

California State University, Fullerton
Mechanical Engineering Department

PROGRAM PERFORMANCE REVIEW (PPR)
External Review Report
Master of Science in Mechanical Engineering (MSME)

Review Team

External Reviewers

Dr. Travis Hu
Associate Professor of Mechanical Engineering
Department Graduate Coordinator and Principal Advisor, ME and MSE Programs (2019 present)
California State University, Los Angeles

Dr. April Si
Professor of Aerospace, Industrial, and Mechanical Engineering Department
Department Chair (2017-2020)
California Baptist University

Dr. Jalal Torabzadeh
Professor of Mechanical and Aerospace Engineering
Department Chair (2012-present)
California State University, Long Beach

Internal Reviewer

Dr. Jidong Huang
Professor of Electrical and Computer Engineering Department
Department Chair (2021-present), Graduate Program Advisor (2018-2021)
California State University, Fullerton

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Introduction

The Master of Science in Mechanical Engineering (MSME) at California State University, Fullerton was established over 30 years ago and has been offered continuously. The program has been one of the main MSME programs offered in Southern California and has educated and prepared qualified MSME graduates who have been successful in securing employment in related industries at local, regional, national, and international levels or pursuing higher degrees. The Program Educational Objectives (PEOs) include Technical Growth, Professional Skills, and Professional Attitude and Citizenship for its graduates. These PEO's have been reviewed periodically with primary constituents (faculty, students, industrial advisory board, and alumni). There has been no change to the PEOs since the last review in 2016. The program offers a solid MSME education/degree with many course options but no concentration/emphasis. For the culminating experience, students have three options: Thesis, Project, or Comprehensive Exam.

The department currently has 11 tenured and tenure-track faculty members with a diverse and wide range of mechanical engineering sub-disciplines and 12 part-time faculty mainly from local industries. Since the last PPR in 2016, the department has hired 6 faculty members, however, lost 5 faculty members due to retirement, separation, and moving to the college administration.

Since the last review, the department has taken several steps and initiatives in response to the recommendations to improve various aspects of the MSME program including enrollment management, initiating a systematic and periodic assessment plan, enhancing research activities and resources, and initiating other strategic plans. The department is commended on implementing some of the recommendations and for some new initiatives. However, there are still several areas of the program which need attention for the program to be successful and fulfill its mission and goals.

Overview of the Review Process

The Program Performance Review (PPR) for the MSME program was initiated in early April by the Chair of the Mechanical Engineering (ME) Department by inviting qualified external reviewers to form a team for PPR. The team was assembled in mid-May and included three external reviewers from three different institutions and an internal reviewer from CSU Fullerton (listed above). The review process was schedule in early May with an on-site visit for May 17. The review team received the PPR Review Team Information and the agenda for a 1-day On-Site Visit on May 5th (attached). The Self-Study Report prepared by the ME Department was received by the reviewers on May 12th, with ample time for the team of reviewers to review the document before the PPR on-site visit.

On May 17, the ME Department Chair met and greeted the Review Team at 8 AM. A series of

meeting with various constituents started at 8:30 am meeting with the Department Chair. Then the Team met with the ME Graduate Program Advisor; the College of Engineering and Computer Science (ECS) Associate Dean; Dean of the College of Engineering and Computer Science, Two groups of ME faculty; several ME graduate students and department staff in consecutive and separate meetings according to the scheduled agenda.

The Chair introduced the department to the reviewers, emphasizing the MSME program. The Dean and the Associate Dean provided information about resources available within the College to support teaching, faculty research, and graduate students' culminating experience (e.g., Project vs. Thesis). Participated faculty members (a mixture of junior and senior faculty) and current graduate students (a mix of of ME undergraduate major and non-ME undergraduate major before starting the program) shared their experiences, opinions, and concerns about the program regarding class options, project availability and work, faculty, student support, etc. Reviewers asked pertinent questions based on the eight topics in the self-study report and received further briefings, clarifications, and answers from the deans, department chair, faculty, and students.

