Appendix E

Engineering resources task force report

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Charge

In March 2016, Provost Oberem formed this Task Force to give consideration to the following aspects of what it will take to implement two or three engineering degree programs in CSM:

- Personnel (faculty, admin support, tech support, etc.)
- Space (building, lab space, office space, equipment storage, etc.)
- Equipment needs
- Short- and long-term financial model (to include support departments)
- An enrollment model (FTES growth planning)
- Impact on allied departments (MATH, PHYS, etc.)
- Scalability

The work of the Task Force was intended to inform university planning and the preparation of an HSI-STEM proposal to the Department of Education.

The task force met regularly during spring 2016.

Background

In fall 2014, Academic Affairs administrators expressed interest in exploring engineering programs, and encouraged faculty in computer science and physics to develop program abstract forms (A forms). In winter 2014, computer science submitted A forms for computer engineering and software engineering, and physics submitted an A form for electrical engineering. The CSU Board of Trustees approved these in spring 2015. The 2014-15 LAMP Task Force identified and prioritized areas of employment or academic study based on regional relevance, demand from students and community partners, consistency with CSUSM's mission and values, and need for foundational programs. Several engineering programs were given high priority.

In summer 2015, the Education Advisory Board Company was commissioned, using funds from an external grant, to conduct a feasibility study, which was completed in fall 2015. The study surveyed the competitive landscape for engineering programs, suggested concentrations for priority launch, and described audiences and recruitment strategies. The study compared local employer demand for engineers to the number of relevant degree completions at California universities, considered relevant community college programs (sources of students with relevant preparation), and evaluated the "gap" between existing curriculum at CSUSM and that needed for engineering. Candidate programs for priority launch were those that draw upon a large number of existing courses and require the least amount of course development, have ample employer demand (i.e., large numbers of job postings and above average job growth), and face low competition relative to employer demand. Based on these criteria, the study prioritized Software Engineering (SE), Electrical Engineering (EE), and Mechanical Engineering (ME).

Methodology

The Task Force began by making guiding assumptions and identifying example programs. An enrollment model was generated based in part on the Feasibility Study. The example programs and enrollment model were used to estimate the number of required sections, and thereby lab classroom and faculty needed. An inventory of required resources was based on experience in physics and computer science and examination of comparable programs. Combined with a roll out timeline, this gave start-up and steady-state costs.

Guiding assumptions

The Task Force focused on SE and EE and was guided by several assumptions:
These programs would be housed in computer science (SE) and physics (EE).
The programs would be designed to achieve ABET accreditation.
New programs should not negatively impact current programs, e.g., hires, funds, and space needed for existing programs should not be diverted to new programs.
Impacts of service courses (computer science, mathematics, and physics) should be accounted for.
New tenure track faculty should have appropriate salaries, research space, and start up packages.
External funds are available during the start-up phase, such as a Department of Education HSI-STEM grant, which could be up to $6M over 5 years.

Required resource categories

The Task Force identified the following categories of resources required for engineering programs:

a) Personnel, including salary and benefits
   i) Faculty (TT and LF)

   ii) Staff (admin support, instructional tech support)
b) Instructional lab supplies and equipment
c) Library acquisitions and subscriptions
d) Computer support
e) Space
   i) General purpose instructional (for engineering and service courses)
   ii) Instructional lab (for engineering and service courses),
   iii) Equipment storage, lab prep
   iv) Student project space
   v) Office space (TT and LF faculty, staff)
   vi) Faculty research
   vii) Meeting rooms (conference)
f) General program expenses
   i) Operating expenses
   ii) Reassigned time for additional department chair workload
   iii) Student assistants

Enrollment models and revenue

The Task Force used the following enrollment model for **each** program:

AY	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24
FRESHMN		10	23	28	35	45	58	58
SOPH		0	9	21	25	32	41	52
JUNIOR		0	0	29	50	54	60	68
SENIOR		0	0	0	29	50	54	60
TOTAL		10	32	77	138	180	212	239
FTES		8.67	27.73	66.95	119.96	156.09	184.05	206.79

Planning Assumptions
0. 16-17 is first year of external funding, no students
1. 10% attrition from FY to SOPH
2. 5% attrition from SOPH to JUNIOR
3. By Yr 5, program at steady state
4. FTES assumes average unit load of 13 units undergrad.
5. No transfers until 19-20. No current students allowed to change majors into program until 19-20. [This is to allow time to establish instructional lab space needed for upper division students.]

