



University of Colorado **Boulder**

2018 Program Review

Engineering Management Program

Academic Review and Planning  
Advisory Committee Report

Approved

A handwritten signature in black ink, appearing to read 'Ronald Moore'.

05/06/2019

Provost and Executive Vice Chancellor for Academic Affairs. | Date

# Contents

Process Overview – 3

AY 2018-19 ARPAC Members – 4

Unit Overview – 5

Past Reviews – 14

Unit Impact – 15

Analysis – 16

Recommendations – 20

Required Follow-Up – 22

## Process Overview

The review of the Engineering Management Program (EMP) was completed in accordance with the 2018 review guidelines. The Academic Review and Planning Advisory Committee (ARPAC) conducts and writes the final reviews of all Boulder campus academic units. EMP completed a self-study in December 2017. An internal review committee of two CU Boulder faculty members from outside of the unit checked the study and issued findings in February 2018. The internal reviewers generally found the report fair and accurate and noted several issues for subsequent exploration by the external reviewers and ARPAC. The external review committee, consisting of two experts within the discipline from outside of the University of Colorado, visited the unit over March 19 - 20, 2018, reviewed relevant documents, and met with faculty, students, staff, and university administrators. Internal and external reviewer comments and recommendations are cited at appropriate points throughout the report. This public document reflects the assessment of and recommendations for the Engineering Management Program as approved by ARPAC.

# Academic Review and Planning Advisory Committee (ARPAC)

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Academic year 2018-19  
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## Unit Overview

The campus's standardized description of the unit is available on the website of the Office of Data Analytics (ODA) at

<https://www.colorado.edu/oda/institutional-research/institutional-level-data/information-department/academic-review-and-planning>.

ODA updates the profile annually in the fall semester. This report cites data posted in October 2017, reflecting the state of the Engineering Management Program (EMP) as of the academic year (AY) 2016-2017.

EMP is a growing and accomplished program with a 30-year history of curricular excellence. EMP initially reported to the Center for Advanced Engineering and Technology Education (CAETE) in the Division of Continuing Education but since 2015 reports to the College of Engineering and Applied Science (CEAS). EMP provides engineers and other professionals with the skills and knowledge necessary to excel in technical management and leadership.

## Personnel and Governance

According to the Office of Data Analytics (ODA), in AY 2017-2018 EMP employed four instructors, 10 lecturers, five scholars in residence, and three exempt non-academic staff members. The EMP self-study report lists 22 faculty members (eight full-time faculty, two part-time faculty, and 12 adjunct faculty) supported by a faculty director, a director of undergraduate engineering management, and three administrative staff. EMP collaborates with the Division of Continuing Education, the Leeds School of Business, and other CEAS units including the departments of Aerospace Engineering Sciences, Computer Science, Electrical, Computer, and Energy Engineering, and Mechanical Engineering.

The program bylaws conform to campus norms with regards to executive structure, voting rights, and standing committees. As

the program does not function as a tenure home, the bylaws do not address tenure or promotion criteria. They also do not address annual merit review criteria or grievance procedures. EMP faculty members do not participate in a formal mentoring process although occasionally the program has assigned senior faculty members to mentor new faculty hires. Recognizing an unaddressed need, EMP has tasked its executive committee with establishing a formal mentoring process.

Research  
and  
Scholarship

As EMP serves as a teaching program it does not conduct research in the traditional sense. The program rosters no tenure stream faculty members and has no research agenda other than what individual faculty members might pursue for their own professional development. The program's faculty members typically have academic interests in engineering management education and technology forecasting. EMP makes its faculty hires based on a consideration of their field experience and their instructional success. That said, the program anticipates that new hires might contribute to peer-reviewed research and publications but doing so is a challenge given the program's demanding teaching norm (five courses per academic year). EMP is investigating the possibility of advancing a PhD in engineering management program proposal.

The internal and external reviewers noted that the EMP faculty and undergraduate engineering management directors oversee a complex organization in addition to carrying significant teaching loads. They recommend that the college extend course relief to the directors to give them more time to complete administrative work.

EMP grant expenditures totaled \$5000 (direct) for the last five years according to ODA (ranking EMP ninth of nine engineering units).

