CTE Program Review

Program Name: **Engineering**
Program Contact: **Demsetz, Laura**
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Status: **Submitted for review**
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1. Description of Program

Provide a brief description of the program and how it supports the college's College Mission and Diversity Statements, CSM Strategic Goals 2013/14 to 2015/16, and other Institutional Program Planning as appropriate. What is the program's vision for sustaining and improving student learning and success over the next three years?

The engineering program provides the lower division engineering classes necessary for transfer to baccalaureate programs in various engineering fields. Though occupational demand in specific fields fluctuates over time, engineers and the problem-solving skills developed through an engineering education are considered critical to the region's economic development.

The engineering program supports *Strategic Goal 2: Promote Academic Excellence* by providing transfer into baccalaureate programs that lead to employment in high demand, high wage occupations. The program also supports *Strategic Goal 3: Develop Responsive, High-quality Program and Services*, by preparing students for high-demand careers and by offering classes in both on-campus and hybrid modes. The program's former full-time faculty member served as a faculty advisor, a role that enhances communication between instructional programs and student services, and was actively involved in participatory governance, supporting *Strategic Goal 6: Enhance Institutional Dialog*. We hope to have a new full time faculty member in place in Fall 2017 and anticipate that this individual will also develop relationships across the campus.

Engineering students typically take Math (251, 252, 253, 270, 275), Chemistry (210, often 220), and Physics (250, 260, 270). Depending on transfer school and major, students also take up to 6 engineering classes and up to 4 CIS classes along with general education requirements. Due to the continued diversification of lower division transfer requirements and the increased popularity of majors such as bio/biomedical engineering and environmental engineering, some students who transfer in engineering may not take any engineering courses. However, the presence of an engineering program may be part of what initially draws these students to CSM.

Although the program offers an A.S. degree in engineering, the B.S. degree is considered necessary for work in the field and most students do not take classes beyond the many required for transfer. The program also offers a very flexible A.S. degree in engineering technology, which allows students to focus on a particular technical area.

The engineering program resides in the basement of Building 19, one of the few remaining spaces on campus that has not yet been updated with bond measure funds. The planned demolition of Buildings 12 and 19 and the construction of a new Center for Innovation and Emerging Technologies presents a challenge for the program in terms of disruption but an exciting longer term opportunity for modern facilities designed to support a project-based approach to learning.

The next three years will be a period of transition for the program -- a new full-time faculty member; continued planning for the new building; and perhaps the temporary relocation of lab, office, and student study space during demolition and construction. Skyline College recently added an engineering program, improving access for students and increasing opportunities for student and faculty collaboration, but potentially draining enrollment from the programs at CSM and Canada College.

2. Student Learning and Program Data

A. Discuss Student Learning Outcomes Assessment

1. Reflect on recent SLO assessment results for courses and degrees and certificates offered by the program.
Specify how SLO assessment informs curriculum development and changes to curriculum.

SLO assessment data were collected in all courses in Fall 2014, Spring 2015, and Summer 2015. However, assessment has been delayed due the former full-time faculty member's change in job function. Assessment will be completed and documented in Tracdat prior to the Spring 2017 census date.

2. Comment on the success rates in the program SLOs that are aligned with specific course SLOs. What do the program SLO and course data reveal about students completing the program? Identify trends and discuss areas in need of improvement. Is the alignment between course and program SLOs appropriate and informative? Describe any additional methods used to assess program SLOs and reflect on the results of those assessments. See course-to-program SLO alignment mapping.

The alignment between course and program SLOs seems reasonable. Each program SLO is supported by SLOs in more than one course.

- Work effectively in teams: ENGR 100 and ENGR 270
- Communicate the results of design and analysis orally and through text and graphics: ENGR 100, ENGR 210, ENGR 215, ENGR 260, ENGR 270
- Use math, science, and engineering concepts to identify, formulate, and solve engineering problems: ENGR 100, ENGR 210, ENGR 215, ENGR 230, ENGR 260, ENGR 270
- Use the techniques and tools of engineering at an elementary level to design a device, program, or process to meet specified requirements: ENGR 100, ENGR 210, ENGR 215, ENGR 260, ENGR 270

The program SLO exit survey that was previously presented to students as they apply for a degree has been discontinued. The A.S. degree in engineering has sufficient flexibility to allow it to be earned by students transferring to engineering majors and schools with different transfer requirements. Even with SLOs in multiple courses supporting each program SLO, the flexibility of course selection in the degree makes it difficult to use general course-to-program SLO mapping to comment on program SLO success rates. If the college shifts to a system where course-level assessment results can be searched by student ID, it would be possible to use student-specific course-level assessment to comment on program SLO success.

