PROGRAM ABSTRACT - Form A

Proposed Degree Title: **Software Engineering, B.S.** in **Dept of Computer Science & Information Systems**

COLLEGE: **College of Science and Mathematics** Proposed Implementation Date: **August 2019**

About the A-Form.

Background: New baccalaureate and graduate-level degrees must be approved by the Chancellor's Office. Every January, CSU campuses send updated University Academic Master Plans (or UAMPs) to the Chancellor's Office, which are then approved by the Board of Trustees at their March meeting. When the Board of Trustees approves a campus request to add a new program to the UAMP, it authorizes the campus to submit a formal proposal to the Chancellor's Office for establishing such a degree program.

Purpose: The A-Form is used to propose the addition of a new baccalaureate or graduate degree to the UAMP.

Process: After review by the appropriate college curriculum or planning committee in the Spring semester, A-Forms are sent to Academic Programs at the beginning of the Summer. The forms are distributed to key University officers (including all members of Provost's Council and the President's Cabinet) over the Summer for information dissemination, review and feedback. The feedback received as a result of this distribution is provided to proposers as it is received during the Summer (to inform development of the program proposal) and to the Budget and Long-range Planning Committee (BLP) at the beginning of the Fall semester.

Outcomes: BLP reviews the A-Forms and the feedback collected by Academic Programs, and makes recommendations as to whether programs should be added to the next UAMP. Placement of a program on the UAMP is the campus-level authorization to proposers to submit a complete new program proposal (via a P-Form). Comments from BLP are sent back to the proposal originator to inform the final design and plan for the proposed program. The A-Form, Summer reviewer feedback, and BLP comments are additionally used to prepare a summary statement for the Chancellor's Office, which is required for any addition to the UAMP.

Directions.

- Fill in the degree title, college and implementation date above.
- Attach a program abstract addressing items 1-5 to this form.
- Identify the program proposer and obtain the department chair or program director signature below.
- Submit the abstract and the Form A to the college curriculum or planning committee. (Check with the college for submission deadlines.)

1. Description: Briefly describe the essential features of the curriculum that will be developed.

    - If the new degree is currently offered as an option in an existing degree program, give a rationale for the conversion.
    - If the new degree program is not commonly offered as a bachelor's or master's degree, provide a compelling academic rationale explaining how the proposed subject area constitutes a coherent, integrated degree major that has potential value to students.

2. Mission: How will this program benefit the college, university, region and/or state? How is it aligned with the College and University Mission and Vision?

3. Demand: What evidence is there of adequate student demand for this program?

[Note that Board of Trustees classifies Anthropology, Art, Biology, Chemistry, Economics, English, Foreign Languages, Geography, Geology, History, Mathematics, Music, Philosophy, Physics, Political Science, Psychology, Sociology, Speech/Communication and Theatre Arts/Drama as "Broad Foundation Programs" for which societal need and student demand are not "the preeminent criteria" for offering baccalaureate programs.]

Preliminary evidence of adequate student demand for the proposed program should include

(i) A list of other CSU campuses currently offering the proposed degree major program (see the CSU Mentor website at http://www2.assist.org/browseAreas.do),
(ii) A list of neighboring institutions, public or private, currently offering the proposed degree major program,
(iii) Information indicating substantial regional demand for individuals who have earned this degree (contact the Career Center for assistance), and
(iv) Information indicating adequate student interest in the proposed program (e.g., numbers of minors, existing programs at feeder community colleges, or results of student surveys).

Graduate degree program proposals must also include the number of declared undergraduate majors and the degree production over the preceding three years for the corresponding baccalaureate program.

4. Resources: Give preliminary estimates of the following resources needed to implement the program:

- Additional faculty positions;
- Additional resources required for program administration (e.g., release time for a Chair or Director);
- Additional staff support;
- Additional space requirements; and
- Additional specialized equipment and materials other than those expected to be provided by the Library and Instructional and Information Technology Services (IITS).

Note that in the course of reviewing the A-Form over the Summer, the Library and IITS will estimate additional library, information technology and academic computing resources needed for implementation. Indicate whether there are any unusual aspects of the curriculum design that need to be taken into account in the preparation of the Library and IITS estimates.

If there are recognized accrediting bodies in the program area, what are the accreditation criteria and how necessary is accreditation?

5. Relation to Existing Programs: Describe the potential effect on existing programs (e.g., enrollment changes, opportunities for collaboration, resources).

