

Submission date: 01/31/2020

Program/s in this review: Mechanical Engineering (BS-MS)

Specialized accrediting agency (if applicable): ABET

Campuses where the program is delivered: UAA

Members of the program review committee:

- Jifeng Peng, Associate Professor & Department Chair, UAA
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1. Centrality of Program Mission and Supporting Role (700 words or less)

- Relevancy of the program/s;

More than a hundred engineering, energy, utilities and construction employers are located within the immediate area surrounding the UAA campus, with more in Anchorage and the surrounding communities. Many of these employers need qualified mechanical engineers. Due to high relocation cost and high turn-over rate for out-of-state recruits, the engineering labor market in Alaska, especially the entry level, is relatively regionalized.

The BSME program provides local employers qualified entry-level engineers with broad knowledge in many mechanical engineering disciplines, including solid mechanics, dynamics, heat transfer, fluid mechanics, material science, and design. The MSME program, in addition, provides access to graduate-level continuing education in mechanical engineering to place-based students and Southcentral employers. It also expands partnerships with local industry and communities by promoting more significant hands-on research opportunities which address important local engineering problems and often generate intellectual property. The MSME program also enhances interdisciplinary study, research and other collaborations.

Both programs advance UAA's mission of serving the higher education needs of the state and its communities, and discovering and disseminating knowledge through teaching and research. EMSI data for 2008-2019 shows that 82% of our graduates remain in Alaska for employment.

- Any role the program plays in supporting other academic programs;

In addition to UAA GER courses, the BSME program also requires students to take an upper level math elective. BSME students sometimes also take upper-level engineering electives from other engineering departments, such as EE, CE or CSE, as part of their degree requirements.

Examples of the interconnectedness of MSME program to other programs include:

- MSME students take many 400- and 600-level mathematics courses;
 - EE A472 Advanced Linear Systems has been stacked with ME A672 Advanced Linear Systems;
 - ME faculty frequently serve on the committees of students in the MSCE program.
- Partnerships with outside agencies, businesses, or organizations;

The ME programs receive support from local industries, such as oil and gas, transportation and facilities, aerospace, heating, ventilation, and air conditioning (HVAC), in the form of internships for our students and employment for our graduates. The continued relationship between the program and local industry better prepares mechanical engineering students for their careers after graduation. The department also has an active Advisory Board from local industries with exceptional engagement and dedication to supporting and growing the ME programs. ME students

also frequently partner with outside clients for capstone design projects; a few examples include: Snow-making system for Arctic Valley Ski Area; Parking fee collection box for Chugach State Park; HVAC system for National Park Service Cordova ranger district building; Fish weir and mounting for US Army, etc.

- Specific workforce development and employment opportunities relevant to the program;

As the economic center of Alaska, Anchorage has an active community of professional engineering societies, including the American Society of Mechanical Engineers (ASME), the American Society of Heating, Ventilation, Refrigeration, and Air-conditioning Engineers (ASHRAE), the Society of Women Engineers (SWE), the Society of American Military Engineers (SAME), the National Association of Corrosion Engineers (NACE), etc. Interacting with CoEng's active Alumni Society and ME Department and CoEng Advisory Boards, students have numerous opportunities to network with local professionals prior to graduation. Graduates from the ME programs fill positions in various engineering professions in HVAC, design, aerospace, pipelines, facilities, process, systems, drilling, corrosion, quality control, and maintenance. According to EMSI occupation employment data, there were 1,251 Mechanical Engineering related (mechanical engineers, health and safety engineers, industrial engineers, aerospace engineers, materials engineers, mechanical drafters) positions and 89 openings in 2018 in Alaska. According to our last Alumni Survey (conducted in 2019 as part of ABET assessment process), 92% of respondents felt well-prepared to perform at their first job.

- Sources of extramural support and funding for the program;

The department faculty have obtained extramural funding from sponsors such as National Science Foundation, Federal and Alaska Departments of Transportation, BP, ConocoPhillips, Gordon and Betty Moore Foundation, US Air Force, NASA, Department of Homeland Security, Alaska Department of Environmental Conservation, Alaska Energy Authority, NACE, ASHRAE, US Hovercraft, etc.

- Any high demand job designation for the program.

The State of Alaska Department of Labor and Workforce Development designates engineering as a high demand job area (HDJA).

