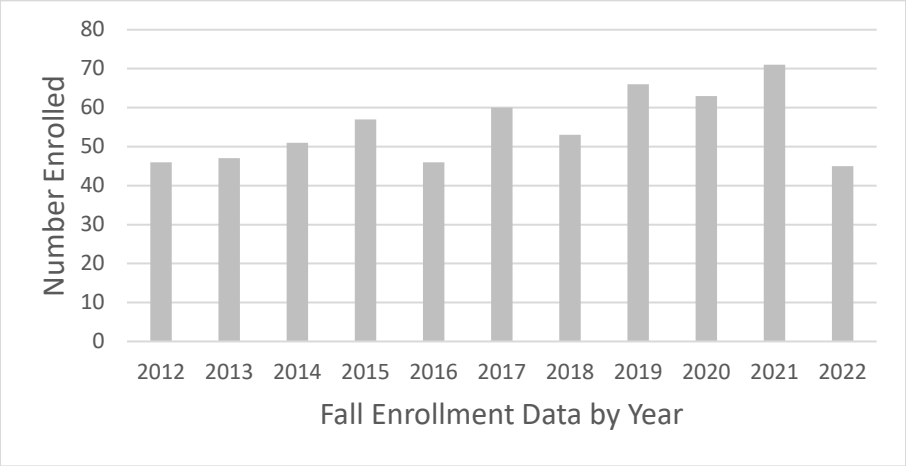

Figure 7: Fall enrollment data from 2012 to 2022.

Program Graduation Data

Program graduation data are not available at this time but the Department is investigating tracking mechanisms, such as exit seminars and thesis completion with graduate studies. Exit seminar data is internal to the department and is a good indicator of graduation. Students can, however, complete the exit seminar session prior to thesis submission.

Analysis on admission, retention, and graduation data

Reflecting on the data and methods of collection, improvements are needed in our tracking. To that end, Canvas pages have been developed and newly hired staff are being engaged in the process to assist the Graduate Coordinator.

Summary of current partnerships in success efforts

The Department works with the Office of Graduate studies to promote student success initiatives supporting advising, the Writing Center, Library Student Success Center, internship sites, etc.

We are considering ways to better work together to maintain success and improve time to degree.

Element Four: Developing Resources to Ensure Sustainability

A. Currently, the Department has 4 specializations – Aerospace Systems, Design and Dynamic Systems, Manufacturing and Materials Engineering, and Thermal and Fluid Systems. New specializations, such as Robotics and Controls, are being considered. The new specialization may be cross listed with the Department of Electronics and Electrical Engineering in the future. Another potential specialization may be Sustainable Energy in collaboration with the California Mobility Center as part of the Anchor University initiative for Sacramento State.

B. The Department recently lost a faculty member in the area of Thermal Sciences to another university. Two active searches are ongoing – Thermal Fluids and System Dynamics and Controls. Another faculty will be sought in the next cycle for Thermal Fluids in 2023/24.

C. The budget for the Mechanical Engineering Department is limited. Some faculty have external funding and the college has launched a research assistanceship program (RAP) that can fund 1-2 students per year for up to $3600.

D. Revenue opportunities for the Department are limited but are actively being investigated. Recently, the College has approved a mechanism for charging external users for work using research instruments. This is seen as an opportunity to grow research, training and equipment.

Element Five: Planning to Maintain Success and Engage in Continuous Improvement

A. Faculty workload is a major area of concern. To that end, growth of the program is not of interest at this time, as far as number of students. Accepting more than 25-30 students per semester is not sustainable for the number of faculty in the Department. In order to improve, more faculty are needed and time to be more engaged in supporting student research is needed. The College currently supports one course of release time for every 6 graduate students whose theses are advised to completion. This is a good start, but advising theses is very time consuming if quality is expected.

B. With the initiation of this report and a recent ABET review, the Department has taken a greater interest in assessment of the graduate program. Growth from this self-study and execution of assessment plans are needed to have continued success.

