

Submission date: January 31, 2020

Program/s in this review: Civil Engineering (MS)

Specialized accrediting agency (if applicable): N/A

Campuses where the program is delivered: UAA's Anchorage campus as well as unlimited distance delivery

Members of the program review committee:

- Joey Yang, Professor & Department Chair, Program Committee Chair, UAA
- Tom Ravens, Professor, UAA

1. Centrality of Program Mission and Supporting Role (700 words or less)

The Master of Science in Civil Engineering (MSCE) program has offered graduate courses in Civil Engineering since 1961, and it is the oldest and most mature graduate engineering program at the University of Alaska Anchorage. The program is versatile and includes both a research track (available to students taking the Thesis option) and two professional tracks (Project option and Comprehensive Exam option). In the 2013-2019 review period, the program had an average of 33 majors and 10 degrees per year. In the same period, the program has grown steadily, with student numbers increasing at about two students per year.

The program is extremely relevant to the Alaska professional engineering community, to the growth of Alaska's economy, and to the engineering research enterprise. The program is recognized as one that prepares students for high-demand careers. Almost all of our students are either full-time engineering professionals working in the Anchorage area or full-time Research Assistants/Teaching Assistants. The MSCE program, which the college operates at a relatively small cost (see below), plays an outsized role in advancing the careers of engineering professionals, in strengthening the Alaska economy, and in supporting applied engineering research.

According to data collected in the Program Prioritization effort, 2751 people hold Alaska Professional Engineer (CE) licenses. Of these, 1396 (or 51%) have Alaska residences, and, of these, 950 (or 68%) are residents of Anchorage, Chugiak, Eagle River, Girdwood, Palmer, or Wasilla. Thus, the majority of Alaska Professional Engineers who reside in Alaska are based in the Anchorage and UAA area, and the UAA MSCE program directly supports this community of Alaska-based Professional Engineers with their continuing education needs. The outsized role of the UAA MSCE program in the state of Alaska is even more apparent when one considers enrollment data from fall 2018 and fall 2019, indicating that UAA's MSCE program provides instruction to about 70% Alaska's Civil Engineering Master's Degree candidates. The enrollment data was provided to CE Chair Joey Yang by Dean Kenrick Mock in an email dated Aug. 27, 2019.

The UAA's MSCE program is also essential considering the direction of the Civil Engineering (CE) branch of Professional Engineers. The American Society of Civil Engineers (ASCE) Policy 465 "Academic Prerequisites for Licensure and Professional Practice" calls for an ABET-accredited BSCE + "Master's degree or 30 acceptable credits [post-BS]..." Thus, it is generally recognized that, with the increasing complexity and sophistication of engineering practice, Professional Civil Engineers will require significant post-graduate education equivalent to the Master's Degree. UAA's well-established MSCE program is prepared to meet this demand, and it is ideally located in the state considering the majority of the engineering firms and the existing Professional Engineers are located in the Anchorage area.

In addition to its help in providing a well-trained professional workforce, UAA's MSCE program supports the high research productivity of the Civil Engineering Department. Many MSCE graduate students work as Research Assistants under the direction of Civil Engineering faculty, allowing the faculty to be more productive researchers. Historically, the majority of the College's funded research was conducted by the CE Department. Institutional Research (IR) indicates that, in the 2008-2018 period, the majority of CE faculty had Fiscal Year (FY) Award Averages

above \$100,000 per year, and at least two had averages above \$200,000 per year. UAA faculty published more than 36 research reports, 128 peer-reviewed journal and conference articles in the last five years, mostly resulting from UAA's MSCE graduate student supervised research. This has enhanced the UAA civil engineering program's visibility and reputation on the national and international levels and has led to several partnerships with outside agencies and organizations.

Finally, the MSCE program directly supports the BSCE program by providing a steady flow of highly-qualified Teaching Assistants.

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

The Enrollment and Degree Award Trends data provided by IR shows **significant positive trends in the number of majors and the number of degrees**. It does not show significant trends in the credits per degree and the semesters or years per degree. The increase in MSCE degrees reflects the increase in the number of majors and also results from the consolidation of all of the MS degrees in Civil Engineering under the MSCE degree.

The data on Course Pass Rates by Subject and Level shows higher pass rates for graduate-level Arctic Engineering (AE) courses relative to graduate-level courses in Applied Environmental Science and Technology (AEST) and Civil Engineering (CE).

The data on Internal Demand provides In-Major and Out-of-Major Student Credit Hour (SCH) data and shows significant variability year to year but no apparent trends.