The enrollment model was used to estimate revenues assuming $4,500/FTES. This is more than the $4,000/FTES given in the BLP worksheet for new programs. However, given the recent increase in system rate from approximately $9k/FTES to $10k/FTES, the $4,500/FTES figure is considered realistic.

The financial- and space-needs analyses presented below are sensitive to enrollment, and this model is subject to considerable uncertainty. However, given local employer demand, impaction of engineering programs at UCSD and SDSU, and enrollment in relevant community college programs (all documented in the Feasibility Study), **over-enrollment** is judged a greater risk than under enrollment. Effective enrollment control measures are therefore important.

Example curricula

For planning purposes, the Task Force surveyed several EE and SE programs in the CSU. This gave an estimate of the number and subject area of required courses, and the number of lab-based courses. Several programs were evaluated to determine commonalities and trends. Given the structured nature of the subject and the constraints of ABET accreditation, the core features of most programs are similar. The SE estimates most closely followed the San Jose State SE curriculum, while the EE estimates follow the Sonoma State EE curriculum. It is important to note that these were used for planning purposes only, and are not being recommended as models or templates for CSUSM programs.

Number of sections and teaching load

The example curricula were used to estimate the number of courses that would need to be offered each semester. An enrollment estimate and assumptions about course format and teaching load were then used to calculate the WTU required to offer the curriculum.

These calculations were based on an enrollment of 60 students at each level (freshman to senior) in each program. This is a simple assumption that is consistent with the later years of the enrollment model; in the early years it is an over-estimate. Each lecture was counted as 3 WTU and each lab as 2 WTU. Lab section cap was assumed to be 24, thus each lab course requires 3 lab sections. Calculus courses and intro CS courses require 9 WTU (3 for lecture and 2 each for 3 breakout sections). Other math and CS courses are assumed to be lectures requiring 3 WTU.

EE course requirements^

	fall			spring		
	# required courses	# lab sections	# WTU	# required courses	# lab sections	# WTU
EE lecture	6		18	7		21
EE lab	3	9	18	5	15	30
math	2		18	2		18
phys lecture	1		3	1		3
phys lab	1	3	6	1	3	6
CS	1		9			
total	14	12	72	16	18	78

^based on CSU Sonoma EE curriculum. Fall/spring includes courses offered that semester for students in all four program years. Senior design project is not included.

SE course requirements^

	fall			spring		
	# required courses	# lab sections	# WTU	# required courses	# lab sections	# WTU
SE lecture	7		21	5		15
SE lab	0	0	0	0	0	0
math	3		21	3		15
phys lecture	0		0	2		6
phys lab	0	0	0	2	6	12
CS lecture	4		12	3		9
CS lab	1	3	6	1	3	6
total	15	3	60	16	9	63

^based on SJSU SE curriculum. Fall/spring includes courses offered that semester for students in all four program years. Senior design project is not included. 1 CS course with lab each fall and spring; 3 of the 6 math courses are only 3 units.

Faculty needed

Assuming 64.3% of the WTU are TTF[1] leads to the following requirements:

Electrical engineering:

	TTF required		LF FTE required
dept	calculation	recommended	calculation
EE	1.8-3.1	2-3	1.8-1
math	0.8-1.3	1	0.8-0.4
phys	0.4-0.6	0.5	0.4-0.2

Software engineering:

	TTF required		LF FTE required
dept	calculation	recommended	calculation
SE	0.8-1.3	1-2	0.8-0.4
math	0.8-1.3	1	0.8-0.4
phys	0.4-0.6	0.5	0.4-0.2
CS	0.7-1.2	1	0.7-0.4

The recommended number of TTF is based on rounding up the calculated number required. Combining the physics TTF needed for both programs gives 1 TTF. Given the expected service load associated with starting the program, having TTF teach a max of 6 WTU may be more realistic. Furthermore, more TTF will help ensure ABET accreditation. Thus, the higher number of TTF is recommended, as follows:

Total TTF needed:	**3 EE**	**2 SE**	**1 CS**	**1 phys**	**2 math**

The curriculum analysis did not include senior design projects, which will be essential to ensure accreditation. Supervising projects is faculty-intensive; for instance, CoBA's Senior Experience uses a dedicated director. This element of the curriculum will add to the workload beyond what is projected here.