REVIEW PROCESS

1. _____ 10/20/14
Originator (Please Print and Sign) — Date

2. _____ 10/20/14
Program/Department Director/Chair* – if applicable — Date

3. _____ Oct 20, 2014
College Curriculum/Planning Committee* — Date

4. _____ 10/21/14
College Dean (or Designee)* — Date

5. _____
Date received in Academic Programs

* Signature indicates support that the proposed program moves forward for consideration for placement on the UAMP.

REC'D OCT 22 2014

1. Description: Briefly describe the essential features of the curriculum that will be developed.

Software Engineering is the application of engineering principles to the design, development, implementation, integration, and maintenance of large software systems. It also includes non-functional concerns such as safety, security, predictability, and reliability. Large software systems are needed in a variety of applications, such as mobile devices, command and control systems, operating systems and servers, telecommunications networks, medical information systems, financial and insurance web services, and business systems. One company that focused on medical information systems shared among hospitals, clinics, labs, and medical offices had about "six million lines of source code distributed across 373 files."[1] The radio and navigation system of a luxury car requires approximately 20 million lines of code.[2] Both of these applications required years of coordinated teamwork with software engineers, programmers, managers, and domain experts. Some of the engineering principles include project planning, resource allocation, analysis of tradeoffs, testing tools, metrics, interface design, and quality assurance. *Note: Software Engineers may also be referred to as "Software Developers."*

A Software Engineer must possess a solid basis in computer science and apply engineering principles to solve problems.

A Software Engineer must possess a solid basis in computer science. The Department of Computer Science and Information Systems currently offers some of the core computer science curriculum for Software Engineering:

A. CS 111 Computer Science I
B. CS 211 Computer Science II
C. CS 311 Data Structures
D. CS 331 Computer Architecture
E. CS 351 Programming Languages
F. CS441 Software Engineering

The Department of Computer Science and Information Systems also currently offers some possible computer science electives for Software Engineering, such as:

G. CS 421 Theory of Computing
H. CS 436 Introduction to Networking
I. CS 443 Database Management

A Software Engineer must also be able to apply engineering principles to solve problems. The Department of Computer Science and Information Systems would need to develop new engineering curriculum for Software Engineering to give their students the abilities, for example, to:

J. Design a system or process to meet desired needs
K. Function on multi-disciplinary teams
L. Formulate and solve engineering problems
M. Understand professional and ethical responsibility
N. Integrate feedback from the various design activities such as architectural design, abstract specification, interface design, component design, data structure design, and algorithm design (Software Engineering, Ian Somerville, Addison-Wesley)
O. Incorporate basic principles of human-computer interaction (interface design techniques, design guidelines, and usability testing)
P. Apply engineering principles and practices in project planning and management, software testing, software metrics, and quality assurance
Q. Construct, install, and maintain large software systems
R. Track software development failures (organizational, people, process, and technical)

[1] http://www.sciencedirect.com/science/article/pii/S0164121213002598

[2] http://www.motorauthority.com/news/1026505_modern-luxury-vehicles-claimed-to-feature-more-software-than-a-fighter-jet

2. Mission: How will this program benefit the college, university, region and/or state? How is it aligned with the College and University Mission and Vision?

The Mission of the College of Science and Mathematics states:
The College of Science and Mathematics will build and sustain a supportive and inspiring undergraduate and Master's level educational environment where excellent instruction, interdisciplinary and collaborative research, innovation and creative endeavors provide students with the foundational knowledge and skills needed to meet technological challenges in a rapidly evolving world.

The Vision of CSUSM states, in part:
Students will select from a growing array of specialized programs responsive to state and regional needs.

A Software Engineering degree would prepare students *to meet technological challenges in a rapidly evolving world* and allow students to *select from a growing array of specialized programs responsive to state and regional needs.*

Software engineers are equipped to use their skills in areas involving large software systems that arise in diverse areas such as cloud computing (e.g., on-demand service; shared resources such as storage, hardware, and software; broad network access), mobile health and fitness devices (e.g., with computing power, sensors, multimedia and communication capacities, and capacities for tracking daily activities), wireless sensor network applications (e.g., a large network of spatially distributed sensors to monitor physical or environment conditions and sending the data to a central location that processes the data), embedded systems in automobiles (e.g., integration of software, hardware, and real-time sensors in vehicles to increase fuel efficiency, reliability, performance, comfort, and safety and include WiFi, Bluetooth, and infotainment technologies), and business systems (e.g., online banking with synchronization of transactions, data warehousing, bank services interface, phone and web applications, bank operations, cybersecurity, customer database, …). These examples illustrate a rapidly evolving technological world that increasingly requires complex skills such as the ones possessed by Software Engineers (in view of the curriculum described in #1, parts A-R). Figures 1-5 in this proposal support the present and projected regional, state, and national needs for Software Engineers.