Based on the information from the previous review conducted in May 2016, the current review is the second review of the MSME program.

The review team also reviewed the previous PPR External Review Report (from May 20, 2016) and related communications/responses to follow changes made and activities conducted since the last review.

The review team would like to thank the College of Engineering and Computer Science administrators; the Mechanical Engineering Department chair, faculty, staff, students; and all who were involved with the preparation of self-study report, planning, and arranging of on-site visit and related meetings, collecting, and providing information; and providing input to the review team. Thank you for your time and efforts and the opportunity to learn about your program. We hope our input would be helpful in your plan on continuous improvement plan.

I. Department/Program Mission, Goals, and Environment

Strengths:

- The program mission and goals are aligned with university mission, goals, and strategies in offering affordable graduate programs and providing quality teaching and research to mechanical engineering students
- Program Educational Objectives (PEOs) are clearly identified and mapped to the Cal State Fullerton Graduate Learning Goals (GLGs)

- The PEOs address the issues of developing both the hard and soft skills of the graduate students to be incorporated into the engineering workforce
- Unique geographic location in Southern California at the heart of major high-tech industries
- Excellent opportunities to attract well-qualified faculty and students
- Great opportunities for collaboration with top high-tech industries on research, student projects, engineering training, and professional and continuing education
- Department and faculty are committed to program and student success
- Diverse, motivated, well-qualified, and enthusiastic faculty
- Diverse and enthusiastic student population

Challenges:

- PEO 2 and PEO 3 overlap with each other in terms of developing the soft skills and professional work ethics to become a competent and successful engineer
- There needs to be more emphasis on preparing graduate students for alternative career paths (e.g., Ph.D., Research Scientist in National Labs, government agencies) other than an employee in a company or corporation
- In Part A, under PEO 1, one mission is to prepare the students to integrate into the local and global workforce; however, in Part B, the department's responses to the change and trend of the job market only looked at data of the local region (i.e., Orange County)
- Department assumes that since most students getting into the MSME program are from local region, they do not want to relocate to other states or work internationally upon graduation. The assumption or conclusion may be false leading without any supporting data
- A very competitive job market (for engineers) in Southern California, a region with high cost of living
- High competition with Biomechanics and Bio-Medical Engineering graduates in Orange County area

Recommendations:

- The realms of PEO 2 and 3 need to be clearly defined so that they don't overlap with each other
- MSME graduates may find desirable and attractive jobs in industry, academia, government agencies, and nonprofits at local, regional, national, and international levels. Also, some may find it practical to get into this program as a steppingstone for a Ph.D. program to become a scientific researcher or educator in academia.
- Upon building a good knowledge base and technical foundation, character building and mindset changing of the admitted students (i.e., primarily first-generation

minority students in southern California) to become successful mechanical engineers, scientific researchers, or working professionals should be considered.

- Rather than introducing some specific special topic courses (e.g., EGME 442- Computational Cardiovascular Engineering or EGME 481- Human Centered Design) to address the changes of direction in the work fields (or to chase the fad), helping students in early career planning and to find internship opportunities may be more effective. Then more time and energy can be devoted to developing the engineering cores.
- Survey alumni to collect and analyze information on their current job, position, career path, level of satisfaction with their MSME degree, their experiences with the program and their recommendation for program improvement.
- Survey local industry for their current needs, technology trends, curriculum improvement, etc.