Space required

The number of required lab sections each semester can be used to determine the amount of lab classroom space needed. For example, the EE curriculum at Sonoma State includes 4 lab courses in fall and 6 in spring. With 3 sections per course, this would require enough space to offer a max of 18 sections. Balancing the lab courses between fall and spring would reduce this requirement to 15 lab sections. With

[1] Based on 75% of FTEF being TTF, assuming TTF FTE = 9 WTU, LF FTE = 15 WTU.

current scheduling patterns, a lab classroom can accommodate a max of 14, 3-hr sections/week.

Accommodating required lab courses, and allowing some space for senior design projects (essentially an ABET requirement), growth, and flexibility suggests that two lab classrooms are needed for each program. Recommended size is 1200 sq. ft. These spaces will need appropriate infrastructure (e.g. raised floor, power, temperature control, etc.).

Additional space needs include lab stockroom and prep space, faculty research space, faculty office space, and general-purpose instructional space (a SCALE-UP classroom is recommended to support research-based instruction).

Space needed*

area	#	sq ft each	sq ft total
instructional lab	4	1200	4800
SCALE-UP classroom	1	2800	2800
stockroom	2	300	600
faculty research	7	400	2800
office	7	110	770
conference	1	300	300
total			12070

**Does not include hallways, restrooms, etc.*
Assumes tech staff offices in stockroom; AC offices in current department space.

We note that the current physics instructional lab space is near capacity, and CS currently has **no** dedicated instructional lab space.

This analysis does not include the cost to build the needed space.

Expenses

Program expenses were based on costs for personnel (salary, benefits, start-up), equipment and supplies, library acquisitions, and department operating expenses.

Personnel cost assumptions:
1. Salary and startup as listed below
2. Starting engineering faculty for each program is at associate level
3. Average lecturer salary = $1,777/wtu
4. Benefits at 48.5%

Anticipated TTF salary and start-up costs

engin salary, associate	$120,000
engin salary, assistant	$90,000
CS salary	$80,000

physics/math salary	$75,000
EE/physics startup	$80,000
CS/SE start up	$40,000
math start up	$15,000

Most TTF were assumed to start in the programs' third year, as program size increases and students begin the upper division, moving from mostly prerequisite courses in physics, math, and CS to specialized engineering courses.

Supply, equipment, and computing needs were based on an analysis of lab courses included in typical SE and EE programs, as well as experience with similar courses in the physics and computer science departments. IT expenses are included with computer equipment. Total estimated supply and equipment costs approach $1M for each program (this includes workbenches, workstations and storage for outfitting instructional labs). Costs for consumable supplies, and a prorated 10-year lifetime for equipment with long-term durability suggest $80k/yr for EE and $75k/yr for SE is needed for instructional equipment.

Financial model – externally funded and ongoing

Total expenses during the externally funded period total $3.86M for EE and $3.5M for SE. Expected revenue from FTES and external funds (anticipated $6M award from Department of Education) total $7.97M. The table below summarizes.

5-year externally funded period	
REVENUE	
SE Tuition Revenue	$1,004,894
EE Tuition Revenue	$965,894
Grants* and donations	$6,000,000
TOTAL REVENUE	$7,970,787
COSTS	
SE costs	-$3,504,468
EE costs	-$3,861,794
TOTAL COSTS	-$7,366,262
NET	$604,525

The costs during this period depend greatly on the timing of personnel hiring, which in this analysis was synced with enrollment. It was assumed that all needed personnel would be hired, and needed instructional equipment purchased, before the end of the external funding period.

Beyond the external funding period, estimated annual expenses and revenues are:

Annual CSM costs	
REVENUE	
SE Tuition Revenue	$930,540
EE Tuition Revenue	$930,540
Course fees	$35,873
TOTAL REVENUE	$1,896,953
COSTS	
SE costs	-$888,927
EE costs	-$1,000,152
TOTAL COSTS	-$1,889,079
NET	$7,873.38
NET/FTES	$19.04

Scalability and Limitations

If the enrollment model is exceeded, this will increase both costs and revenues. Enrollment control is important during the start up phase so that the timing of course need matches available faculty, space, and other resources. Scalability is constrained by the availability of instructional lab space and tenure track faculty.

The validity of this analysis depends on assumptions about curricula, enrollment, and resources. Any program is complex, and many details will not be determined until the curriculum is designed and the programs implemented. In particular, faculty supervision of senior design projects was not accounted for here. A more lab-intensive curriculum will impact space, personnel, and equipment resources. It is important to emphasize that the distribution of lab, lecture, and prerequisite courses is **not** intended to be a template for program development; it was simply used as a best estimate of program structure for resource planning. CSUSM program development should strive for quality programs, coordinate with and leverage existing programs, and plan for ABET accreditation.