## Undergraduate Education

EMP does not have an undergraduate degree program. Instead, EMP offers undergraduates options to earn an engineering management minor, and/or certificates in engineering management or engineering leadership. EMP also offers engineering economics, leadership, and project management general education courses. EMP-generated student credit hours (SCH) have increased rapidly in recent years. ODA data for fiscal year (FY) 2016-2017 shows 2,754 EMP undergraduate SCH, a five-year 434% increase. EMP's SCH total ranks the program eighth among eight engineering and 49th among 53 CU Boulder units offering undergraduate courses. EMP instruction quality has remained high despite rapidly expanding enrollments. Both ODA course ratings and instructor ratings ranked the unit first among eight engineering units. EMP wishes to maintain an annual 10% undergraduate enrollment growth rate through 2020.

The internal review committee's undergraduate student surveys returned a positive assessment. Most of the program's undergraduates rated themselves as "satisfied" or "very satisfied" with EMP. They expressed similar satisfaction with EMP course sequencing and course continuity and with elective availability. Students also expressed satisfaction with faculty and staff advising. In survey comments, the undergraduates praised the program's flexibility and its instructors for bringing real-world knowledge to the classroom. When queried about desirable program changes, the students mentioned wanting more industry-focused interactions and more course flexibility, including more online courses.

In offering undergraduate courses, EMP faculty members are challenged to accommodate their teaching methods to a population that usually lacks the work experience of the program's more typical student who takes EMP courses having

already completed at least a bachelor's degree. Indeed, as the external reviewers noted, EMP has yet to develop a systematic course sequence geared to undergraduates, especially in a way that compliments the students' development of domain expertise in their majors. The external reviewers doubted that EMP has the resources to successfully address undergraduates' needs, suggesting that at a minimum it would require at least three additional full-time faculty positions and at least one more administrative staff member. The external reviewers suggested that if the college finds value in attempting an effective EMP undergraduate curriculum it must devote resources adequate to building new course offerings and teaching methodologies. If the college fails to make such an investment, EMP must consider how it can best succeed in teaching undergraduates with its on-hand resources. This might involve reducing undergraduate course offerings, or freeing up resources by reducing master's level offerings.

#### Graduate Education

EMP offers an ME in engineering management and a graduate certificate for non-degree students who wish to specialize in a specific area of study. At the time of the ODA fall 2016 census, EMP enrolled 179 graduate students, representing a five-year 43% increase. Academic year 2016-2017 ODA statistics show that 71 students earned the ME degree, a five-year 109% increase. EMP offers graduate level courses in leadership, project management, and commercialization. EMP course ratings for FY 2016-2017 place the program first among nine engineering units offering graduate instruction. EMP counted enrollments of approximately 1000 students for AY 2016-2017 (enrollments defined as students enrolled in a class), representing a 10% increase over the prior year. The numbers show that EMP is on track to double its graduate enrollments between 2007 and 2020 to 1100. The program has established 6% annual growth as a goal through 2020.

EMP is the university's largest provider of graduate distance education and teaches students by a combination of synchronous and asynchronous course access. Classes consist of students attending in person or participating online or watching recordings of past lectures. EMP faculty members are challenged to optimize their courses for each of these modalities. To meet student needs, EMP makes use of video tools, evening class hours, and online chat rooms. The external reviewers reported that faculty members who they interviewed indicated that up to 80% of graduate students attend courses virtually. The external reviewers made it clear that continued access to distance equipped classrooms counts as a fundamental EMP need. The program also identified staying current with evolving industry demands for skills considered critical to long-term growth, such as in the areas of innovation and data analytics, as a requirement. One strategy it has for keeping current is to incorporate state-of-the-art ideas and skillsets brought into the program by new faculty members.

Thirty-seven certificate students and 102 master's students replied to the internal review committee's online survey in January 2018. Ninety two percent of respondents reported feeling "satisfied" or "very satisfied" with EMP. Availability of required courses and program requirement clarity also rated highly. Twenty-nine percent of the respondents chose to reply "N/A/Don't know" to a prompt to rate the ease of identifying an advisor; likewise, 33% chose "N/A/Don't know" when prompted to rate advising quality, both indicators that advising might stand as a source of student confusion. In survey comments, the graduate students mentioned amazing and accessible faculty, the program's flexibility, and course synergy as EMP strengths. In response to what they would change about EMP, the students mentioned wanting increased course availability, less course material overlap, more challenging

courses, more industry-related interactions, and better online course editing/presentation. The external reviewers determined that the program should do more to guide faculty member course content selection and better align the curriculum. The external reviewers suggested that EMP seek regular stakeholder input and develop a curriculum roadmap to address shortfalls. The external reviewers also echoed concerns expressed by some EMP-affiliated faculty members and students that individuals with limited science and math backgrounds, who are allowed to enroll in EMP courses, complicate instruction. They recommended establishing minimum competencies for acceptance into the program. Both the internal and external reviewers agreed that EMP's success hinges on it retaining an engineering management and leadership education focus.