The Instructional Productivity data provides key information such as Student Credit Hour (SCH) Production, Full-Time Equivalent Faculty (FTEF), Student Credit Hours relative to FTEF, Enrollment relative to FTEF, Full-Time Equivalent Students (FTES) relative to FTEF, Average Class Size, Cost per SCH, and Tuition Revenue per SCH. The data shown indicate that Cost/SCH is significantly higher than the Tuition Revenue/SCH. However, we do not think that the cost numbers presented above provide an accurate representation of the MSCE program. Instead, the MSCE program should be considered as a **low-cost/high-value extension of the BSCE program**, rather than a stand-alone program. Most courses offered in the MSCE degree program are stacked courses, meaning that there are both graduate and undergraduate students enrolled in the class. For example, in the Water Resources Engineering subdiscipline of Civil Engineering, 5 out of 6 of the graduate courses offered in the past two years (Fall 2018 – Spring 2020) were stacked classes. The students in the BSCE take these stacked courses as technical electives that are required for their degree program. Even if the MSCE program were eliminated, we still would need to teach these courses. Hence, with the BSCE program in place, we get the graduate MSCE program – and all of its benefits – at a relatively low additional cost. Nationally, we are not aware of any MSCE programs that operate as stand-alone programs. In all cases, the MSCE program serves as an extension of the BSCE program. Consequently, it makes sense that the MSCE and BSCE programs are reviewed as a single entity.

The CE Department is a research-focused department, and the faculty do bring significant extramural funding to the university (as described above). These applied research activities not only help solve the unique engineering problems faced by the public agencies in charge of care and expansion of Alaska infrastructure and industries responsible for natural resource development but also provide invaluable undergraduate and graduate research opportunities for the BSCE and MSCE programs, respectively. It should be noted that the undergrad research activities would be less available, without the support of the MSCE program.

In summary, we feel that the MSCE program should be considered a natural extension of the BSCE program, rather than a stand-alone program. Analysis of the actual cost of the MSCE program shows that the program cost is relatively low and much lower than the figure provided by IR. This is because the majority of MSCE courses serve as technical electives for students in the BSCE program, and they would be taught even if the MSCE program did not exist. This low-cost MSCE program provides considerable benefits to the state of Alaska and to the university: (1) it provides graduate courses and a graduate program for the engineering professionals of Alaska and enables them to acquire and maintain their Professional Engineering license; (2) it trains early-career engineers in research methods

and enables engineering research that tackles some of the biggest challenges facing the state, its peoples, and its industries; and (3) it supports the BSCE program by providing high-quality Teaching Assistants.

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

The MSCE program is not subject to an accreditation process. For example, the ABET accreditation process that governs the BSCE program, does not yet address graduate programs.

The curriculum has a high level of currency largely because the MSCE faculty are highly engaged in the solution of many of Alaska's pressing problems. For example, the graduate classes on coastal engineering, sediment transport, and coastal measurements illuminate the coastal hazards and risks that many Alaska communities face. Similarly, graduate classes on earthquake engineering directly address the tremendous seismic hazards that we face here and now.

The MSCE program has several innovative features. Many graduate classes directly serve as technical electives for the BSCE program. Further, most of the courses are distance delivered throughout the state, country, and continent providing both a synchronous and asynchronous distance-learning experience. The MSCE program also offers the 100% distance-delivered Arctic Engineering emphasis area which is valued far and wide and is featured in the University of the Arctic (UArctic, uarctic.org) and, in particular, in its Arctic Engineering Thematic Network.

The MSCE program has, over the past few years, become more focused and efficient by bringing all of its graduate programs (e.g., MS Arctic Engineering, MS-AEST) under one single program, i.e., the MSCE program. Also, in 2019, in order to attract highly qualified undergrad students to the MSCE program, the Civil Engineering Department initiated the Fast Track BS-MS option. The Fast Track incentivizes enrollment of CE undergrads into the MSCE program, by allowing undergrads to apply two undergrad technical electives to their graduate program. In the past year, we have seen about 10 undergraduate students taking advantage of the Fast Track program. As the table above shows, the MSCE program is currently experiencing significant growth and the student interest in the Fast Track BS-MS option will lead to even greater growth in the MSCE program.

The MSCE program has a consistent assessment plan in place. The program follows this plan in collecting data to evaluate how the Program Student Learning Outcomes (SLO's) are delivered and mastered. Findings from the assessment activities are used to guide curriculum improvement. The program uses data from three major activities, i.e., Course Level Assessment, Graduate Exit Survey, and Faculty Assessment. In addition, a Civil Engineering Department Advisory Committee is regularly consulted for program assessment.

Assessment data shows that the MSCE program is doing a good job of delivering the program SLO's. The average satisfaction rate was over 85% from the Alumni and current students and 100% from the employers, based on a survey in 2017. The rate was 88% from a survey of the students in four classes in 2018.