The balanced financial models presented here depend on external funding and revenue to the programs of $4,500/FTES. Space (~12k sq ft) is required as well.

The financial model for the startup period depends on the relative timing between personnel hiring and student enrollment. It was assumed that these would happen together. The process and timing for program development remains uncertain, and the analysis of the start up phase should be viewed accordingly.

A. ANTICIPATED COST PROJECTIONS FOR NEW STATESIDE PROGRAM: Software Engineering

	P form process		1st year students				xfer students; building					
	16-17		17-18		18-19		19-20		20-21		annual CSM costs		
Personnel	**Number**	**Cost**	**Number**	**Cost**	**Number**	**Cost**	**Number**	**Cost**	**Number**	**Cost**	**Number**	**Cost**	
TT Faculty salary, engin	0	$0	0	$0	2	$210,000	2	$210,000	2	$210,000	2	$210,000	
TT faculty benefits (48.5%)		$0		$0		$101,850		$101,850		$101,850		$101,850	
TT Faculty start-up funds, SE		$0				$80,000							
TT Faculty salary, CS	0	$0	0	$0	0	$0	1	$80,000	1	$80,000	1	$80,000	
TT faculty benefits (48.5%)		$0		$0		$0		$38,800		$38,800		$38,800	
TT Faculty start-up funds, CS		$0		$0		$0		$40,000					
TT Faculty salary, math	0	$0	0	$0	1	$75,000	1	$75,000	1	$75,000	1	$75,000	
TT faculty benefits (48.5%)		$0		$0		$36,375		$36,375		$36,375		$36,375	
TT Faculty start-up funds, math		$0		$0		$15,000							
Lecturers	0	$0	0.6	$31,986	1.3	$69,303	1.6	$85,296	1.6	$85,296	1.6	$85,296	
Lecturer benefits (48.5%)		$0		$15,513		$33,612		$41,369		$41,369		$41,369	
Technician	0	$0	1	$45,000	1	$45,000	1	$45,000	1	$45,000	1	$45,000	
Staff benefits (48.5%)		$0		$21,825		$21,825		$21,825		$21,825		$21,825	
Library Resources													
Acquisition				$15,000		$1,500		$1,500		$1,500			$180,000
Subscription				$6,000		$6,000		$7,000		$7,000			
Equipment/Materials													
Computer Network & Software				$60,000		$60,000		$60,000				$75,000	$500,000
Lab benches & equipment				$150,000		$250,000		$50,000		$50,000		$10,000	$260,000
Expendables				$100,000		$100,000		$50,000		$10,000		$10,000	$940,000
Dept expenses													
OE				$3,000		$5,000		$7,000		$7,000		$7,000	
DC resassigned time			1CR	$5,500	1CR	$5,500	2CR	$11,000	2CR	$11,000	2CR	$11,000	
AC			0.5	$22,500	0.5	$22,500	0.5	$22,500	0.5	$22,500	0.5	$22,500	
AC benefits (48.5%)				$10,913		$10,913		$10,913		$10,913		$10,913	
student assistants				$2,000		$3,000		$5,000		$7,000		$7,000	**Projected 5-year cost**
Program Cost (SUM)		**$0**		**$489,237**		**$1,152,377**		**$1,000,427**		**$862,427**		**$888,927**	**$ 3,504,468**

Planning Assumptions:

0. Salary and startup as listed below
1. Starting Faculty is at associate level
2. Average Lecturer Costs = $1,777/wtu + 41% benefits if time base at .4
3. Staff Costs = salary + 41% benefits
4. 1 TTF in physics included in EE, 0 in SE
5. 1 TTF each in math included in EE, SE
6. Math TTF start 1 each in 18-19, 19-20; Phys and CS TTF start in 19-20

engin salary, associate	$ 120,000
engin salary, assistant	$ 90,000
CS salary	$ 80,000
math salary	$ 75,000
CS/SE start up	$ 40,000
math start up	$ 15,000