2. Program Demand (including service to other programs), Efficiency, and Productivity (7 year trend; 1400 words or less)

Prior to AY2015, the BSME degree existed as one of three concentrations within the Bachelor of Science in Engineering (BSE) degree, the others being electrical engineering and computer systems engineering. It was difficult historically to keep track of which BSE students belonged to which concentration and accurate data are difficult to access. Therefore, the data used in this review only pertains to students enrolled in the BSME after AY2015, and students enrolled in the BSE with concentration ME are left out of the data. This has artificially lowered the enrollment figures for FY2016 and 2017 and also the average values.

For the BSME program, the number of students and the SCH production remained consistently strong. Enrollment in AY19 decreased slightly as did enrollments in the College of Engineering (CoEng) and at UAA. However, the BSME program is still the largest undergraduate engineering program at not only at UAA, but in the entire UA system.

The MSME degree is still relatively new, and, as a consequence, there is no seven-year data available currently. While enrollment is relatively low, the program is still fairly new and needs more time before it can be fully evaluated. The Fast Track MSME program (approved starting spring 2018) has increased student enrollment into the MSME program. For example, of the 24 students graduating with BSME in fall 2019, 4 of them applied and are enrolled in the Fast Track MSME. The majority of students enrolled in the program are part-time, non-thesis students who are pursuing their MS degrees while working an engineering job full-time, which was expected when the program was

proposed, and it is expected that their completion frequently takes longer than two years. However, many graduates of the MSME program have been full-time thesis students.

Unsurprisingly, the BSME and MSME programs generated the majority of their SCH through students enrolled in the major. Our students enroll in courses from mathematics, physics, and chemistry, as well as from the GER program, to meet the requirements of our ABET accreditation. In terms of instructional productivity, the average FTEF of 5.1 does not match our actual number of full-time faculty, which has averaged approximately 8 for the review period (all of our full-time faculty are tripartite, whereas the FTEF is calculated by assuming an average teaching load of 24 credits/year, so this number is not realistic for our program). On the other hand, we tend to schedule a mix of lower-level classes which are more highly enrolled and run sections (or multiple sections) every semester, and several upper-level classes which are offered once per year to manage enrollments. We have therefore maintained an average SCH/FTEF of 628, which is 35% above the UAA average of approximately 464. Our average enrollment/FTEF (277.4), FTES/FTEF (42.2), and average class size (22.0) are also above the UAA averages of 168.1, 15.7, and 17.7, respectively, thanks to our relatively high number of enrolled majors. Our average cost/SCH (\$314.02) is above the UAA average of \$221.92 (but low in CoEng), in part because engineering faculty do command relatively high salaries. Because of this, CoEng instituted 20% differential tuition in FY2017, so our average tuition/SCH is higher than the UAA average of \$202.64 for baccalaureate programs.

Excluding AY2015 and AY2016 for the aforementioned reason (i.e., revenue from BSE students not included in the data), the ratio of tuition revenue from students enrolled the courses taught by the ME Department, to the cost of the ME programs are 91.7% for AY2017, 101.8% for AY 2018 and 94.2% for AY 2019. The data has demonstrated the success of the both ME programs, which generated excellent return-on-investment for the State of Alaska.

The CoEng currently sees recruitment and retention as two of its top focus areas for the near term, as UAA moves to a more tuition-funded model. As the largest engineering program, the UAA BSME will continue to play a key role in the success of the College. As noted by our Advisory Board, the market for graduates of ME programs is expected to remain strong.

3. Program Quality, Improvement and Student Success (1500 words or less)

- Specialized accreditation process and status

The BSME program (originally the BSE program) has been continuously accredited by the Engineering Accreditation Commission (EAC) of ABET since 2007. The next general ABET review of the BSME is scheduled for the 2022-23 accreditation cycle.

- Currency of the curriculum

Our ABET accreditation requires us to demonstrate that our curriculum prepares students to enter the practice of engineering, and that it includes modern engineering tools and appropriate engineering standards (see Criterion 5: Curriculum, abet.org). In particular, ABET closely evaluates the capstone design experience for evidence that it “1) incorporates appropriate engineering standards and multiple constraints, and 2) is based on the knowledge and skills acquired in earlier course work (source: EAC Accreditation Criteria, abet.org).”

