2012-2013 Assessment Report

B. S. in Computer Science

Computer Science Department

College of Engineering and Computer Science

California State University, Sacramento

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INTRODUCTION

This introduction provides information about the Computer Science Department's mission, goals, program educational objectives, and student learning outcomes. The current review plan for objectives and the assessment plan for outcomes are also provided. The relationship between learning outcomes and the University's Baccalaureate Learning Goals (BALG's) is presented in the form of a matrix.

Mission of the Department

The mission of the Computer Science Department is to:

- Be a department of choice for high-quality and innovative undergraduate and graduate degree programs in computer science, software engineering, and computer engineering.
- Educate a diverse student population.
- Foster research and professional development activities that enable faculty to maintain currency in their fields, and engage students in their research.
- Provide technological leadership to the University community and the Sacramento region.
- Provide experiences that reflect state-of-the-art/state-of-the-practice by incorporating new areas and technologies into its academic programs.
- Strive to serve regional educational needs for professional development and interdisciplinary programs.
- Participate in the development of new technologies that drive local, regional, and national economies through interaction with industry.

Goals of the BS Degree Program

The goals of the program are to produce graduates who are technically and professionally competent, broadly educated, and who will:

- Be sought by organizations in a competitive environment.
- Succeed in graduate or professional programs in a variety of related fields.
- Appreciate the need for and pursue life-long learning and continual professional development.
- Are active contributors to the discipline, their chosen profession, their communities, and society.
- Demonstrate an understanding of professional ethics and responsibilities, and the global and societal impact of the profession.

Program Educational Objectives

Program educational objectives are desired characteristics of our graduates three to five years after graduation, Our program objectives were reviewed this cycle and updated as follows:

A graduate of the computer science program will be able to:

1. Make contributions to the development, maintenance, and support of real world computing systems.
2. Be an effective and contributing member of a project team, taking initiative and responsibilities.
3. Engage in professional development and maintain currency in the discipline.
4. Communicate ideas clearly and concisely in both verbal and written forms to both technical and non-technical audiences.
5. Adhere to the ethical standards of the profession and understand the social and global implications of his/her professional activities.
6. Work independently and function in an environment with incomplete and/or changing information and requirements. Demonstrate flexibility and an ability to adapt to changes.

Inputs on program objectives are solicited from our Industry Advisory Council, alumni, and employers of our graduates. The review plan for periodic review of program objectives is provided in Table 1 below.

Table 1. Three-Year Review Plan for Program Educational Objectives

Year	Tasks	Sources of Input	Continuous Improvement
Year 1 (2012-2013)	Solicit input from constituents on program objectives	Industry Advisory Council (IAC) Industry Site Visit	Input reviewed by Department faculty
Year 2 (2013-2014)	Refine program objectives	Department faculty	Objectives updated by Department faculty.
Year 3 (2014-2015)	Solicit input from constituents on program objectives	Industry Advisory Council (IAC) Alumni	Input reviewed by Department faculty.

Student Learning Outcomes

Student learning outcomes are abilities a B.S. graduate from our program will possess at the time of graduation. At graduation, a B.S. student should be able to:

(a) Apply fundamental knowledge of mathematics, algorithmic principles, computer theory, and principles of computing systems in the modeling and design of computer-based systems that demonstrate an understanding of tradeoffs involved in design choices.
(b) Analyze a problem, specify the requirements, design, implement, and evaluate a computer-based system, process, component, or program that satisfies the requirements.
(c) Apply design and development principles in the construction of software systems of varying complexity.
(d) Use current skills, techniques, and tools necessary for computing practice.
(e) Function effectively as a member of a team to accomplish a common goal.
(f) Understand professional, ethical, legal, social, and security issues and responsibilities; analyze the impact of computing on individuals, organizations, and society both locally and globally.
(g) Write effectively.
(h) Give effective oral presentations.
(i) Recognize the need for, and an ability to engage in, continuing professional development.

