Startup of a New Civil Engineering Program at Mercer University

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Abstract

This paper discusses the startup of a new Civil Engineering program at Mercer University and how it will be assessed to comply with the Engineering Accreditation Commission (EAC) General Criteria for Baccalaureate Programs that have been approved for implementation in the 2019-20 accreditation cycle. The new civil program curriculum consists of 129 credit hours with 31 credit hours devoted to civil engineering and science topics. Emphasis is placed on four tracks: structural, geotechnical, water resources, and environmental engineering. Primary assessment tools will include specific courses throughout the curriculum, senior design exhibits, and senior surveys.

Keywords

Curriculum, ABET, assessment, civil, design-exhibits.

Introduction

During the 2016-17 academic year, the Environmental Engineering (EVE) Department faculty developed a curriculum for a new Civil Engineering specialization within the Mercer University School of Engineering (MUSE). There were several reasons for starting a Civil Engineering program; however, the main impetus was to help meet the high demand for civil engineers. With help from the Associate Dean's Office, a Proposal and Pro Forma were submitted to and approved by the Provost's Office and Mercer's Board of Trustees in April 2017. The proposed curriculum was approved by the Undergraduate Curriculum council and published in the Mercer catalog for the 2017-18 academic year. A national faculty search was undertaken, and two faculty members were recruited to help build the program: one in structures and the other one in geotechnical. Since Mercer engineering students take essentially the same courses for the first two years, civil engineering courses would not be offered until the 2019-2020 academic year.

Need for Civil Engineering at Mercer

The Bureau of Labor Statistics (BLS) of the U.S. Department of Labor estimates that the job outlook for civil engineers is very good [1]. In 2016, there were 303,500 civil engineering jobs set to increase to approximately 335,700 through 2026. This is a growth of about 11%, faster than the average job growth rate and greater than any other engineering discipline (Figure 1). The median annual pay for civil engineers in May 2017 was $84,770.

Over the last several decades, America's infrastructure has fallen into a dismal state of repair and is sorely requiring investment to meet the needs of the 21st century. Periodically, the American Society of Civil Engineers (ASCE) evaluates the nation's infrastructure in the following

categories: bridges, dams, drinking water, energy, hazardous waste, inland waterways, levees, public parks and recreation, rails, roads, schools, solid waste, transit, and wastewater. The grades on the 2017 ASCE Infrastructure Report Card ranged from D to B, averaging D+ [2]. Georgia's 2014 ASCE Infrastructure Report Card grades ranged from D- to B+, averaging C [2]. ASCE estimates that approximately $4.59 trillion is necessary for improving America's infrastructure.

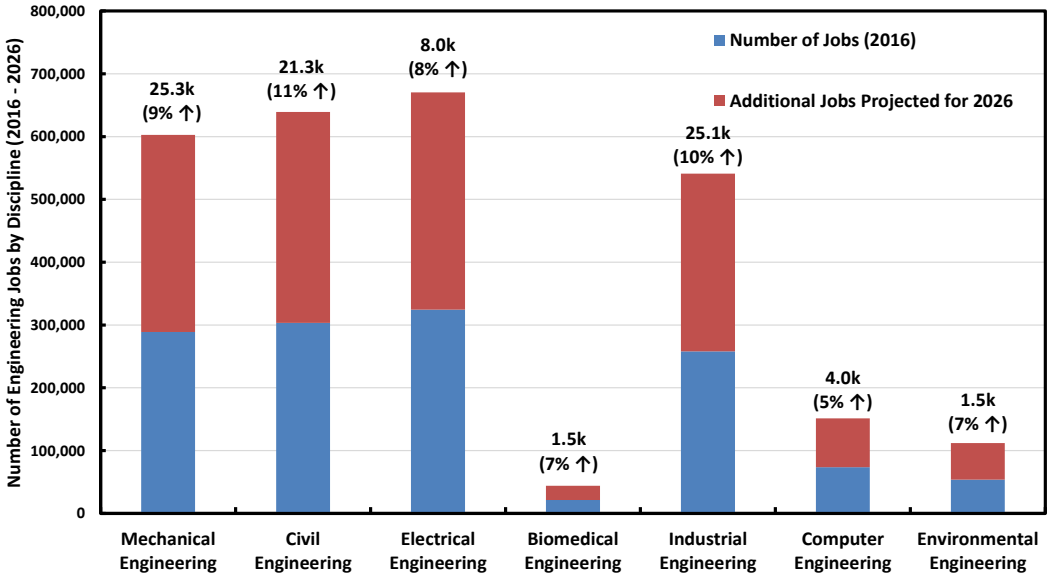

Figure 1. Number of Engineering Jobs by Discipline (2016-2026)