3. Demand:

The following CSU and UC campuses offer a Bachelor of Science in Software Engineering:

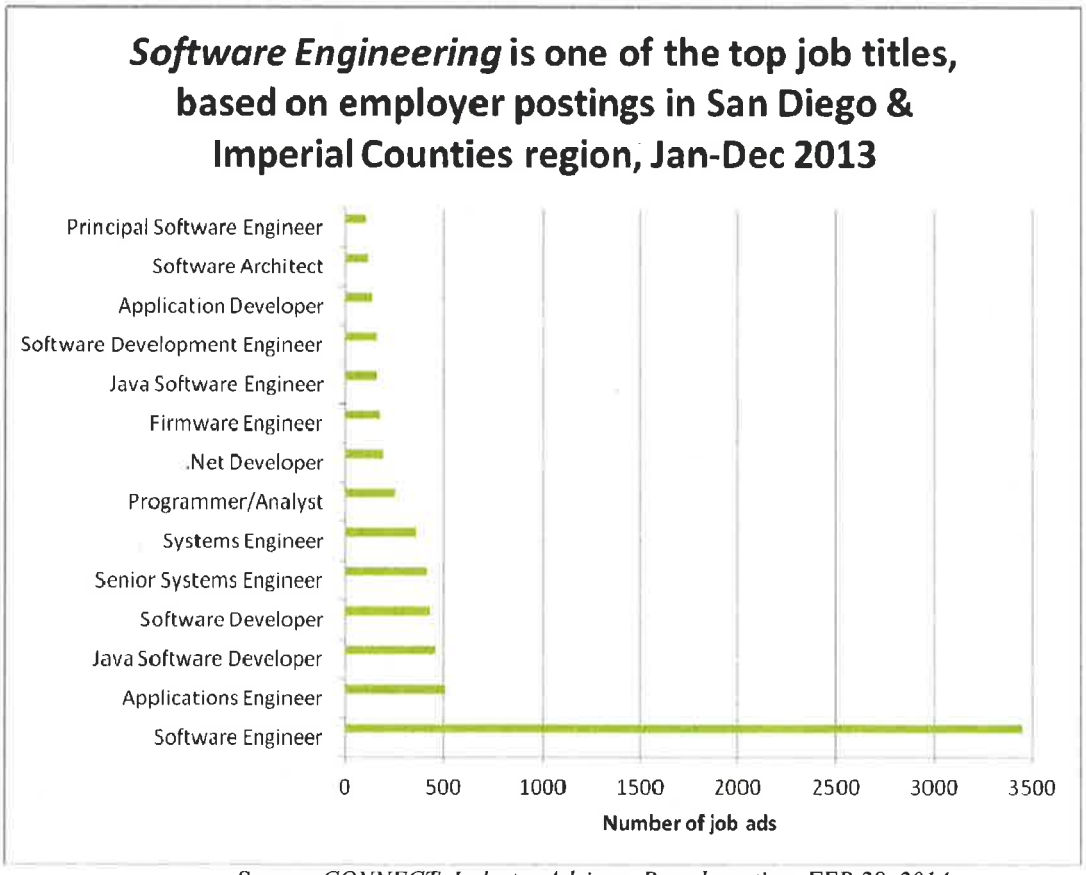
- Cal Poly San Luis Obispo
- San Jose State University
- UC Irvine

Note: CSU East Bay offers a Bachelor of Science in Computer Science with an option in Software Engineering.

Figures 1, 2, and 3 show preliminary evidence of substantial demand for software engineers. The regional demand for Software Engineering will be closely explored in a feasibility study that would be commissioned after the approval of the proposal, and the cost of the study would be funded by external sources, such as industry partners.

Figure 1 shows the number of top job titles based on employer postings in the San Diego and Imperial Counties Region in 2013, from the organization CONNECT. According to *www.connect.org*, "CONNECT is a regional program that catalyzes the creation of innovative technology and life sciences products in San Diego County by linking inventors and entrepreneurs with the resources they need for success."

Figure 1.