For each learning outcome (macro level), the faculty identified a set of measurable performance criteria (micro level) in related upper division core courses. Assignments, exam questions, etc. were developed to evaluate performance criteria. Outcomes (a) through (d) address the theoretical concepts, technical knowledge, and skills necessary for our B.S. graduates to be successful upon graduation. Outcomes (e) through (i) address non-technical characteristics or abilities the Department expect graduates to have, such as, effective oral and written communication skills, teamwork, and ethical, legal, and social and responsibilities. The assessment plan for student outcomes is provided in Table 2.

University Baccalaureate Learning Goals (BALGs)

The relationship between our program's student outcomes and the University's BALGs is represented in a matrix in Appendix A. This table indicates how well our outcomes match the BALGs.

Table 2. Three-Year Assessment Plan for Student Learning Outcomes

Year	Outcomes Assessed	Courses Assessed	Data Collected	Continuous Improvement
Year 1 (2012-2013)	(a) Application of fundamental knowledge	CSC 130, 133, 134, 135, 137, 138, and 139	Direct assessment in course embedded exam questions, assignments, and projects Supervisor evaluations	Close the loop. Review learning outcomes and performance criteria.
	(b) Computer system development cycle	CSC 131, 137, 138, 139, and 190/191		
	(c) Application of software development principles	CSC 131, 133, 138, and 190/191		
	(d) Skills and techniques for computing practice	CSC 133, 134, 135,137, and 139		
Year 2 (2013-2014)	(e) Team work	CSC 131 and 190/ 191	Instructor evaluation Student self-assessment and reflection	Implement faculty recommendations based on assessment of outcomes (a) through (d).
	(f) Professional and ethical issues and responsibilities	CSC 131, 138, 190/191, and 195/195A, and PHIL 103	Course embedded exam questions Student surveys Written essays Supervisor evaluations	
	(g) Written communication	CSC 131, 190/191, and 195/195A	Written reports Supervisor evaluations	
	(h) Oral Communication	CSC 131, 190/191, and 195/195A	Oral presentations Supervisor evaluations	
	(i) Life-long learning	CSC 192, 194, and 195/195A	Industry visits Reports Supervisor evaluations	
Year 3 (2014-2015)	Review of evaluation procedures and rubrics used for assessment of all outcomes (a) to (i).			Implement faculty recommendations based on assessment of outcomes (e) through (i).

ANNUAL ASSESSMENT REPORT RESPONSE

1. *As a result of last year's assessment effort, have you implemented* ***any changes for your assessment including learning outcomes, assessment plan, assessment tools (methods, rubrics, curriculum map, or key assignment etc.), and/or the university baccalaureate learning goals?*** Yes

   a. If so, what are those changes? How did you implement those changes?

   The changes implemented during this period are:

   - Plans for both program objectives and student outcomes were changed from a two-year to a three-year cycle.
   - Program objectives were reviewed and updated.
   - Performance criteria for learning outcomes were expanded and updated.

   Plans

   Based on recommendations from our accrediting body, ABET/CAC, the assessment plans for both objectives and outcomes were changed from a three-year to a two-year cycle in 2010-2011. After some thought, the Department concluded that a two-year cycle did not provide adequate time for reflection and review of the assessment results as well as for closing the loop. The Department decided to return to a three-year assessment cycle for both objectives and outcomes. This is well below the University's suggestion of no longer than a six-year assessment cycle. The revised assessment plans are provided in the Introduction.

   Review of Program Objectives

   In spring 2013, Industry Advisory Council (IAC) members were asked to rate six program objectives as Essential, Important, Desirable, and Not Relevant prior to the scheduled meeting on April 19, 2013. Members were also asked to provide additional objectives which they believe to be essential or important. Eleven (11) additional objectives were recommended. IAC members rated five out of the six objectives as essential or important. Objective 4 received four positive rating. Two members recommended and rated highly objective 7 which addressed objective 4. See Appendix B for the survey results. Discussion of the survey took place at the IAC meeting.