DATE: May 1, 2023

TO: Amy Wallace, Associate Vice President for Academic Excellence
California State University, Sacramento

FROM: Dr. John Abraham, Professor and Chair
Department of Mechanical Engineering
San Diego State University, San Diego

Dr. Yayoi Takamura, Professor and Chair
Department of Materials Science and Engineering
University of California, Davis

SUB: Academic Review of the Mechanical Engineering (ME) Graduate Program at California State University, Sacramento

Mechanical Engineering (ME) is one of the Programs within the College of Engineering and Computer Science (ECS) at the California State University (CSU), Sacramento. The Graduate Program in the ME Department consists of two programs: MS in Mechanical Engineering and the blended BS/MS in Mechanical Engineering. The academic review of the Graduate Program was conducted through a Self-Study Report submitted to the Reviewers on April 4, 2023 and meetings with ME Chair, Faculty, Students, and College and University Administrators, on Thursday, April 13 and Friday, April 14, 2023.

This is a summary of our observations and recommendations from the review.

Observations:

The Graduate Program is well structured, strong, and provides excellent education for its students. Enrollment in the program is strong and well aligned with the size of the Faculty. The Department Chair, Interim Graduate Coordinator, and Faculty are invested in the success of the students and Program. The Exit Seminar Poster Session, introduced in 2019, is a culminating experience for students in the Program and is viewed as a significant improvement by Faculty and students. Graduated students from both the regular MS and the blended BS/MS programs provided reflections which emphasized the commitment of Faculty Advisors to their success. While data was not provided, the evidence from the conversations suggest that graduates from the program are able to obtain good jobs and are pleased with the outcomes from the program as they impact their career trajectories.

There is evidence that the Program is making efforts to continuously improve and meet the expectations of industrial partners in the region. The blended BS/MS program was introduced in 2013. This program is intended to enable BS students to get an MS degree by extending their study

one year beyond that required for the BS program alone. While the numbers of students graduating from the blended program is lower than from the regular MS program, indications are that it is successfully contributing to the overall graduate program. The program added a new area of specialization in Manufacturing and Materials Engineering in 2014. The Program recently introduced the assessment of Program Learning Outcomes for their courses.

Recommendations:

1) **Recruitment:** There is no formal recruitment process to the program. While this does not appear to impact enrollment, it may impact the quality of students and the diversity of the enrolled students. Based on the data provided in the Self-Study Report, the program appears to have a stark imbalance in the distribution of URM and women students. It may be instructive for the program to compare their demographics to reported values for ME/Engineering/STEM programs across the nation, other CSUs, or other R2/R3 institutions. The Program has relationships with industry in the local region which are exploited to attract students. While this is encouraging. a broader approach to recruitment is recommended to attract a diverse group of students. Travel to national conferences for recruitment, and developing pipelines for students from Institutions which serve URM students are approaches that the Program may explore. It is recommended that resources be allocated from the College and University to support these recruitment efforts. As most students access information about their prospective graduate programs through Department websites, the Department should prioritize a revamp of their website (see point (7) for more information).

2) **Timeline for Completion of MS Program**: The timeline for students to select an Advisor and a thesis project can be shortened, and therefore positively impact the time to graduation. The process could be broken up into specific steps, including meeting with potential advisors, selecting a faculty advisor, defining the topic of the MS thesis, and completing the MS thesis. Each step should have a clear deadline and a required form/assignment for enforcement. A contingency plan should be put in place for students who are 'unable' to fulfill one of these steps. ME 209 is a pivotal course that the Program uses to prepare students for their graduate studies. It is also used to measure several student outcomes. However, it appears that the content of the course can change based on the Instructor. It is important to ensure that the course has a content that is agreed upon by all Faculty and able to meet program objectives. For example, several of the steps in the Advisor selection process described above can be completed while the students are enrolled in ME 209. This does not appear to be occurring consistently. Enrollment in ME 209 in the first semester should be mandatory.

3) **Blended BS/MS Program**: Currently, the number of students who continue with the blended program after initially enrolling in the program appears to be about 30%. This percentage can potentially increase if projects can be assigned to the students early in their time at CSU-Sacramento (see point (2)). The reasons for this relatively low retention rate in the program must be identified. Not meeting the required GPA was mentioned as one reason, but it is possible that BS students are using the blended program as a backup plan in case they do not get a good paying job. It is also possible that students are frustrated with lack of guidance from faculty advisor about the research project. Once the reasons are identified, the program should work to increase the retention rate.