II. Department/Program Description and Analysis

Strengths:

- Introduction of nine new courses since last review has provided students with more class choices and faculty with opportunity to recruit and engage students in their research activities
- Newly introduced courses - EGME 430: Introduction to Continuum Mechanics; and EGME 458: Biomaterials can help building a strong core and are tailored to the job market and regional demand, respectively
- Bridge courses for non-major students are identified and selected upon admission by meeting a graduate advisor
- Flexibility in admitting non-major students regarding the minimum criteria and background
- Stabilization of enrollment over the past three years
- New spaces for student learning and faculty research are on the horizon
- Faculty hires, both completed recently and projected shortly, help to alienate the expert shortage issue of the department for course offerings and research projects available for students for the culminating experiences of project or thesis

Challenges:

- The number of bridge courses is on the higher side. Due to the limited number of 500-level courses and their rotation, students originally planned and committed to taking electives in one area may be forced to switch to other specialty areas as they approach graduation, which could be frustrating and detrimental.
- Requiring only a 3-unit core course in the program poses a significant challenge to the

course offering considering the department's size and student body.

- Graduates of the program with no concentration/emphasis may have tough time competing for job with graduates from other universities/programs with concentration/specialization
- It seems like few faculty members are heavily loaded with supervising too many student projects for the culminating experience all at once (one case brought to our attention is that one faculty manage about 20 projects per year or two years), and the quality of the work, the learning experience, individual interactions, and attention to details are seriously questionable
- Cancellation of low enrolled classes (less than 15) poses major challenges for timely graduation of students who need to take them as planned.
- Section E: Future Plans for Curricular Changes narrative need to be more specific
- Cross-listing and/or offering of same undergraduate and graduate courses can affect PEOs and SLOs
- Insufficient and irregular offering of core courses which can force students to take unrelated and not planned courses

Recommendations:

- It is recommended to lower the number of bridge courses to 3 at most (of which can be completed within one semester at best or two semesters for justified exceptional circumstances). Additional courses needed to bridge the gap should be taken in 'open university' or other community colleges before an official admission can be offered to help ensure the students are adequately prepared and have a solid commitment to follow through for the "change of major." In this case, the time commitment becomes a relatively low stake and tests the student's true motivation. This also ensures they do not set up for failure from the beginning. Motivations, interests, and life circumstances are prone to change over time.
- Offer a few (two or three) concentrations or specialty areas within the degree program (e.g., Thermal-Fluids, Design and Manufacturing, Control and Robotics, etc.) by reviewing, revising, and updating curriculum; streamlining courses; identifying core courses; and offering courses on a planned 2-year schedule to help students with their planning and selecting courses and timely graduation.
- It is recommended that more core courses (in addition to only one engineering math course) be included in the program (e.g., continuum mechanics and fundamental subjects that are cut across all subareas of mechanical engineering at the graduate level for developing or training both hard and soft skills) so that whatever areas or elective the students choose to take (e.g., solid mechanics and mechanical design, materials and manufacturing, thermal-fluids, robotics and control, etc.), they will have a strong foundation of the disciplines to be competent for more engineering related jobs (e.g., advanced manufacturing, biomedical, aerospace or energy sectors). The

fundamentals rarely change, no matter how the fad shifts overnights or within a few years.

- It is recommended that the department take the SLOs and expected assessment goals, criteria and outcomes into consideration and reverse engineer the setup and offering of the core courses as opposed to the electives for the program at the department level so that it becomes a closed feedback loop.
- It is suggested that the college or department find a way to provide faculty with some compensation for supervision such as using “S-Factors” formula or allocating released/re-assigned time or units to reduce heavy teaching load (so that faculty will have enough quality time spent with students) for supervising graduate students in thesis research or serving on the thesis committee so that the quality of the research can be strengthen (in order to attract external grand from national agencies, e.g., in NSF, DoD or DoE...) and healthy mentor and mentee relationships can be established or years to come.
- Time wisely invested in supervising thesis projects, if implemented successfully, will help faculty to be productive and meet the fund manager’s request for the outcomes of the research when external funds are awarded and help them with consecutive external awards, which will eventually benefit the students, the department, and the college more
- Section E: Future Plans for Curricular Changes narrative are too vague. It is recommended to clearly describe job qualifications and especially the preference of specialization area for the two 2024 hires. Are they going to be a general call for all ME disciplines to be eligible to apply or more specific based on current needs? For instance, to improve the number of full-time faculty teaching the core and elective courses of the program and offer research opportunities in certain areas that are critically missing and demanded by the job market or students’ needs
- Have appropriate assessment methods (requirements) and quality control for work of students enrolling in cross-listed undergraduate-graduate courses (bridge courses) to ensure quality education and desired SLOs
- Communicate updated information on degree requirements, curriculum changes, course offerings, timelines, etc.