   On May 22, 2013, Computer Science faculty along with Ms. Cici Mattuizzi, Director, ECS Career Center, met with seven (7) alumni currently working as employees at Hewlett-Packard (HP) in Roseville. One purpose of this meeting was to solicit this group's input on the six program objectives. Two additional objectives were recommended, each receiving one vote. The results of this survey, provided in Appendix C, indicate that the alumni at HP unanimously rated all original six objectives as essential or important.

   The Department reviewed the input from our IAC and HP and broadened and changed program objectives 4 and 6 by incorporating recommended objectives 7 and 9, respectively, from the IAC response. Program objective 4 was changed from "Produce

quality technical and non-technical documents and presentations for a variety of audiences" to "Able to communicate ideas clearly and concisely in both verbal and written forms to both technical and non-technical audiences." Program objective 6 was changed from "Work independently and function in an environment with incomplete information." to "Work independently and function in an environment with incomplete and/or changing information and requirements."

The revised list of program objectives is provided in the Introduction.

Student Learning Outcomes and Performance Criteria

In the last two years, although no changes were made in student outcomes, the performance criteria for outcomes (a) to (d) were reviewed, expanded from 31 to 35, refined, and updated. The updated criteria for outcomes (a) to (d) are provided in the response to question 6 below.

b. How do you know if these changes have achieved the desired results?

The change from a two-year to a three-year assessment cycle is designed to balance our assessment efforts over a longer and more reasonable length of time. This change has already achieved the desired results of providing faculty with additional, needed time to conduct assessment.

Input from our industry representatives regarding program objectives is a requirement of our accreditation body ABET/CAC. The changes made in program objectives have clarified and broadened our objectives.

The expanded and updated list of performance criteria provides a more complete assessment of our learning outcomes as well as some flexibility and choice in the selection of criteria to evaluate for each assessment cycle.

c. If no, why not?

2. *As a result of last year's assessment effort, have you implemented* ***any other changes at the department, the college or the university, including advising, co-curriculum, budgeting and planning?***

No.

a. If so, what are those changes? How did you implement those changes?

b. How do you know if these changes have achieved the desired results?

c. If no, why not?

3. *What **PROGRAM** (not course) learning outcome(s) have you assessed this academic year?*

This academic year, the Department conducted the most comprehensive assessment of its core concepts to date. All faculty members teaching upper division core courses were involved in the direct evaluation of student performance in outcomes (a) through (d). These outcomes are:

At the time of graduation, a graduate will be able to:

(a) Apply fundamental knowledge of mathematics, algorithmic principles, computer theory, and principles of computing systems in the modeling and design of computer-based systems that demonstrate an understanding of tradeoffs involved in design choices.

(b) Analyze a problem, specify the requirements, design, implement, and evaluate a computer-based system, process, component, or program that satisfies the requirements.

(c) Apply design and development principles in the construction of software systems of varying complexity.

(d) Use current skills, techniques, and tools necessary for computing practice.

For each outcome, the department had defined a series of measurable performance criteria allowing the department to determine if an outcome has been satisfied.

4. *What method(s)/measure(s) have you used to collect the data?*

Performance criteria for the four outcomes were assessed using course embedded exam questions in midterms and final exams. Instructors for upper division core courses developed test questions and evaluated student responses. (In this way, assessment efforts are part of the normal responsibilities of faculty.) A total of 27 of 35 performance criteria for outcomes (a) through (d) were evaluated.

5. *What are the criteria and/or standards of performance for the program learning outcome?*

A criterion is defined as satisfied when at least 75% of the students are assessed by the faculty member teaching the core course as meeting that criterion. A learning outcome is defined as satisfied when the aggregate (average) score of all performance criteria evaluated for that outcome meets or exceeds the 75% minimum threshold.