Currently, students in the blended program require 120 units to graduate with the BS degree, i.e., 2 less than the 122 required for regular BS students, and 30 units to graduate with the MS degree. The revised CSU policy on blended degree programs (https://calstate.policystat.com/policy/12518003/latest) allows up to 12 units to be double counted for the BS and MS degrees of the blended program. The total number of units required for graduation from the blended program is 138 according to the revised policy. It is recommended that the Program take advantage of these allowances and consider double counting a certain number of units so that the students are motivated to enroll in the program and complete it within 5 years. This change can also help to address the retention issue.

4) **Communication with Students**: Improved communication of requirements and deadlines to students from the Office of Graduate Studies and from the Graduate Coordinator can improve the experience of students. Students identified lack of clear communication as a challenge that they faced. Students may have different preferred ways of communication that do not match with those of the Department. An improved and regularly updated website (see point (7) below) can contribute to improved communication.

5) **Program Assessment and Continuous Improvement**: The program has introduced assessment of Program Learning Outcomes for their courses only recently. As a result, data is missing for some outcomes and data is not available for several courses in which the outcomes are measured. The Program thus lacks important metrics for conducting continuous improvement. Data for various other important metrics, e.g., retention data, job placement, alumni surveys, are not available in the Self-Study Report. Improved ways to gather and maintain such data must be identified, and can facilitate data-driven improvement steps. The Program should investigate what information can be gathered at the Office of Graduate Studies level.

6) **Support from the Office of Graduate Studies**: Support from the Office of Graduate Studies is strong during certain periods, but slower during busy periods. The busy periods may when such support is critical. It was suggested that the Office of Graduate Studies may be short-staffed. As noted before, some of the data gathering in point (5) could be performed by the Office Graduate Studies and aid all programs at the university. Additional resources for the Office of Graduate Studies can address some of the challenges.

7) **Departmental Website**: Department/Faculty websites are how most students learn about graduate programs, so while there may not be funds to travel to national conferences for recruitment, putting clear and easy to find information on the Department website about their degree programs, and the types of research projects offered, could go a long way in attracting a diverse group of resident and non-resident students. Currently, the information on the Department website is limited, and the graduate program link goes to a stark catalog page. The Department's website needs to be completely revamped. The Reviewers found the site hard to navigate and not appealing to external stakeholders. The landing page does not have any pictures, does not have a clear tab showing a listing of Faculty and their websites, and does not have any description of facilities. The listing of Faculty is accessed at the bottom of the main page from a link entitled "Meet Us" which is not intuitive. There is no mission statement nor is there a listing of program outcomes either at the undergraduate or the graduate levels. Accomplishments of the Program are

not highlighted. The review suggested that resources are not available at the Department level to revamp the website. It is strongly recommended that the University provide these resources. The ME Department should review websites of other programs from across the country and bring its own website up to prevailing standards.

Internal Review Report

Internal Review Report:	Mechanical Engineering
College:	College of Engineering & Computer Science
Degree Programs:	**MS in Mechanical Engineering**
Internal Reviewers:	Ben Amata, Library Pooria Assadi, College of Business
Date Submitted:	May 24, 2023 (Due by June 2)

I. Context:

The Department of Mechanical Engineering submitted a 20-page Self-Study in fall 2022 that conformed structurally to the Self-Study requirements in the *Academic Program Review Guide* (referred to as the *Guide*). It was timely, complete, and comprehensive. Overall it lacked sufficient self-reflection. **The Internal Reviewers (IRs) strongly recommend that all the faculty read and discuss Civil Engineering's Self-Study as a model in order to understand what and how to collect appropriate information and what valuable reflection looks like.**

The External Reviewers made 7 recommendations. In their report's observation (introduction) section, they stated: "The Graduate Program is well structured, strong, and provides excellent education for its students."

The External Reviewers (ERs) were Dr. John Abraham Professor and Chair, Department of Mechanical Engineering at San Diego State University, San Diego and Dr. Yayoi Takamura, Professor and Chair Department of Materials Science and Engineering at University of California, Davis. As a CSU and UCD mechanical engineering faculty, they appear to have sufficient qualifications.