Background

The Mercer University School of Engineering (MUSE) was founded in 1985. It is primarily an undergraduate program that encompasses a set of traditional core engineering courses, liberal arts, sciences, math, and technical courses. Students receive a Bachelor of Science Degree in a specific specialization that includes Biomedical, Computer, Electrical, Environmental, Industrial, and Mechanical. These engineering programs are currently accredited by the Accreditation Board for Engineering and Technology (ABET) under General Engineering. The undergraduate engineering programs will be seeking re-accreditation in Fall 2019 under the revised learning outcomes of Criterion 3, as approved by the Engineering Area Delegation (EAD) [4].

MUSE programs are experiencing rapid growth and the full-time, undergraduate population has increased from 391 to 664 since Fall 2011 [5]. Growth among disciplines has been disparate; the major increased demand has been in the biomedical and mechanical specializations. These departments are struggling to meet the new student demand with current resources. The new Civil Engineering specialization is expected to encourage additional, well-balanced growth. National [6] and MUSE [5] enrollment trends in engineering by discipline for 2016 are shown in Figure 2. The national data is compiled by the American Society for Engineering Education (ASEE) and is published in the 2016 Profiles of Engineering and Engineering Technology Colleges [6]. It shows that 23.8 percent of engineering students are pursuing the mechanical specialty and 11.9 percent are enrolled in civil engineering programs. If the Mercer enrollment in engineering disciplines follows the national trends, recruitment of 30 civil engineering students

per year is expected and having approximately 100 civil engineering students once the program is well established.

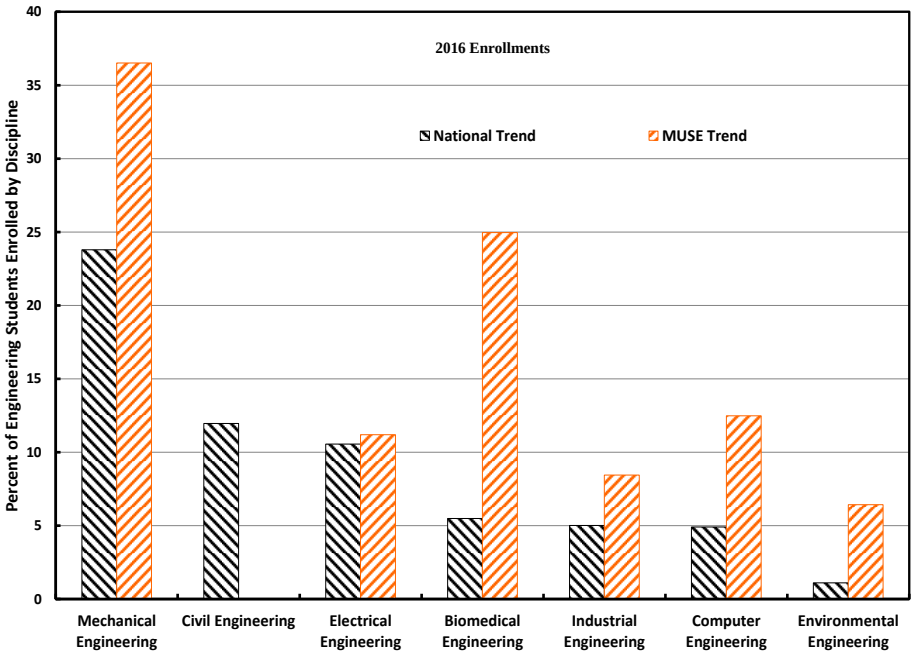

Figure 2. National and MUSE Enrollment Trends in 2016.

Civil Engineering Curriculum

A broad-based civil engineering curriculum was developed (Table 1). The number of credit hours is denoted by CH. Mercer's engineering curriculum is essentially the same for all engineering specialties for the first two years. For the junior and senior years, traditional courses focusing on geotechnical engineering, structural analysis, surveying, water and wastewater treatment, and transportation are required. Electives such as green engineering and engineering for development allow students to engage in hot topic areas. During the senior year, a two-semester capstone course (CVE 487/488) allows students to work in teams to select, design, build and test a project related to civil engineering.