The 2018 Program SLO assessment identified three areas potentially needing improvement: (1) an ability to conduct advanced civil engineering research; (2) an ability to apply advanced engineering theory to the design of civil engineering systems; and (3) an ability to work effectively in a professional environment. These findings have been discussed in faculty meetings, and individual faculty have suggested ways they can modify their courses to achieve improved outcomes. For example, faculty can have more team projects in graduate classes so students have more experience working together in a professional environment. Also, faculty can introduce more research and design methods into graduate classes so more students get direct exposure to research and design in the classroom. Anecdotally, the faculty feel that these measures have been effective, and a Qualtrics-based assessment is planned for later this year.

The data available indicates that the MSCE program is performing well in the area of Student Success. Indicators of Student Success include the large numbers of students who are graduating, the relatively high pass rates in the different subject areas, the engagement of a large number of MSCE students on research projects as Research Assistants, and the full employment of our graduates. In part, the high level of Student Success reflects the care that

CE faculty and staff show to all of the MSCE students. All students have an engaged faculty advisor who supports them through mentoring, helping them with their Graduate Student Program, etc.

Finally, it is noteworthy that faculty expertise and research capabilities supported by the MSCE program have attracted interest from national and international research entities who seek collaboration with us. For example, an MoU was signed in 2019 for joint Master student research supervision between UAA and the University of the Andes in Colombia, the top in the country, and two students and a UAA CE faculty member are engaged on a major research project through this agreement.

Besides serving local demand, the quality of the MSCE program and faculty expertise have attracted several out-of-state Masters students to the program, generating more income from tuition and attracting top students with a high research caliber to assist faculty in producing innovative research.

Research enabled by the MSCE program has resulted in 4 NSF awards to CE researchers in the past few years. These awards from this prestigious Foundation are a testament to the high-quality research and scholarship produced by the UAA College of Engineering largely based on the strength of the MSCE program.

Below are a few highlights for demonstrating our student accomplishments:

- A MSCE student won an NSF Graduate Research Fellowship in 2017.
- A MSCE student is a co-recipient of a US patent “Self-heated enclosure with carbon fiber” in 2018.
- A MSCE graduate has been promoted to an executive position at Michael Baker International in 2018.
- Eight recent MSCE graduates are currently enrolled in the PhD program at UAF or other US institutions.
- Over the past five years, MSCE students produced 61 theses and 36 project reports, and they co-authored the majority of the 128 peer-reviewed conference or journal articles with the CE faculty.

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

The University of Alaska statewide system has two MSCE programs, one at UAA and one at UAF. The MSCE program at UAA is distinct in many respects. First, the UAA MSCE program currently supports 70% of the MSCE graduate students in Alaska. The UAA MSCE program also supports Alaska’s largest population center, which includes: Anchorage, Chugiak, Eagle River, Girdwood, Palmer, and Wasilla. The UAA MSCE program mainly supports full-time engineering professionals who are furthering their careers, acquiring professional licensure, and supporting Alaska’s development. This community of students cannot be practically served and supported from Fairbanks, 300 miles away.

The UAA MSCE program’s distinctiveness also stems from the uniqueness of several UAA MSCE program’s subdisciplines, relative to what is available from UAF. A prime example is the contribution of earthquake engineering to the UAA MSCE program. UAA offers six distinct earthquake engineering courses while the UAF program offers only three courses. Such a high-demand field in the most seismically active state in the U.S. warrants a larger number of specialized graduate courses to cover more than the fundamental basics, serving an urgent need of the local and state engineering community. This unique program, along with faculty expertise, has led to recent approval of UAA as an education member by the Board of Directors of the Pacific Earthquake Engineering Research Center (PEER) located in Berkeley, CA, a leading institute promoting earthquake engineering education and research in the world.

The UAA MSCE program has also been distinct in its decision to distance deliver all of its graduate courses. Considering the above, it is clear that the MSCE program at UAA is justified. It makes sense for the successful, growing, and low-cost MSCE program at UAA to continue.

Meanwhile, UAA and UAF MSCE programs are collaborating closely by sharing a number of courses every semester and could do more in the future. This would strengthen both programs and lead to improved efficiencies.

5. Summary Analysis (500 words or less)

It is crucial to recognize that the MSCE program is not a stand-alone program. Instead, the MSCE program is a natural extension of the very successful BSCE program. It is a relatively low-cost extension because the two programs share many courses through course stacking. At the same time, the UAA MSCE program is distinct, because it directly meets the professional development needs of the engineer population in and surrounding Anchorage, where currently 70% of the Alaska-based professional engineers reside. The MSCE program is also vital to enable the unique research strengths, such as earthquake engineering and coastal engineering, offered by UAA's Civil Engineering Department, by providing Research Assistants. Last but not least, the MSCE program supports the BSCE program by providing high-quality Teaching Assistants.

In summary, the MSCE is a unique program that offers enormous benefits to students, stakeholders (like agencies and industry), and to UAA's engineering research enterprise. With the newly implemented Fast-Track option in the MSCE program, we are confident that our growing program will serve more engineering professionals in the future.