The scheduled visit on Zoom on April 13, 2023 conformed to the *Guide's* requirements.

II. Recommendations:

Element 1. To Maintain Success

The IRs commend the Department takes advantage of various outreach efforts in the region as they relate to the overall success of the Department's mission in general and its recruitment efforts in particular. For example, the Department has 4 student clubs and organizations that are active and registered with Sacramento State's Student Organization and Leadership program. They include: American Society of Mechanical Engineers; American Society of Heating, Refrigeration, and Air Conditioning Engineers; Hornet Racing - Formula SAE; and Material Advantage Club. While the Department does note that the "clubs organize many events, tours, and activities to engage our students and industry," it has an opportunity in their Self-Study to provide a more in-depth explanation on how they might utilize these clubs and organizations in their student recruitment efforts in keeping

with their mission. Furthermore, the Department should clarify if graduate students participate in the clubs. For some master's programs, the students work during the day and take classes during evenings and nights. In fact, out of 5 classes that it offered in Spring 2023, 4 were in evening.

This would also address one of ERs' recommendation that "There is no formal recruitment process to the program. While this does not appear to impact enrollment, it may impact the quality of students and the diversity of the enrolled students" and that "The Program has relationships with industry in the local region which are exploited to attract students. While this is encouraging, a broader approach to recruitment is recommended to attract a diverse group of students." Building and expanding partnerships through these clubs and organizations can help enhance student experience in the Department.

Recommendation R.1.1: The IRs recommend that the Department analyze and take advantage of potential student recruitment opportunities in their existing outreach efforts in the region.

Recommendation R.1.2: The IRs recommend that the Department include in its Self-Study only information, e.g. clubs, relevant to the master's program.

Element 2. To Improve Student Learning (consider university/college goals on learning, research/scholarship, diversity)

The Department hasn't initiated programmatic assessment for its master's degree, including the blended program. They've collected course data but failed to analyze and reflect on it in order to move to the next level and do it for their PLOs. As the IRs noted in our introduction, the faculty would greatly benefit from reading Civil Engineering's Self-Study and our accompanying report.

The ERs didn't fill out the chart in the *Guide* to determine the stages of assessment development. This is a requirement. That said, the IRs consider it more important and appreciated that they wrote their recommendations rather than furnishing just bullet points, since the IRs find that explanations are superior for analyzing stages of assessment than assigning a single initial letter to convey assessment stage development (I=Initial, E=Emerging, D=Developed or HD=Highly Developed).

The ER's recommendation that consulting with the Office of Graduate Studies would assist faculty in determining what data and evidence they should collect demonstrated a lack of understanding of our assessment resources. The faculty, not just the graduate coordinator, needs to consult with an Office of Academic Program Assessment (OAPA) representative for appropriate training on developing an assessment plan and conducting assessment. Additionally, OAPA can explain how the Department can combine direct and indirect measures to create a robust assessment program.

The Department's assessment plan will need to be flexible and modifiable as the faculty become more skillful and sophisticated in conducting assessment. They should include their plan in future self-studies.

Faculty will need to address whether or not they will assess blended program students differently and note in future Self-Studies.

Recommendation: 2.R.1: The IRs strongly recommend that all graduate faculty meet with a representative from OAPA for assessment training.

Recommendation: 2.R.2: The IRs recommend that the faculty create an assessment plan with sufficient detail providing how, what, and when they assess PLOs and the type of collected data utilizing direct and indirect measures.

Recommendation: 2.R.3: The IRs recommend that the faculty create an assessment committee or team of more than one faculty for assessing PLOs.

Recommendation: 2.R.4: The IRs recommend that the Department include its assessment plan in future Self-Studies.

Element 3. To Improve Student Success (consider university/college goals on recruitment, retention, graduation, diversity, engagement)

Besides revamping the Department's website as the ERs recommended, it can quickly implement some strategies for recruitment and retention. If it hasn't considered an open house (virtual, in-person, or both), it could experiment with it. Also, it can conduct surveys for its introductory course as to how students chose the program. Academic advising should allow faculty to monitor student performance and alert them to problems in the program as well as a graduating survey. The Department can examine other universities' efforts, for example, Arizona State University's best practices checklist for marketing graduate programs. (https://graduate.asu.edu/sites/default/files/gradrecruitmentbestpractices-feb2017.pdf). Conducting a literature review may provide some useful strategies that other programs have developed. See Appendix.