General course-to-program mapping could be used to comment on program SLO success rates if the program were to shift from the current A.S. degree to multiple degrees aligned with the recently developed Intersegmental Model Curricula in Engineering (Mechanical/Aero/Manufacturing Track; Civil Track; Electrical Track; Computer/Software Track).

3. For any courses in the program that satisfy a GE requirement, which GE SLOs are supported or reinforced by the course SLOs? What do assessment results for the course SLOs (and for the GE SLOs, if available) reveal about student attainment of the GE SLOs? See GE SLO Alignment Summary Report or All Courses GE SLO Alignment Data.

ENGR 100 Introduction to Engineering satisfies the AA/AS General Education Requirement in Career Development and Self

Exploration (Area E5d). Several ENGR 100 course SLOs are aligned with GE SLOs.
Effective Communication is supported by a student's ability to "communicate orally and through text and graphics." and to "work in teams on in both highly specified and open-ended projects."
Quantitative Skills is supported by a student's ability to "begin to use the techniques and tools of engineering practice, including problem solving strategies, analytical skills, and standard software."
Critical Thinking is supported by a student's ability to "design a device or process to meet desired needs within specified constraints."

Social Awareness and *Ethical Responsibility* are supported by a student's ability to "begin to understand the impact of engineering solutions on society and the corresponding need for ethical professional behavior.
SLO assessment data for this ENGR 100 was collected in Fall 2014 and Summer 2015. Assessment was delayed, but will be completed by the Spring 2017 census date.

B. Student Success Indicators

1. Review Student Success and Core Program Indicators and discuss any differences in student success indicators across demographic variables. Also refer to the College Index and other relevant sections of the Educational Master Plan: Update, 2012, e.g., Student Outcomes and Student Outcomes: Transfer. Basic Skills programs should also refer to ARCC data.

In 2015-16, student success rates in engineering courses increased to 78% (from 76% in 2013-14 and 72% in 2014-15). The three-year average of 75% is consistent with longer term historical level. Retention rates increased to 84% in 2015-2016 from 77% in 2014-15 and were slightly below the recent peak of 85% in 2013-14. Success and retention are above the division averages, which is to be expected given that engineering courses have fairly advanced math prerequisites and are taken primarily by students who plan to major in an engineering field.

Engineering enrollments remain heavily male and over the most recent period the percentage of students in engineering courses who are female declined (16% in 2013-14, 11% in 2014-15, 12% in 2015-16) and remains lower than the national average for undergraduate engineering programs (19.6% in 2013, https://www.nsf.gov/statistics/2015/nsf15311/tables/pdf/tab2-10-updated-2016-08.pdf). However, the national average includes bioengineering and environmental engineering, which have larger fractions of women but typically do not require many lower division engineering courses for transfer.

Over the three-year period (AY 13-14, 14-15, 15-16) there are no clear trends in the relative success rates of women and men.

Like other community college programs, the engineering program at CSM serves as a gateway for traditionally underrepresented students. At CSM, 80% of engineering enrollment is now from students who identify as other than white, compared with 37% nationally for all schools and 48% nationally for 2-year schools (2013, derived from https://www.nsf.gov/statistics/2015/nsf15311/tables/pdf/tab2-9-updated-2016-08.pdf and https://www.nsf.gov/statistics/2015/nsf15311/tables/pdf/tab2-3-updated-2016-08.pdf). Over the past three years, the percentage of engineering students who identify as Asian or Filipino has increased, while the percentage of engineering students who identify as Hispanic or White has decreased.

Over the three year period (AY 13-14, 14-15, 15-16), average success rates for students who identify as Filipino were higher in engineering (80%) than in the math/science division (68%) or the college as a whole (69%). Of concern is the decrease in success for students who identify as Hispanic, from 79% in 2013-14 to 65.6% in 2014-15 to 54.5% in 2015-16. Initiatives supported by the recently awarded HSI-STEM grant may be of help in reversing this trend. Engineering enrollments of other traditionally underrepresented groups are too small for meaningful comparison of success rates.

Success rates for 20-24 year-olds, the largest age group, remain strong (77%) compared with the division (64%) and college (70.4). Success rates for students under 19 remain high (79%); this is not surprising, as those who have completed the math and science prerequisites and are ready for engineering courses at a young age have the ability and skill-set required to be successful students. The number of engineering students who are 30 or older is small. Success rates for students in the 25-29 and 30-34 age categories have increased (to 74% and 78%) and are now in the same range as those of younger students

2. Discuss any differences in student success indicators across modes of delivery (on-campus versus distance education). Refer to Delivery Mode Course Comparison.

For several years, the engineering program offered distance education sections (online with on-campus or proctored exams) of ENGR 215 and of ENGR 230 on a no-load basis cross-listedl with traditional face-to-face sections. Success and retention rates in the online sections were well below those of the face-to-face sections. The online sections did not seem to enhance access -- over the years, there were only a few students in the online sections who were not simultaneously taking face-to-face classes in the district. Rather, students seemed to select the online sections primarily as a way to fit required courses into their schedules.