B. ANTICIPATED REVENUES FOR NEW STATESIDE PROGRAMS: Software Engineering

	16-17	17-18	18-19	19-20	20-21	21-22	22-23	23-24
FRESHMN		10	23	28	35	45	58	58
SOPH		0	9	21	25	32	41	52
JUNIOR		0	0	29	50	54	60	68
SENIOR		0	0	0	29	50	54	60
TOTAL		10	32	77	138	180	212	239
FTES		8.67	27.73	66.95	119.96	156.09	184.05	206.79
Revenue to AA		$39,000	$124,800	$301,275	$539,819	$702,410	$828,224	$930,540
COURSE FEES		$600	$2,190	$6,113	$10,551	$13,370	$15,755	$17,936
Total Revenue		$39,600	$126,990	$307,388	$550,369	$715,779	$843,978	$948,476

5-year external funding period (Yrs 16-17 to 20-21):	
Tuition Revenue	$1,004,894
Grants* and donations	$0
Course fees	$19,453
TOTAL	$1,004,894

included in EE worksheet

Planning Assumptions

0. 16-17 is first year of grant
1. 10% attrition from FY to SOPH
2. 5% attrition from SOPH to JUNIOR
3. By Yr 5, program at steady state
4. FTES assumes average unit load of 13 units undergrad.
5. Academic Affairs will receive approx. $4,500 per FTES
6. *Expected as federal grant funding (likely Dept of Ed, eg, Title IV funds)
7. Course fees of $30/student-lab course, ~10 labs offered each year
8. No transfers until 19-20. No current students allowed to change majors into program until 19-20

A. ANTICIPATED COST PROJECTIONS FOR NEW STATESIDE PROGRAMS: Electrical Engineering

P form process | 1st year students | xfer students; building

	16-17		17-18		18-19		19-20		20-21		ongoing CSM costs		
Personnel	**Number**	**Cost**	**Number**	**Cost**	**Number**	**Cost**	**Number**	**Cost**	**Number**	**Cost**	**Number**	**Cost**	
TT Faculty salary, engin	0	$0	0	$0	2	$210,000	3	$300,000	3	$300,000	3	$300,000	
TT faculty benefits (48.5%)		$0		$0		$101,850		$145,500		$145,500		$145,500	
TT Faculty start-up funds, engin		$0		$0		$180,000		$90,000		$0		$0	
TT Faculty salary, phys	0	$0	0	$0	0	$0	1	$75,000	1	$75,000	1	$75,000	
TT faculty benefits (48.5%)		$0		$0		$0		$36,375		$36,375		$36,375	
TT Faculty start-up funds, phys				$0		$0		$90,000					
TT Faculty salary, math	0	$0	0	$0	0	$0	1	$75,000	1	$75,000	1	$75,000	
TT faculty benefits (48.5%)		$0		$0		$0		$36,375		$36,375		$36,375	
TT Faculty start-up funds, math		$0		$0				$15,000					
Lecturers	0	$0	0.6	$31,986	1.3	$69,303	1.3	$69,303	1.6	$85,296	1.6	$85,296	
Lecturer benefits (48.5%)		$0		$15,513		$33,612		$33,612		$41,369		$41,369	
Technician	0	$0	1	$45,000	1	$45,000	1	$45,000	1	$45,000	1	$45,000	
Staff benefits (48.5%)		$0		$21,825		$21,825		$21,825		$21,825		$21,825	
Library Resources													
Acquisition				$15,000		$1,500		$1,500		$1,500			
Subscription				$6,000		$6,000		$7,000		$7,000			
Equipment/Materials													
Computer Network & Software				$40,000				$40,000				$10,000	$80,000
Lab benches & equipment				$250,000		$250,000		$100,000		$50,000		$60,000	$650,000
Expendables				$75,000		$75,000		$50,000		$10,000		$10,000	$210,000
													$940,000
Dept expenses													
OE				$3,000		$5,000		$7,000		$7,000		$7,000	
DC resassigned time			1CR	$5,500	1CR	$5,500	2CR	$11,000	2CR	$11,000	2CR	$11,000	
AC			0.5	$22,500	0.5	$22,500	0.5	$22,500	0.5	$22,500	0.5	$22,500	
AC benefits (48.5%)				$10,913		$10,913		$10,913		$10,913		$10,913	
student assistants				$2,000		$3,000		$5,000		$7,000		$7,000	**Projected 5-year cost**
Program Cost (SUM)		**$0**		**$544,237**		**$1,041,002**		**$1,287,902**		**$988,652**		**$1,000,152**	**$ 3,861,794**

Planning Assumptions:

0. Salary and startup as listed below
1. Starting Faculty is at associate level
2. Average Lecturer Costs = $1,777/wtu + 41% benefits if time base at .4
3. Staff Costs = salary + 41% benefits
4. 1 TTF in physics included in EE, 0 in SE
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