The U.S. Bureau of Labor Statistics forecasts slow, small growth for the field. "Employment of mechanical engineers is projected to grow 2 percent from 2021 to 2031, slower than the average for all occupations. Despite limited employment growth, about 17,900 openings for mechanical engineers are projected each year, on average, over the decade. Most of those openings are expected to result from the need to replace workers who transfer to different occupations or exit the labor force, such as to retire." https://www.bls.gov/ooh/architecture-and-engineering/mechanical-engineers.htm There are 1,060 employed mechanical engineers in Sacramento-Roseville-Arden Arcade Metropolitan/Non-Metropolitan area. Sacramento--Roseville--Arden-Arcade, CA - May 2022 OEWS Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates (bls.gov)
The faculty through their industry contacts may be able to determine how much possible growth and value of marketing their master's degree exists for local professionals.

The Self-Study supplied some bar graphs on enrollment and student diversity but lacked reflection. The latest National Science Foundation's statistics (2018; N=3,999) provided demographics for the field.

Demographic:	#	%
Male	3,694	92
Female	655	16
African-American	122	.03
Asian-Pacific Islander	474	12
Hispanic/Latino	410	10
Native American	8	.002
White	2,660	67

nsf.gov - NCSES Science and Engineering Degrees, by Race/Ethnicity of Recipients: 2008–18 - US National Science Foundation (NSF)

The Department suggested that possibly the College's newly formed Diversity Equity Inclusion (DEI) Committee may address these major issues. The IRs realize that increasing diversity for underrepresented minorities (URMs) is something that all colleges and universities struggle with, and there are no easy, simple answers. The IRs suggest that the Department take a more active role in exploring possible strategies in diversifying their student enrollment by reviewing their literature, possibly conducting surveys of other institutions, and consulting professional organizations (e.g. NACME https://www.nacme.org/). See Appendix for some sample articles.

Recommendation: 3.R.1: IRs recommend the faculty consider open houses (in-person, virtual, or both).

Recommendation: 3.R.2: IRs recommend the faculty conduct surveys to obtain relevant data from introductory courses and graduating students.

Recommendation: 3.R.3: IRs recommend the faculty take a more active role in increasing overall enrollment, retention, and diversification, in particular for URMs, by reviewing their literature.

Element 4. To Build Partnerships and Resource Development to Enhance the Student Experience (consider university/college goals on university as place, university experience, community engagement)

The Department has an opportunity to use a more evidence-based approach to their program development. In their Self-Study, in a section entitled "Analysis on admission, retention, and graduation data," it acknowledged that "Reflecting on the data and methods of collection, improvements are needed in our tracking. To that end, Canvas pages have been developed and newly hired staff are being engaged in the process to assist the Graduate Coordinator."

Such an evidence-based approach can prove to be useful. For example, in their Self-Study, the Department noted that "Figure 1 shows the number of applicants and admitted applicants during the period. While the numbers dropped from Spring 2020 to Spring 2021, primarily due to the pandemic, they bounced back stronger in the subsequent semesters." There is an opportunity for the Department to reflect on why they attribute the drop primarily to the pandemic as the Fall 2019 to Spring 2020 numbers show a decline even before the pandemic. The Department might also reflect on whether any increased enrolment after the pandemic might be a short-term impact of pent-up demand and assess any potential long-term implications.

This can also potentially address an ER's observation that "Data for various other important metrics, e.g., retention data, job placement, alumni surveys, are not available in the Self-Study Report. Improved ways to gather and maintain such data must be identified and can facilitate data-driven improvement steps." Adopting a data driven approach can help the Department in their long-term planning.

Recommendation 4. D.1: The IRs recommend that the Department consider and assess student enrollment trends, among others, using data in their long-term planning.