Source: CONNECT, Industry Advisory Board meeting, FEB 28, 2014

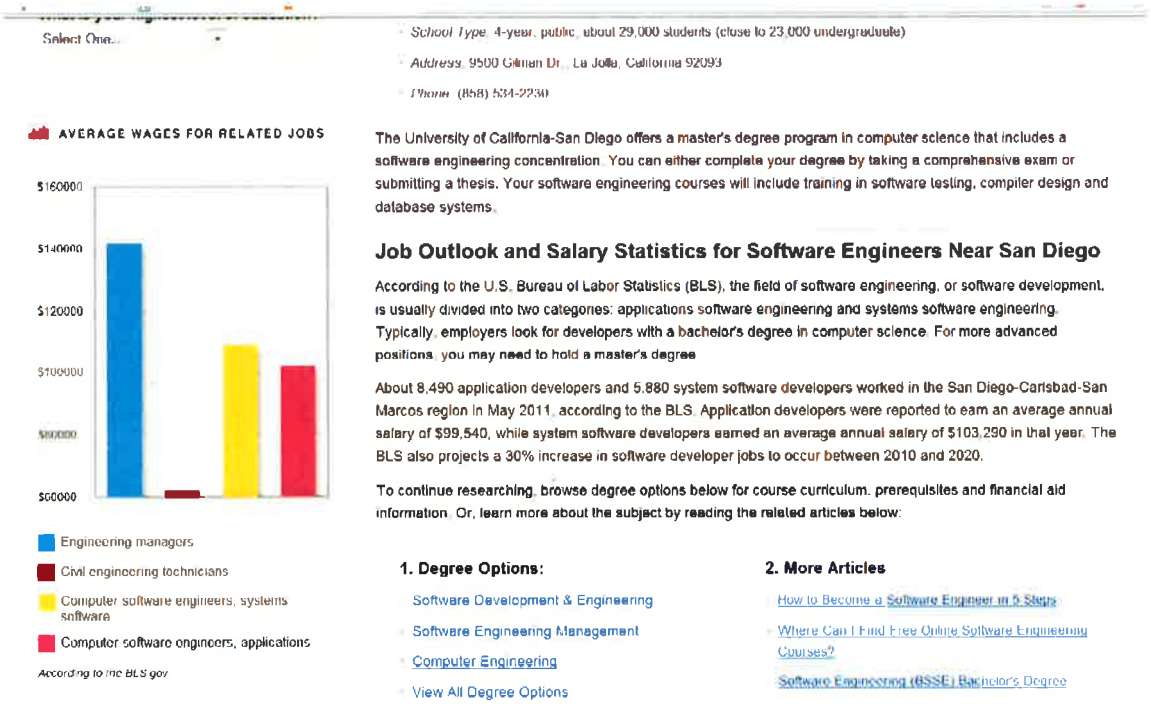
In addition, Figure 2 indicates that the Bureau of Labor and Statistics provides a 22% growth outlook for Software Engineers (categorized within Software Developers) from 2012-2020.

Figure 2.

Source: http://www.bls.gov/ooh/computer-and-information-technology/software-developers.htm

Figure 3 shows that the website degreedirectory.org notes that approximately 14,000 Software Engineers (8,490 + 5,880 ≈ 14,000) work in the San Diego-Carlsbad-San Marcos region with average salaries of approximately $100,000.

Figure 3.



Source: http://degreedirectory.org/articles/Software_Engineering_Degrees_Where_Can_I_Find_Software_Engineering_Degree_Programs_in_the_San_Diego_California_Area.html

Figure 4 shows that software engineers experienced one of the largest employments growths in science and engineering, according to a congressional report on STEM workforce trends; see the two categories Software Developers, Applications (ranked No. 1) and Software Developers, Systems Software (ranked No. 6).

Figure 4.

Table 5 shows the 10 S&E occupations with the largest employment growth from 2008 to 2012. The list includes six engineering occupations, three computer occupations, and one mathematics occupation.

Table 5. S&E Occupations with the Largest Employment Growth, 2008-2012

Rank	S&E Occupation	Employment Growth
1	Software Developers, Applications	92,180
2	Network and Computer Systems Administrators	22,470
3	Mechanical Engineers	18,930
4	Petroleum Engineers	15,530
5	Aerospace Engineers	12,620
6	Software Developers, Systems Software	9,870
7	Operations Research Analysts	8,320
8	Computer Hardware Engineers	6,210
9	Electrical Engineers	5,890
10	Industrial Engineers	5,550

Source: The U.S. Science and engineering Workforce: Recent, Current, and Projected Employment, Wages, and Unemployment; Congressional Research Report, John F. Sargent, Jr. Februrary 19, 2014

Figure 5 shows that software engineers have high growth expectations from 2012-2020, according to a congressional report on STEM workforce trends; see the two categories Software Developers, Applications (ranked No. 1) and Software Developers, Systems Software (ranked No. 4).