The currency of the curriculum is also represented by the success of our students passing the Fundamentals of Engineering (FE) exam, which is a national exam administered by the state and required for state Professional Engineer licensure. The exam is divided into over 20 sections dealing with different topics and data is provided to institutions on their students’ performance in relation to national averages. ME seniors are encouraged but not required to take the FE. However, the significant majority of ME students take the FE exam, and the students have consistently shown success in passing the FE and high performance relative to test takers nationally.

- Availability and indications of quality of distance offerings (e.g., Quality Matters, C-RAC standards, etc.)

With the new Engineering & Industry Building and a complete renovation of the Engineering Computation Building, the state of the art e-Learning classrooms in both buildings have facilitated course sharing between ME programs in UAA and UAF, which has positively impacted student learning at both campuses.

The UAA ME Programs have participated in a course sharing project whereby the UAA ME faculty taught a few selected courses that were also remotely delivered to students in UAF's BSME and MSME programs. Current participating courses included ME A494 Propulsion, ME A642 Advanced Fluid Mechanics and ME A659 Fracture Mechanics.

- Program Student Learning Outcomes assessment: Describe your key findings, actions taken to improve student learning, and evidence that these actions are working

The BSME program is assessed using ABET's listed Student Learning Outcomes. The heart of the ME assessment strategy is direct course-level assessment (CLA). The goal is to assess each outcome, for each assessment cycle, by direct CLA and by other means as well, in a minimum of two required courses. The ME faculty use the eWolf ePortfolio system to document the results of past accreditation cycles. The CLAs used for the most recent ABET review showed that the overall attainment rate for Student Learning Outcomes at 83%, demonstrating the majority of the students are meeting all learning outcomes.

- How well the program is doing on Student Success and what it is doing to facilitate it

Faculty members employ undergraduate students as assistants in research projects supported by the university or by external funding agencies. This is beneficial, especially for students planning to attend graduate school. Many of our students do engineering internships with local companies prior to graduation. According to our last round of senior exit surveys, approximately 61% of our students worked an internship or summer job with an engineering firm prior to graduation. UAA CoEng also has several project-based student clubs, whose activities center on completing national design challenges for national competition and whose membership includes many ME students. These include the Rocketry Club, the SAE (Society of Automotive Engineers) Baja Team, and the Robotics Club. Through research, student clubs, and capstone projects, our programs train the students on many professional skills such as "Understanding of project planning and management", "Effective communication to technical and non-technical audiences", "Function effectively on a team", and "Embracing interdisciplinary/multidisciplinary perspective" desired by employers.

- Student support

BSME Students receive advising through the CoEng Student Advising Center in their freshman and sophomore years. In their junior and senior years, ME faculty directly advise them. The program also established a student academic progress policy. All students must complete all classes with a grade of at least C, and those who fail to receive a passing grade in a course offered by the CoEng are required to receive mandatory advising in the following semester. This holds ME students to a high standard of quality, while at the same time giving them the support needed to reach it, and allows us to concentrate advising resources on the students who need more support.

- Student accomplishments

Program quality is best demonstrated by the accomplishments of our students and their faculty advisors. The following are some examples of student achievements:

- A team of ME undergraduate students competed in the 2015 NASA student rocket launch competition, finished 6th place of all university teams competed and won the University Level Rocket Fair Award. Some members of the team graduated and went on to work for leading Aerospace companies such as SpaceX and Northrop Grumman;

- ME students have competed regularly in the Society of Automotive Engineers Baja Competition since 2010;
- An ME student senior design project, “Adjustable Atmospheric Corrosion Test Rack”, advised by Dr. Raghu Srinivasan, was one of the 10 winners for the national 2019 MP Corrosion Innovation of the Year Awards.
- An ME student was awarded the prestigious NSF Graduate Research fellowship during his senior year in 2017 to pursue PhD studies at Texas A&M;
- Many ME students have been awarded the Alaska Space Grant Undergraduate Fellowship;
- ME students have been listed as co-inventors on two patents with Dr. Anthony Paris: “Bending instrument and methods of using same,” US Patent 9,003,859, 2015 and “Bending instrument and methods of using same,” US Patent 9,421,596, 2016;
- ME A664 Corrosion Processes and Engineering course has been approved by NACE Collegiate Student Certificate Program that recognizes the accomplishments of students who successfully complete a course in corrosion offered as part of the regular curriculum at a college or university;
- Many BSME graduates have gone on to in prestigious graduate programs at universities including Oxford and Columbia;
- Our senior exit surveys indicate that a significant majority of ME graduates have job offers (or plans for graduate school) at the time of graduation, and EMSI data indicate that 82% remain in Alaska to work;
- Almost all faculty publications have undergraduate and/or graduate student co-authors.