Table 1. Civil Curriculum

Fall	**Freshman Year**	**CH**	**Spring**	**Freshman Year**	**CH**
CHM 111	General Chemistry	4	PHY 161	Physics I	4
MAT 191	Calculus I	4	MAT 192	Calculus II	4
UNV 101	Fresh. Experience	1	EGR 107	Intro Engr. Design	3
EGR 126	Programming	3	TCO 141	Prof. Comm.	3
XXX	Gen Ed Group	3	XXX	Gen Ed Group	3
Fall	**Sophomore Year**	**CH**	**Spring**	**Sophomore Year**	**CH**
MAT 330	Diff. Equations	3	EGR 235	Thermodynamics	3
EGR 244	Circuits	4	EGR 236	Dynamics	3
EGR 232	Statics/Solids	3	EGR 245	Electronics/Power	3
XXX	Lab Science	4	EGR 246L	Circuits Lab	1

EVE 290	Intro Environ. Engr.	3	EGR 252	Prob. & Statistics	3
EVE 290L	EVE Lab	1	XXX	Gen Ed Group	3
Fall	**Junior Year**	**CH**	**Spring**	**Junior Year**	**CH**
MAT 293	Multivar. Calculus	3	EVE 384	Hydraulics	3
EVE 385	Hydrology	3	EGR 386	Feedback Control	3
TCO 342	Tech Communication	3	CVE 345	Geotechnical Engr.	3
MAE 205	Graphics	2	CVE 345L	Geotechnical Lab	1
CVE 322	Surveying/GIS	4	CVE 480	Intro to CVE Design	0
CVE 421	Intro Structural Design	3	CVE 310	Water & Wastewater Des.	3
			XXX	Hum/SS/Comm. Elec	3
Fall	**Senior Year**	**CH**	**Spring**	**Senior Year**	**CH**
CVE 487	Engr Design I	2	CVE 488	Engr. Design II	2
CVE 445	Foundations	3	EGR 312	Engr. Economy	3
CVE 420	Structural Analysis	3	EVE 412	Green Engineering	3
CVE 320L	Structures Lab	1	4XX	EVE/CVE Elective	3
CVE 410	Transportation Engr.	3	XXX	Hum/SS/Comm. Elec	3
XXX	Tech Elective	3			

The EVE/CVE Department has two full-time civil professors and four, full-time environmental professors. CVE faculty members teach courses on structures, foundations, and soil mechanics. EVE professors teach several environmental courses required for CVE students, such as Hydrology, Hydraulics, Water and Wastewater Treatment, and Green Engineering. Other EVE courses from the current catalog will serve as technical electives.

Engineering Accreditation Commission (EAC) General Criteria

In the United States, ABET is the sole agency responsible for accrediting engineering programs[7]. Programs may be accredited at the basic and/or advanced level. General and program specific criteria must be met to obtain accreditation for discipline-specific departments. Each program must meet the following eight criteria: Students, Program Educational Objectives, Student Outcomes, Continuous Improvement, Curriculum, Faculty, Facilities, and Institutional Support. The main emphasis of this work is placed on Criterion 3, the new Student Outcomes (Table 2).

Table 2. Criterion 3 Student Outcomes (SOs)

SO	Description
1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3	An ability to communicate effectively with a range of audiences.
4	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

SO	Description
6	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Tentative Assessment Strategy

MUSE has developed an integrated assessment plan for the undergraduate engineering program. Design Courses, Capstone Laboratory Courses (CVE 320L and 345L), Senior Design Exhibits (CVE487/488) evaluations as well as Senior Surveys are used to assess student performance. The means and criteria for meeting each Student Outcome (SO) of Criterion 3 for the Civil Program are shown in Table 3. For most SOs, three faculty members from the EVE/CVE Department will examine the student work. For Senior Exhibits, the teams will consist of other faculty members in the roles of "client" and "technical advisor."