Space  
and  
Infrastructure

EMP has secured space for its faculty and staff members in the Engineering Center and in the Fleming Building. While EMP has sufficient office space for its current personnel, future growth might result in office sharing. That might prove problematic as EMP personnel often require privacy to work with students. EMP's current space assignments are non-contiguous. EMP has expressed an interest in gaining more contiguous space, both to help it build community and to better support its instructional needs.

Inclusive  
Excellence

EMP understands the challenges associated with increasing faculty and student diversity and is committed to making meaningful changes. EMP reports that in fall 2017 individuals identifying as women accounted for 33% of its scholars in residence, 25% of instructors, and 40-50% of adjunct lecturers. EMP maintains that the men-to-women faculty member ratio reflects the gender diversity of its graduate student population which they report has held at 26% women over the last few

years. ODA data for AY 2017-2018 show that 20% of EMP graduate students identify as women, which is a five-year 39% reduction. EMP also reports that none of its full and part-time faculty and only two of 12 adjunct lecturers identify as belonging to an underrepresented minority population. These numbers do not reflect the EMP graduate student population which ODA data shows as consisting of 22% individuals belonging to a minority group and 15% belonging to an underrepresented minority. EMP deems its lack of women graduate student population growth as “unacceptable” and it intends to do more to improve program diversity overall. The internal reviewers noted that, while EMP has a clear goal to recruit more women and underrepresented group members to its faculty, the program lacks a clear strategy for doing so.

Indeed, ARPAC observes that EMP has yet to submit an inclusive excellence narrative the Office of Diversity, Equity and Community Engagement.

Climate      The internal reviewers’ January 2018 surveys of EMP undergraduate and graduate students indicate a good EMP climate. Over 95% of student respondents “agreed” or “strongly agreed” that EMP encourages a climate that is tolerant and respectful of diversity. The respondents also agreed with prompts saying that EMP’s social and professional climate is positive. In a September 2017 climate assessment managed by ARPAC staff, the majority of EMP faculty respondents indicated that the program’s director, other colleagues, staff members, and students treat them with respect. However, a small number of respondents agreed with the prompt that one or more faculty members say things or behave in ways that humiliate or intimidate others. Some also responded in disagreement to a prompt asking if they feel like a

valued EMP community member and/or if they feel included in EMP informal networks.

Students who met with the external reviewers provided “overwhelmingly positive” feedback. The reviewers reported that students described EMP faculty member availability as among the best of any CU Boulder faculty cohort. One area of student complaint was a perceived lack of community building.

Likewise, the external reviewers registered a desire among EMP faculty members for more community building. Some part-time instructors and adjunct faculty said they felt more like contract workers and less like members of a linked faculty team. The interviewed faculty also expressed a desire for more information about distance education best practices. They expressed concern about the FCQ-based-evaluation system, saying it could negatively impact their employment status, even when acquiring poor student ratings might result from demanding more of students than they like. The external reviewers suggested that EMP consider implementing a peer review system as another teaching measure and as a way to promote best practices knowledge sharing.

#### Budget

While the program gains some revenue from engineering student enrollments, from Division of Continuing Education non-degree enrollments, and by hosting an annual Danube University summer program, ME degree program enrollments constitute EMP’s main revenue source. EMP’s 2015 transition to the College of Engineering and Applied Science involved switching budget models from one where EMP stood to gain a profit from its revenue generation (anywhere between \$700k to \$1.5 million annually) to one where it gains no profits. The program must now navigate a difficult calculus. As already noted, EMP undergraduate enrollments have grown

significantly: from 392 in AY 2013-2014 to 980 in AY 2016-2017 and to over 1000 in AY 2017-2018. While EMP has managed to address this demand, the program receives no tuition revenue to support the added cost. Moreover, the main campus now takes \$300 per EMP-generated credit hour as revenue; and other CEAS departments who have students enrolled in EMP courses get 50% of the tuition revenue from those students (versus EMP getting 100% in the past under CAETE/Continuing Education). The internal reviewers also expressed concern that the program's distance learners are charged out of state tuition, saying that this might negatively impact the program's graduate student recruitment potential.