4. Program Duplication / Distinctiveness (300 words or less)

There is also a BSME program and an MSME program at UAF. The UAA BSME program is slightly larger than UAF’s BSME in student enrollment and graduates, but both BSME programs are the largest engineering programs at their respective campuses, representing strong demands for both programs. The MSME programs at UAA and UAF both largely cater to local students, with the fast-track MSME students (local BSME graduates continuing their study in MSME) dominating the enrollment.

While similar in structure, the UAA and UAF BSME/MSME programs are both necessary as they serve student populations which are located in two distinct and geographically separated areas of Alaska and which have different demographic characteristics. For example, UAF is primarily a residential campus, while 96% of UAA students are commuters. UAA students are more likely to be part-time and to be working while attending school. UAA students are also on average older than traditional students. Many of the students enrolled in UAA’s ME programs do fit these characteristics. Student demographic data has shown repeatedly that UAA and UAF are truly regional institutions who for the most part do not compete for the same students. The UAA BSME program is relatively new compared with UAF, having been initially accredited in 2007, but enrollment figures show that UAA BSME program has since experienced rapid increase in student enrollment (before a small decrease in AY2019-20). UAF and UAA have fundamentally different missions, and this is also reflected in the differing faculty expertise and research interests between the ME programs at the two campuses.

5. Summary Analysis (500 words or less)

Although relatively new, UAA’s BS and MS ME programs have become an essential part of STEM workforce development in the state of Alaska. Strengths of the program include its well-qualified faculty, networking opportunities with local firms in the state’s economic hub, and many opportunities to participate in high-impact educational experiences, such as internships and undergraduate research.

Since initial accreditation in 2007, the UAA BSME program has consistently generated excellent return-on-investment for the State of Alaska. The number of students and the SCH production has been consistently increasing up to AY2018 before a small decrease in AY19. The ratio of tuition revenue to the cost of the ME programs have consistently remained over 90%. And the BSME program has for many years been the largest undergraduate engineering program at not only at UAA, but in the entire UA system.

To enhance student learning and to generate more revenue, the UAA ME department plans to:

- *Cultivate closer collaboration with local corporations and businesses*
The department will work to further utilize the advantage of the geographic location of the UAA. The faculty have built close relationships with ConocoPhillips, Hilcorp, Alyeska Pipeline, AMC Engineering, etc. The department will further cater to the local industry by providing new courses and collaborating on applied research projects. This will be facilitated by an ever increasing network of BSME and MSME alumni employed in Anchorage.
- *Launch initiatives to encourage even more students to participate in internships and undergraduate research activities*
Many BSME students participate in either internships or undergraduate research. Considering that most ME graduates stay in Alaska for employment, the department will emphasize the many benefits of participating in internships. The department will facilitate this by helping students to connect with local employers. For students interested in graduate programs, the department will also encourage engagement in research projects with faculty and in student club activities. As the number of BSME alumni continues to increase, it is anticipated that industry recognition of the quality of our programs, faculty and students will increase as well and will lead to opportunities to place current students in internships and lead to collaboration with industry on research projects involving undergraduate and graduate students.
- *Participate in a college-wide effort to establish a recharge center*
The ME Machine Shop is equipped with state-of-the-art equipment including several 3D printers. Though the Machine Shop mostly serves the students with their course projects (and faculty and students with their research), there is also external demand for its services. The department is working with CoEng to set up the Machine Shop as part of CoEng recharge center to both serve the general public and to generate new revenue.
- *Increase collaboration with our counterparts at UAF CEM*
The ME Departments at UAA and UAF already enjoy a good working relationship and collaborate on research, share courses, and coordinate programs, and we look forward to finding ways to collaborate even more. Examples of areas under discussion include faculty research, intercampus capstone projects, and student club project collaborations.