Table 3. Courses for Evaluation and Criteria of Success for the SOs of Criterion 3

SO	Courses for Evaluation [(a)]	Criteria for Success
1	CVE 420, CVE 421, CVE 487	70% of senior design projects will be rated as acceptable, strong, or excellent for Question 4 on the Instructor/Client/Tech Advisor Assessment form [(b)]. 70% of student work in CVE 420/421 will be rated 3.0 or higher by 3 faculty members.
2	CVE 487, CVE 488	At least 75% of senior design projects will be rated 3.0 or better on a 5-point Likert scale by a team of instructor, technical advisor(s), client, and visiting faculty. Question 2 on the Instructor/Client/Tech Advisor form [(c)]. A least 75% of senior design projects will be rated 3 or better on a 5-point scale by a team of instructor, technical advisor(s), client, and visiting faculty using Question 2 on the Instructor/Client/Tech Advisor form [(d)].
3	CVE 488	For Question 6, at least 75% of senior design teams written Critical Design Review (CDR) will be rated as acceptable, strong or excellent by a team [(e)] using a common rubric on a 1 to 5 scale. For Question 5, at least 75% of senior design teams' oral portion of the CDR will be rated as acceptable, strong or excellent by a public audience [(f)].
4	CVE 487	50% of students will score 60% or better on an ethics exam developed by faculty or the MUSE Assessment Committee and administered in CVE 487. The average score of Mercer University students who take the FE Exam will exceed the national score on the set of "Ethics and Professional Practices" questions.
5	CVE 488	75% of senior design teams will be rated in the highest two categories for Question 1a-d on the

SO	Courses for Evaluation [(a)]	Criteria for Success
		Instructor/Advisor/Tech Advisor form [(g)]. 75% of the students' individual assessments using the Peer Rating of Team Members form [(h)] must average 3 or better.
6	CVE 320L, CVE 488	Three faculty members will assess an open-ended experiment based assignment on the ability to design an experiment, the ability to conduct an experiment and gather and analyze data. 75% or more of the students/teams obtain a 3.0 or better, when the grades of the 3 tasks are averaged and (2) 75% of the students/teams score is a 3.0 or better for each of the three tasks separately. 75% of the senior design teams develop an acceptable or better test plan, 75% of them conduct experiments acceptably or better, and 75% of them analyze and interpret results obtained from the executed test plans in an acceptable or better fashion. Questions 8a-c on the Instructor/Client/Tech Advisor form [(i)]
7	CVE 488	70% of the senior design students must list at least one learning strategy used to acquire new knowledge outside the classroom on the Senior Survey form [(j)] completed in CVE 488. 70% of senior design students must rate the importance of "an ability to acquire and apply new knowledge as needed, using appropriate learning strategies important in the practice of engineering; on the Senior Survey form [(j)].

Table 3 Notes:

(a) For course title, see Table 1
(b) Question 4 on the Instructor/Client/Tech Advisor form in CVE 487 will be used
(c) Question 2 on the Instructor/Client/Tech Advisor form in CVE 487 will be used
(d) Question 2 on the Instructor/Client/Tech Advisor form in CVE 488 will be used
(e) Question 6 on the Instructor/Client/Tech Advisor form in CVE 488 will be used
(f) Question 5 on the Instructor/Client/Tech Advisor form in CVE 488 will be used
(g) Question 1a-d on the Instructor/Client/Tech Advisor form in CVE 488 will be used
(h) Peer Rating of Team Members form in CVE 488 will be used
(i) Question 8a-c on the Instructor/Client/Tech Advisor form in CVE 488 will be used
(j) Senior Survey form completed in CVE 488

Summary and Conclusions

In fall 2017, MUSE launched its inaugural civil engineering specialization. Based on the strengths of the environmental and civil engineering faculty, four technical areas have been selected to provide students with fundamental and advanced principles: structural, geotechnical, water resources, and environmental engineering. Math, science, and humanities courses provide a well-rounded education to support the technical courses. Civil engineering courses will be

offered for the first time during the 2019-20 academic year. Although not required for General Engineering Accreditation, we believe that the proposed civil engineering curriculum exceeds the Program Requirements as outlined by ABET.

References

1 Bureau of Labor Statistics, Occupational Outlook Handbook, accessed on October 30, 2018, https://www.bls.gov/ooh/architecture-and-engineering/civil-engineers.htm#tab-6.

2 ASCE 2017 Infrastructure Report Card, accessed May 1, 2018, https://www.infrastructurereportcard.org/.

3 ASCE Georgia 2014 Infrastructure Report Card, accessed on May 1, 2018, https://www.infrastructurereportcard.org/state-item/georgia/.

4 ABET, Criterion 3, accessed May 1, 2018, http://www.abet.org/wp-content/uploads/2018/03/C3_C5_mapping_SEC_1-13-2018.pdf.

5 Mercer University, Office of Institutional Effectiveness, accessed May 3, 2018, http://documents.mercer.edu/IR/profile/ay1718/EGR_18S.HTM.

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7 ABET website, accessed May 1, 2018, http://www.abet.org/.

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