In an attempt to improve success and retention while recognizing the scheduling difficulties faced by engineering students, in Fall 2015 and again in Fall 2016, ENGR 215 and ENGR 230 were each offered as a single web-assisted section, with either 1/3 (ENGR 230) or just under 1/2 (ENGR 215) of the content delivered online. Results from Fall 2015 are promising. The number of students served remains comparable to previous years. Success and retention rates are significantly improved and are now at or above the rates for on-campus sections in previous years.

C. Program Efficiency Indicators. Do we deliver programs efficiently given our resources?

Summarize trends in program efficiency as indicated in the Student Success and Core Program Indicators (LOAD, Full-time and Part-time FTEF, etc.)

Reported LOAD for 2013-14 was 492. In 2014-15, reported LOAD increased to 619, primarily due to increased enrollments in the Fall 2014 courses. However, there was a drop-off in success and retention in Fall 2014. In 2015-16, reported LOAD fell to 490, roughly the same as the Math/Science Division LOAD (486) and slightly below the College LOAD (499), and success and retention returned to 2013-14 levels.

In most years, the program has been staffed primarily by a full time faculty member with one course taught by an experienced adjunct faculty member with materials science expertise. Because the adjunct faculty member was not available in 2014-15, the full time faculty member taught all courses in the program. The full time faculty member shifted to a new role on campus starting Fall 2015, so 2015-16 all classes were taught by adjunct faculty.

3. Additional Factors

Discuss additional factors as applicable that impact the program, including changes in student populations, state-wide initiatives, transfer requirements, advisory committee recommendations, legal mandates, workforce development and employment opportunities, community needs. See Institutional Research as needed.

Demand: The Bureau of Labor Statistics projections for 2014-2024 show employment increase in the 2-8% range for most of the traditional engineering disciplines. The projected increases for environmental engineering, 12%, and biomedical engineering, 23%, are significantly higher than the projected average, but – due to the small base – the projected increase in the number of jobs in each field (6800 for environmental engineering; 5,100 for biomedical engineering), is lower than that for mechanical engineering, 14,600 [Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, December 2015*; links to specific disciplines at http://www.bls.gov/ooh/architecture-and-engineering/home.htm]. There has been an increase in the number of transfer schools offering programs in bioengineering and biomedical engineering and an increase in the number of our students seeking to transfer in these majors.

Students who transfer and complete a B.S. degree in engineering continue to find high-paying jobs that make visible contributions to society (for an interesting graphical display of college majors and employment, see http://www.census.gov/dataviz/visualizations/stem/stem-html/ including the “hover over” instructions at the bottom). Given the regional emphasis on STEM fields and the increased inclusion of engineering in the Next General Science Standards [http://www.nextgenscience.org], it is likely that interest in engineering among incoming students will remain strong. However, for the large fraction of students who arrive at CSM in need of precollegiate math, it may be difficult to persevere through a course of study

that requires completion of precalculus and then 2 ½ to 3 years of additional study prior to transfer. The math program's introduction of a combined trig/precalculus class will be helpful in this regard.

Transfer requirements: The move away from a common lower division engineering core curriculum has continued. The divergence across majors can be seen in the development at the state level of four Model Transfer Curricula: Civil Engineering, Computer/Software Engineering, Electrical Engineering, and Mechanical/Aerospace/Manufacturing Engineering. The divergence of requirements across transfer schools has increased as well; most significant for CSM's program are changes at U.C. Berkeley, which has combined topics in a way that is very different from traditional offerings (and from the Model Transfer Curricula). The lack of coherence in lower division programs at transfer schools means that each engineering course is required by fewer programs than in the past. Several CSM engineering students have completed transfer requirements through courses at other colleges (dynamics at Canada College; mechanics of materials online through Cuesta College). At the Fall 2016 California Engineering Liaison Council meeting, the development of online or hybrid offerings of specialized classes to be offered only at select community colleges but open to students from throughout the state was proposed as a way to address divergent transfer requirements.

Facilities: There has been a major push toward project-based learning in engineering education (historically at Cal Poly SLO and Stanford and more recently in at a broad range of universities including U.C. Berkeley). Over the past few years, project work for ENGR 100, ENGR 210, and ENGR 270 has been supported on an ad hoc basis in the Engineering Materials Lab (19-040). However, this lab does not have sufficient project workspace for a class of 30 nor is it staffed outside of class and office hours. The Library's 3-D printing initiative has been a valuable resource, in particular for projects in ENGR 210. The engineering program is enthusiastic about the possibility of supervised collaborative workspaces and fabrication facilities within the new Emerging/Innovative Technologies Building.