III. Documentation of Student Academic Achievement and Assessment of Student Learning Outcomes

Strengths:

- A systematic and periodic assessment for the MSME program has been in place after

the previous PPR since 2016

- The recently revised SLOs are well-written and mapped to the PEOs and GLGs
- The process and data collection of the direct and indirect assessment are elaborated

Challenges:

- For SLO 1: The direct assessment indicators do not meet the expected standards for both assessment cycles

Recommendations:

- It is suggested that the department initiate a department retreat/taskforce to develop strategies to improve the engineering fundamentals, knowledge base and skill set, e.g., to expand the core of one 3 Units Match class to include more fundamental ME courses at the 500 levels (for every student to take), which can strengthen SLO 1, help run programs with more structure, and solve issues of low attendance/demand of classes.

IV. Faculty

Strengths:

- Future and strategic faculty hires for emerging mechanical engineering areas are clearly outlined here
- Full-time faculty in the department take ownership of the curriculum and courses through various committees and task forces
- Good communication channels between full-time faculty and part-time faculty, and teaching associates
- Weighted teaching units taught by full-time faculty and part-time faculty, and teaching associates are distributed reasonably (predominantly by full-time faculty, which is 57%)

Challenges:

- Cross-department collaboration with the college needs to be highlighted
- It appears that not much effort was put forward to encourage faculty to lead and initiate collaborations in more prominent research theme or educational grants at the institutional level (e.g., to apply for center grants from NSF, DoE, or DoD in more prominent themes such as urban sustainability, environmental remediation, AI, or advanced manufacturing), even though some activities are happening at the individual lab or group levels.
- Heavy teaching load

Recommendations:

- Some of the emerging areas in Mechanical Engineering (in terms of both teaching and research; in AI, Robotics and Control; Advanced Manufacturing; Environmental Remediation, and Energy Sustainability) can be addressed via cross-department collaborations within the College of Engineering (e.g., in partnership with Civil, Electrical and Computer Engineering and Sciences).
- It is recommended that Faculty in ME initiate and participate in large external grant applications of emerging themes in ME, such that involved students will be part of a team or professional in doing critical research at the national level, making them competitive in the job markets of industry, academia, and governmental agencies, or become an entrepreneur with a strong research and engineering background.
- It is recommended that the department and the college continue their efforts in securing resources to support new faculty with establishing their resech lab/activities. This can also help faculty in engaging more students in their research activities.
- The department and college should continue efforts in recruiting additional tenure-track faculty in areas needed by the department especially in emerging and multi-disciplinary fields

V. Student Support and Advising**Strengths:**

- In-person advising, and info session are conducted right after new graduate student orientation
- Some career advising is available at the university level

Challenges:

- Lack of detailed description and elaboration on many essential aspects of student advising activities makes it hard for the reviewer to evaluate and critique.
- Lack of course planning or documentation for each individual student at the early stage at department level makes it hard to plan for course offering, course rotation, keeping students on track, and monitoring and following up on students' progress or needed changes as they progress in the program.
- Reviewers need clarification on whether department-specific and university-wide general orientation is held for the new MSME students and their timeline (e.g., which comes first and why?)
- Lack of a clear advising process

Recommendations:

- It is suggested that the department expand on the narratives of this section to elaborate more on how graduate advising is carried out, e.g., who is responsible to send out probation notices to the students and keeping them on track? The department or the registrar's office? Who will intervene, and within how many units or courses will the student have to bring up their GPA to the minimum requirements? What if someone fell through the crack? Any historical data would be helpful to see the action plans put forth by the graduate advisors or the department to help students get back on track if things go rough and unexpected.
- It is recommended that a clear advising process and documentation be developed at department level.
- It is recommended that department document and keep record of advising session right after the first in-person meeting or orientation to setup a course planner for each student. Then modify the planner as the advisor actively support student to be on track and make changes to the course planner on a semester basis or at least three times before the student complete his/her course work and/or research and graduate (1. During or right after department orientation; 2. Mid-program checkup before they apply for advancement to candidacy; 3 towards the end before they apply for graduation).