Figure 5.

Table 11 shows the 10 S&E occupations with the highest projected growth in jobs. Eight of the ten S&E occupations on this list are in the computer occupations. One of the remaining two occupations is computer and information systems managers. The only non-IT occupation in the top 10 is civil engineers.

Table 11. S&E Occupations with the Highest Projected Growth in Jobs and Other Selected Occupations, 2012-2022

Rank	S&E Occupation	Projected Average Annual Job Growth[a]
1	Software developers, applications	13,990
2	Computer systems analysts	12,770
3	Computer user support specialists	11,080
4	Software developers, systems software	8,280
5	Civil engineers	5,370

Source: The U.S. Science and engineering Workforce: Recent, Current, and Projected Employment, Wages, and Unemployment; Congressional Research Report, John F. Sargent, Jr. Februrary 19, 2014

4. Resources:

The resources for Software Engineering (e.g., tenure-track faculty, support staff, equipment, and laboratory space) will be closely explored in a feasibility study that would be commissioned after the approval of the proposal, and the cost of the study would be funded by external sources, such as donors and industry partners.

The funding for faculty, staff, infrastructure, equipment and supplies, laboratory space, and all other related resources will be funded entirely by a combination of federal grants and donations from industry as well as private foundations for the first five years of the degree. It is expected that the program will be supported by student enrollment growth from Year 5 and beyond and that the program will continue to seek external resources.
Any P-form that results will reaffirm these two premises.

As mentioned in #1, a Bachelor of Science in Software Engineering requires core courses in Computer Science, along with core course in engineering. Currently the department is at capacity in its enrollment in upper-division Computer Science courses (See #1, courses listed in A-F). The additional majors in Software Engineering would require that some core upper-division Computer Science courses be offered more frequently, or offered in multiple sections. This means that several additional tenure-track faculty would be needed to teach the additional upper-division courses. Also, the core engineering curriculum for Software Engineering (See #1, courses listed in J-R) would require the hiring of several new tenure-track faculty with expertise in teaching the engineering curriculum.

It is expected that release time for the Chair of the department may need to be increased due to the additional managerial workload associated with scheduling courses, hiring lecturers, and interfacing with campus and community entities.

It is expected that two new dedicated computer laboratories would be needed to house new servers and computer networks for the computer laboratories associated with the core computer science and engineering curriculum that accompany the new degree. It is expected that the dedicated computer laboratories will be adequately supplied with servers and computer networks to accommodate the new engineering curriculum.

It is expected that the department would need an Instructional Support Technician to manage the additional servers and computer networks that accompany the new degree. The Academic Support Coordinator (ASC) for the Department of CSIS currently serves two departments, and therefore work 50% time for CSIS. It is expected that the department will have a single ASC that works full-time for CSIS several years prior to the launching of the new degree.

Regarding library resources, there are several quality online per-reviewed, open access journals, or journals that can be obtained through subscription through the campus subscription ScienceDirect, such as:

- Advances in Software Engineering
- Advances in Engineering Software
- International Journal of Software Engineering and Knowledge Engineering
- IEEE Transactions on Software Engineering
- ACM Transactions on Software Engineering Methodology
- Journal of Software Engineering and Applications
- Innovations in Systems and Software Engineering
- Springer Annals of Software Engineering

5. Relation to Existing Programs: The new degree program would affect other programs. The obvious impact is that students who would have enrolled at another university to pursue an engineering degree would increase the demand for supporting courses for the major (such as biology, chemistry, and physics). This is a typical by-product of attracting new STEM majors to a university. It is expected that additional engineering supporting departments in the sciences would feel the greatest impact because engineering majors are required to take more science supporting courses than non-STEM majors. For example, additional sections of calculus, linear algebra, discrete mathematics, and statistics courses may be needed, along with some additional sections of biology, chemistry, and physics. The additional sections would provide students more flexibility in meeting patterns and times for enrolling in courses. Also, there is the possibility that the Software Engineering degree could siphon some students from the Computer Science degree, but its effect on Computer Science is unknown. However, it is proposed that both degrees reside in the same department. Also, it should be mentioned that Computer Science is increasingly evolving into a specialized field so that universities are increasingly offering specialized degrees such as Software Engineering and Computer Engineering.