Competition: For at least 20 years, there have been engineering programs at both CSM and Canada College. In Fall 2015, Skyline College offered its first engineering course and is now expanding to a full engineering curriculum. In addition, there is increased completion from online courses at other community colleges and summer offerings at CSU and UC campuses.

Staffing changes: In Fall 2015, the full time engineering faculty member moved to a different role on campus. We were fortunate to find talented adjunct faculty to teach in 2015-16 and 2016-17. A search is currently underway for a new full time faculty member to lead the program.

4. Planning

A. Results of Program Plans and Actions

Describe results, including measurable outcomes, from plans and actions in recent program reviews.

Peer support for engineering courses
To improve success and retention, the program will investigate the implementation of support strategies such as individual tutoring, small group tutoring, and supplemental instruction. No additional resources are required for this plan. Status: In 2015-16, the learning center hired several engineering tutors. Other aspects of this plan have been postponed due to changes in staffing.

Engineering transfer planning support
Review engineering articulation agreements and submit additional articulation requests as appropriate. Update the engineering transfer guide to reflect changes in transfer requirements and the availability of specialized courses through distance education. No additional resources are required for this plan.

Action(s)	Status	Measurable Outcome(s)
Review engineering articulation agreements and submit additional requests as appropriate	Completed in Fall 2014 for core transfer schools; completed in 2015-16 for additional courses	Gaps in articulation identified; list of gaps and supporting information provide to articulation officer.
Update engineering transfer guide	Partial update completed Summer 2016.	Updated transfer guide is posted on engineering website and distributed to counselors.

B. Future Program Plans and Actions

Prioritize the plans to be carried out to sustain and improve student success. Briefly describe each plan and how it supports the CSM Strategic Goals 2013/14 to 2015/16. For each plan, list actions and measurable outcomes. Plans may extend beyond a single year. Describe the professional activities and institutional collaborations that would be most effective in carrying out the program's vision to improve student learning and success.

The engineering program's vision is to continue to provide to students the coursework and support needed to successfully transfer to the variety of engineering majors available at CSU, UC, and private universities. The vision supports the college's mission of providing a comprehensive curriculum and *CSM Strategic Goal 3: Develop Responsive, High-quality Program and Services*. To improve retention and *student success (CSM Strategic Goal 1)* , the program will continue to increase its emphasis on project-based learning.

The introduction of an electromechanical design component to ENGR 100, the use of a 3-D printer by the engineering club and ENGR 210, and the purchase of new materials testing equipment have helped modernize and generate enthusiasm for the program. A design project has been added to ENGR 260 and the use of software tools has been increased in ENGR 230 and ENGR 260. However, current facilities in building 19 are insufficient -- in terms of space, equipment, and supervision -- to support projects of greater scope.

The demolition of building 19 and the design and construction of a new Center for Innovation and Emerging Technology provides a unique opportunity to create multidisciplinary shared workspaces – for example, a "design space" equipped with whiteboards, multi-purpose computer labs, and a "tech shop" to support prototyping. These workspaces could support project work outside of lecture and lab hours, allowing students to work in interdisciplinary teams and extend what they learn in the classroom to more advanced projects. Students would gain hands-on experience as they prepare for internships and transfer. Projects could go beyond what is currently possible in a single course, making it easier to attract support from local businesses and industry. We anticipate that the new full-time engineering faculty member will assist in the planning of the new building and will work with faculty in other disciplines to develop a physical and curricular infrastructure that will allow students to thrive in new multidisciplinary shared workspaces.

5. Program Maintenance

A. Course Outline Updates

Review the course outline update record. List the courses that will be updated in the next academic year. For each course that will be updated, provide a faculty contact and the planned submission month. See the Committee on Instruction website for course submission instructions. Contact your division's COI representatives if you have questions about submission deadlines. **Career and Technical Education courses must be updated every two years.**

Courses to be updated	Faculty contact	Submission month
Courses will be updated as needed based on C-ID articulation feedback (completed for ENGR 260; in progress for ENGR 215 and 230)	Laura Demsetz	November, 2016

B. Website Review

Review the program's website(s) annually and update as needed.

Faculty contact(s)	Date of next review/update
Laura Demsetz	June 2016 (to reflect catalog changes and new faculty)

C. SLO Assessment Contacts

Faculty contact(s)	Date of next review/update

Laura Demsetz	February, 2017 (for 2014-15 data)

6. Dominant Themes Summary for IPC

Briefly summarize the dominant, most important themes or trends contained in this program review, for division deans to collect and forward to the Institutional Planning Committee. What are the key program issues that matter most? (Brief paragraph or bullet points acceptable).

Access to collaborative workspace and fabrication facilities outside of class hours would help support project-based learning in engineering courses.