Element 5. To Improve Strategic and Budget Planning and Operational Effectiveness and to Ensure Sustainability (consider university/college goals on innovative teaching, scholarship, research, university as place, university experience)

The Self-Study offered some strategies for maintaining and enhancing the program quality including structural changes and enhancement to the program since last review, external partnerships, faculty hiring, and future assessment plan and activities. Specifically, the Self-Study noted that "The Department recently lost a faculty member in the area of Thermal Sciences to another university. Two active searches are ongoing – Thermal Fluids and System Dynamics and Controls. Another faculty will be sought in the next cycle for Thermal Fluids in 2023/24." While the Department briefly mentioned its desire for full-time faculty hiring, it did not address what they are doing for faculty retention, what their plans are for faculty recruitment, and they are relatively quiet on their plans for part-time faculty hiring.

The Self-Study also reported that "the college has launched a research assistanceship program (RAP) that can fund 1-2 students per year for up to $3600" but is unclear whether and how the Department will benefit from such student assistants. A more in-depth reflection and assessment of the needs in these domains would improve the Department's Self-Study for its goal of sustainable improvement, in particular in the area of teaching and research over time.

In addition, the Self-Study seemed to imply that the Department needs more release time for the master's advising. The IRs recommend that they develop a plan for graduate student enrollment that is sustainable and that accounts for adequate faculty assignments, rather than growing enrollment if they cannot internally or externally increase resources. Many departments do not receive extra funding for graduate education. ABET, their external accreditor, places restrictions on the Department for their undergraduate enrollment that they must meet to retain accreditation.

Recommendation 5.R.1: The IRs recommend that Department develop a plan that includes academic personnel hiring needs that incorporates full-time and part-time faculty as well as any teaching/research assistants.

Recommendation 5.R.2: The IRs recommend that Department consider assessing formal and/or informal program changes, e.g. research assistanceship program (RAP), to determine if such programs enhance or detract from the overall quality of the program.

III. Appendix:

Dell, E., Lucietto, A., Cooney, E., Russell, L., & Schott, E. (2019). Diversity in engineering technology students. *Proceeding of the 2019 Conference for Industry and Education Collaboration, CIEC 2019*.

Fertig, J., & Kumpaty, S. (2021). Enhancing University Persistence of Diverse Mechanical Engineering Students. *ASME International Mechanical Engineering Congress and Exposition, Proceedings (IMECE)*, *9*. https://doi.org/10.1115/IMECE2021-70862

Gross, E., Peters, D. L., & Mann, S. L. (2018). Synergies between experience and study in graduate engineering education. *ASEE Annual Conference and Exposition, Conference Proceedings*, *2018-June*.

Gurganus, J. R., Zhu, L., Eggleton, C. D., & Sun, S. (2019). NSF S-STEM program: Recruitment, engagement, and retention: Energizing and supporting students with diverse backgrounds in mechanical engineering (work-in-progress). *ASEE Annual Conference and Exposition, Conference Proceedings*.

Program Review Finding Cite self-study, external review, internal review, and/or accreditation documentation	**2 YR** List goal, success indicator, responsible parties, and resource implications.	**4 YR** List goal, success indicator, responsible parties, and resource implications.	**6 YR** List goal, success indicator, responsible parties, and resource implications.
To Maintain Success			
Recruitment: New MS students while achieving proportional student/faculty ratio to ensure success Ensure MS ME Enrollment is proportional to tenure track faculty	• Conduct surveys in an introductory course (ME209) on how and why students chose the program. • Evaluate student/faculty ratio and time to graduation. • Conduct literature review on strategies for the marketing and development of the program. Articulate 2-3 recruitment strategies to increase applicants to the program.	• Recruit 10% more applicants. • Analyze the results of the efforts in the first 2-years and adjusting the strategies accordingly.	• Recruit 20% more applicant. • Analyze the results of the efforts in the first 4-years and adjusting strategies accordingly.
Increase BS/MS Blended Enrollment	• Introduce program to the potential applicants by delivering a presentation to the students in ME116/117. • MS ME graduate coordinator will monitor growth in the applicant pool.	• Success indicator: Growth in the applicant pool by 15%.	• Success indicator: Growth in the applicant pool by 25%.
Enrollment of more URM and female students	• Collect demographics data related to programs across the nation, other CSUs, or other institutions and comparing them to our program. • Evaluate the impacts of the efforts in the previous item on the collected data over time. • Implement 4 strategies to enroll more URM and female students.	• Increase female and URM enrollment to greater than 40% of graduate students • Gauge impact and adjust strategies according to the results of the first 2-years.	• Increase female and URM enrollment to at least 50% of graduate students • Gauge impact and adjust strategies according to the results of the previous years.
The revised CSU policy on blended degree programs	• Implement the revised CSU policy on blended degree programs to attract high quality and diverse applicant pool for the blended program.	• Track GPA, time to graduation, and % URM and Female Students from year 1 to year 4 • Adjust strategy if trends are negative.	• Track GPA, time to graduation, and % URM and Female Students from year 4 to year 6 • Adjust strategy if trends are negative.