## Past Reviews

This is the first time that EMP has been included in an Academic Review and Planning Advisory Committee review cycle.

## Unit Impacts

EMP is a growing and successful teaching unit with long-standing success in distance education. As already noted, the program offers dual graduate degrees with the departments of Aerospace Engineering Sciences, Computer Science, Electrical, Computer, and Energy Engineering, and Mechanical Engineering and educates non-degree students, including CU Boulder faculty and staff members, through the Division of Continuing Education. A recent agreement between EMP and the Leeds School of Business allows undergraduate cross-listed courses and permits EMP graduate courses to transfer to Leeds at the graduate level. In its response to the internal review report, EMP identified engineering management programs at Colorado State University, Penn State, and Duke University among those that EMP students also considered attending. The program has tasked its graduate committee with identifying aspirational peer programs to potentially gain ideas and benchmark data. In its strategic plan EMP states, “In fifteen years, we would like to see our Program mentioned in surveys external to the University as the example of what other Engineering Management Programs around the world should look like.”

## Analysis

EMP fulfills an important role in CU Boulder by providing engineers and other professionals with the skills necessary to manage technical organizations. EMP's educational mission nicely complements the efforts of units that provide students with other types technical or managerial skills. As the internal reviewers put it, "the program sits at a sweet spot between the engineering and business schools and the real world." Since its transfer to the College of Engineering and Applied Science in 2015, EMP has experienced significant growth in undergraduate demand. Meanwhile, its graduate program succeeds in combining distance and in-class learning and in forging strategic partnerships, such as with the Leeds School of Business. EMP is confronted by enrollment increases and a funding model that does not seem to fully account for its undergraduate education contributions. EMP is also challenged to address questions about inclusive excellence, community building, and enrollment management. ARPAC joins the external reviewers in recommending that the program pursue strategic planning to guide it through these challenges.

## Strategic Vision

The planning the external reviewers urged EMP to undertake includes a recommendation for the unit to complete a stakeholder analysis, including to identify the educational needs of students and employers. The reviewers suggested that the program could do better to understand employer-desired skills and to use this information to target applicants, to educate industry on the value of its program, and to establish realistic graduate program growth expectations. ARPAC agrees that EMP could benefit from enhanced strategic planning that encompasses the external reviewers suggestions and adds issues identified at other review stages, too, including to develop a new financial model, to improve learning outcomes for in-class and remote students, to review its student advising, to develop inclusive excellence goals, and to finalize a

faculty/staff hiring plan that addresses diversity goals and meets the demands of evolving curricular needs and growing enrollments.

Budget The internal reviewers noted an apparent discrepancy between EMP's undergraduate teaching commitments and what the college provides the program to cover related costs. The reviewers reported hearing that the rationale for the current arrangement hinges on the argument that EMP has no majors of its own, does not grant undergraduate degrees, and does not have standing as a department. The internal reviewers found this rationale unreasonable and urged that the campus help EMP more. ARPAC recommends that EMP work with the dean's office to ensure that it is making a convincing case for its resource needs.

Undergraduate Education As already described, growing undergraduate demands impact EMP in a number of ways. The external reviewers echoed the internal reviewers in recommending a considerable college investment to better equip EMP to address undergraduate curricular needs. ARPAC would like EMP to follow-up on a strategic visioning process with a reasoned request to the college dean for more resources.

Graduate Education The EMP graduate program is quite successful. Praise from students highlights the program's value to them as a source of quality teaching and as an opportunity to acquire useful skills. That said, the review process suggested areas for improvement. While some students praised advisor availability others expressed frustration at not connecting with advisors. Other students noted a lack of curriculum continuity or complained that students without a solid background in math and science held classes back. The external reviewers suggested that that EMP could do a better job of creating

community and building networks that students could utilize as they develop their careers. ARPAC is hopeful that EMP will address these issues.