VI. Resources and Facilities**Strengths:**

- Acquisition of some new laboratory equipment and improvement of instructional facilities are commendable.
- Computer and library resources seem to be adequate
- Great potential and opportunities for industry support

Challenges:

- Lack of adequate research equipment and facilities
- Inadequate research infrastructure and support for both faculty and students
- Lack/insufficient funding to support/compensate faculty supervising theses and projects and engaging students in research

Recommendations:

- It is recommended that the department pursue large Instrumentation grants (e.g., NSF MRI) to procure high-end research-quality equipment and facilities for enhancing

faculty and student research in traditional and emerging fields of mechanical engineering and to tackle multidisciplinary and integrated problems of practical significance (e.g., to acquire advanced manufacturing facilities and 3D printers; to build shared HPC facilities within the college of engineering and computer science)

- Department and college should continue working with industry to secure additional fund to support faculty and students' research activities.

VII. Long-Term Plans

Strengths:

- The Self-Study Report outlines a clear and ambitious long-term plan for the department. The plan has identified several key priorities and actions based on departmental needs in line with forward-looking view on support and consistent with the college and university strategic plans (e.g., to align with the new "Fullerton Forward 2024-2029 strategic plan").

Challenges:

- The proposed Long-Term Plan for department relies mainly on the university and college support (CSU allocated budget)
- The "Long-Term Budget Plan" reads relatively passive and predetermined and does not provide details

Recommendations:

- Curriculum needs to be reviewed and updated more frequently
- Create a structure for faculty and student support considering equity, diversity, and inclusion
- It is highly recommended that the department work on preparing a set of guidelines such as a "Graduate Student Handbook) for graduate students to supplement periodic advising
- It is recommended that the department faculty as a whole look into the setup of the Project vs Thesis option and determine if the student learning outcomes are met and are as expected. The reviewers are unclear about how exactly the project and thesis options work and how they are differentiated (pros and cons and rational for both options).
- To enhance research support, the department is encouraged to investigate pursuing/applying for large institutional grants, instrumentation grants, educational grants, and other external funds to support teaching, and research activities of the MSME program

- It is recommended to expand departmental interactions with industry for fundraising and securing support for the graduate program
- Promote faculty and students' research activities and achievements

VIII. Other Comments/Recommendations

The Mechanical Engineering Department and the College of Engineering faculty, staff, and administrators are commended on their efforts in successful offering of the MSME program to interested students globally and for educating and preparing quality graduates who are helping with resolving some of the societal challenges.

As indicated earlier, the program has great potentials for expansion and improvement.

In addition to the recommendations in various parts of this report, the external review Team suggests that the department and the college investigate, consider, and plan on initiating and implementing some of the following recommendations that have worked in other institutions:

- Design and implement a structured advising system for MSME students
- Prepare and provide students with a "Graduate Student Handbook"
- Enhance graduate student orientation and mentoring and create a sense of community
- Improve time-to-degree by offering courses on a regular basis in a structured pattern
- Offer workshops and seminars (by faculty and experienced students) on various topics of interest to students to provide them with peer-mentoring, successful path, motivation to engage with research, and to create a sense of belonging
- Initiate and create more interactions with local industry on activities with mutual interest (for teaching, research, and problem solving)
- Enhance the experiential and research-based nature of the program
- Raise fund and seek additional internal fund to support faculty and students with their research work.