To Improve Student Learning (consider university/college goals on learning, research/scholarship, diversity)			
Fully implement Assessment Plan to know where learning and time to be degree need to be improved.	• Implement Assessment Plan presented in the self-study report with emphasis on data collection from a variety of courses, reflection, and continuous improvement. • Develop Alumni Survey for the graduate program. • Consider other potential tools such as retention data, employment after graduation, Professional Engineering licensure passage rates, PhD program acceptance rates, internships, etc. to measure and improve the program success. • Solicit feedback from the department's Industrial Advisory Committee • Engage department's assessment committee at the graduate level assessment (The department has already had an assessment committee for the undergraduate program).	• Close the loop and implement change for 4 outcomes.	• Close the loop and implement change for all outcomes to be prepared for program review.
Restructure BS/MS Blended Program to Improve Time to Degree based on the Revised CSU Policy on Blended Programs.	• Update blended BS/MS catalog. • Gather and assess time to degree data. • Develop retention and matriculation strategy.	• Improve time to degree by 10%. • Improve retention by 25%.	• Improve time to degree by 20%. • Improve retention by 50%.

To Improve Student Success (consider university/college goals on recruitment, retention, graduation, diversity, engagement)			
Improve time to degree	• Collect data on the average number of years for the completion of the program and the number of semesters in ME500. • Create a mandatory orientation session for new students on the Exit Seminar day so new students can meet faculty and graduating students and learn about the thesis expectations and variety of thesis topics. • Use ME 209 more effectively as the first step for student's engagement with their thesis: - Creating consistent content for the course that is agreed upon by all faculty and able to meet program objectives. - Mandatory enrollment in ME209 in the first semester. - Mandatory engagement of students with potential advisors with a clear deadline and a required form/assignment for enforcement. - Creating a contingency plan for students who are 'unable' to fulfill this step.	• 60% graduate in 2 years.	• 80% graduate in 2 years.
Increase retention	• Implement mandatory advising at least once a year for all graduate students. • Implement mandatory advising every semester for all blended program students while in the BS program (before transition to MS program). • Implement mandatory advising session for new graduate students, including new student orientation. • Collect and analyze student retention data.	• Improve retention by 25%.	• Improve retention by 50%.
Departmental website	• Review and redesign the department website for graduate students.	NA	NA

To Build Partnerships and Resource Development to Enhance the Student Experience (consider university/college goals on university as place, university experience, community engagement)			
Build partnerships with local industry and potential employers.	• Write grants to procure equipment and funding for students. • IAC meeting membership and minutes • Employment survey	• Detail accomplishments • Reflect on impact of grants on student learning and time to degree. • Reflect on impact of grants on students' career/employment outcomes.	• Adjust strategies to further increase partnerships with local industry and potential employers
To Improve Strategic & Budget and Operational Effectiveness and to Insure Sustainability (consider university/college goals on innovative teaching, scholarship, research, university as place, university experience)			
Hiring plan	• Develop a 5 year hiring plan that includes academic personnel hiring needs that incorporates full-time and part-time faculty as well as any teaching/research assistants.	Update Plan	Update Plan

Signatures:

ME Department Chair

Troy Topping 9/21/2023

Troy D. Topping, Ph.D.

Dean, College of Engineering and Computer Science

K. Shafizadeh 9/21/2023

Kevan Shafizadeh, Ph.D., P.E., T.E., PTP, PTOE (he/him)