Climate The internal reviewers assessed EMP's overall climate as good and tolerant and respectful of diversity. Surveys conducted during the review reveal some concerns, however, including that some respondents felt excluded from the program's informal networks or that they felt that a number of faculty members say things or behave in ways that humiliate or intimidate others. ARPAC appreciates the EMP takes these concerns seriously and that it promises to take steps to make improvements.

ARPAC supports EMP efforts to update its instructor and adjunct faculty member mentoring. The committee supports the external reviewers' recommendation that EMP take steps to build community between adjunct, part-time, and full-time faculty. ARPAC also supports the reviewers' suggestion to introduce peer review of faculty teaching.

Space and Infrastructure As EMP grows, space will become a pressing issue. The program could make good use of new space assignments designed to improve student collaborations and to accommodate program employees in a more contiguous fashion. ARPAC recommends that college and campus planners keep these beneficial dynamics in mind as they continue to address needs associated with the expansion of engineering student and faculty member populations. ARPAC is encouraged to hear that the dean's office has EMP's priorities in mind.

Staff Increasing undergraduate student enrollments threaten to exceed the staff's capacity to provide adequate program

support. Needless to say, the systematic changes to the undergraduate program that the external reviewers advised will not succeed without EMP gaining more staff support. APRAC encourages the college to work with EMP to address staffing needs.

Inclusive  
Excellence

EMP is committed to recruiting and retaining individuals who identify as women and as members of underrepresented minority populations as faculty members and students. ARPAC supports the internal reviewers' recommendation that EMP develop clear strategies for engaging the college and the campus (including to seek support from the Office of Institutional Equity and Compliance and the Office of Diversity, Equity and Community Engagement) in assuring progress and securing a shared commitment to developing greater inclusivity.

## Recommendations

The members of ARPAC address the following recommendations to the Engineering Management Program (EMP) to the offices of responsible administrators:

To the Unit:

1. Institute a strategic planning process to inform future steps and to manage program growth. Planning targets should include:
  - A stakeholder needs analysis;
  - A multi-year year financial model;
  - An assessment of possible in-class and remote students learning outcomes improvements;
  - An EMP advising review;
  - An updated curriculum roadmap;
  - A faculty/staff hiring plan designed to meet enrollment goals, to balance instructor and adjunct faculty hiring, and to advance EMP inclusive excellence.
2. Work with the dean's office to secure resources necessary to deliver appropriate undergraduate course offerings.
3. Develop a plan for recruiting more faculty members who identify as women or as members of underrepresented minority populations. Maximize faculty member retention by a focus on improvements in unit climate and mentoring.
4. Complete and submit an inclusive excellence narrative to the Office of Diversity, Equity and Community Engagement.
5. Continue to improve the climate for faculty and staff members, including developing and implementing the means to strengthen a sense of community among program faculty members and between graduate students.
6. Implement multiple measures of teaching, including peer review, to complement FCQs in faculty evaluation.

7. In cooperation with the college, establish and implement guidelines for merit evaluation that conform to regent law and policy. University rules require that each unit have clear written criteria for annual merit and reappointment.
8. Develop clear written criteria for promotion from instructor to senior instructor, and from senior instructor to teaching professor.
9. Work with the dean's office on staffing and on creating a more effective graduate student advising structure.

To the Dean:

10. Support EMP with pursuing a strategic planning process.
11. Consider the unit's strategically considered requests for resources necessary to deliver effective and appropriate undergraduate courses.
12. Address EMP's staffing needs including completion of an adequate graduate student advising structure.
13. Work with the unit and the vice provost for academic resource management to consider EMP space needs.
14. Consider adjusting the EMP directors' teaching loads given their heavy administrative responsibilities.

To the Vice Provost for  
Academic Resource  
Management:

15. Work with the college dean to address EMP space needs.

## Required Follow-Up

The Engineering Management Program director shall report annually on the first of April for a period of three years following the year of the receipt of this report (i.e., April 1st of 2020, 2021, and 2022) to the dean of the College of Engineering and Applied Science and to the provost on the implementation of these recommendations. Likewise, the dean shall report annually on the first of May to the provost on the implementation of recommendations addressed to the college. The provost, as part of the review reforms, has agreed to respond annually to all outstanding matters under their purview arising from this review year. All official responses will be posted online.