6. *What data have you collected? What are the results and findings, including the percentage of students who meet each standard?*

The percentages of students satisfying criteria and the course enrollments are provided in Table 3. An aggregated percentage (averaged over all criteria evaluated) for each outcome is also provided.

The results are quite positive with aggregate scores for learning outcomes (a), (b), (c), and (d) of 79.5%, 75%, 80%, and 86%, respectively. Outcomes (a) to (d) met the minimum threshold of 75%. That is, at least 75% of the students satisfied the performance criteria associated with the four learning outcomes. The Department is pleased with the results.

Table 3. Assessment of Performance Criteria for Outcomes (a) – (d)

Outcome	Performance Criteria	Core Courses	% Satisfying Criteria (enrollment)
(a) Apply fundamental knowledge of mathematics, algorithmic principles, computer theory, and principles of computing systems in the modeling and design of computer-based systems that demonstrate an understanding of tradeoffs involved in design choices.	a-1. Understand fundamental algorithms and essential data structures.	CSC 130	90% (96)
	a-2. Understand trade-offs in the selection of algorithms and data structures.	CSC 130	60% (96)
	a-3. Understand and apply mathematical transformations and algorithms for 2D graphics.	CSC 133	
	a-4. Understand and use relational databases.	CSC 134	89% (58)
	a-5. Understand distinctive features of the design of programming languages.	CSC 135	97% (33)
	a-6. Demonstrate knowledge of abstract machines, languages, and grammars.	CSC 135	74% (33)
	a-7. Understand and apply the logic programming paradigm.	CSC 135	83% (33)
	a-8. Understand and apply the functional programming paradigm.	CSC 135	86% (33)
	a-9. Demonstrate the ability to calculate performance parameters, such as, circuit propagation delay, memory latency, speedup, etc.	CSC 137	80% (38)
	a-10. Understand network architecture, layered model, and protocol stacks.	CSC 138	70% (30)
	a-11. Demonstrate the working knowledge of network management including monitoring, measurement, analysis, and control.	CSC 138	69% (30)
	a-12. Understand principles of concurrency and tradeoffs in synchronization approaches, analysis, and control.	CSC 139	76% (48)
	a-13. Understand deadlocks and their solutions.	CSC 139	82% (48)
	a-14. Understand principles of resource management.	CSC 139	78% (48)
Average for Outcome (a)			79.5%

(b) Analyze a problem, specify the requirements, design, implement, and evaluate a computer-based system, process, component, or program that satisfies the requirements.	b-1. Understand and apply modeling and analysis techniques.	CSC 131, 190/191	
	b-2. Understand and apply requirements engineering process.	CSC 131, 190/191	
	b-3. Understand and apply design principles.	CSC 131*, 190/191	80% (60)*
	b-4. Understand and apply proper testing techniques	CSC 131*, 190/191	86% (60)*
	b-5. Understand and apply project management processes and tools.	CSC 131, 190/191	
	b-6. Demonstrate the ability to design and analyze basic and complex hardware components.	CSC 137	85% (38)
	b-7. Understand and apply error detection and correction, flow control, and congestion control principles.	CSC 138	50% (30)
	b-8. Understand and apply synchronization mechanisms to the critical section problem and to the process coordination.	CSC 139	75% (48)
Average for Outcome (b)			75%
(c) Apply design and development principles in the construction of software systems of varying complexity.	c-1. Understand and use software metrics.	CSC 131	
	c-2. Understand and use object-oriented design.	CSC 131, 133	75% (60)
	c-3. Understand and use design patterns.	CSC 133	90% (35)
	c-4. Understand and use verification and validation techniques.	CSC 131, 190/191	
	c-5. Understand and apply documentation standards.	CSC 131, 190/191	
	c-6. Understand and apply semi-formal modeling languages, such as, UML, in requirement specification and design.	CSC 190/191	
	c-7. Demonstrate the ability to develop communication protocols and networking applications.	CSC 138	64% (30)
Average for Outcome (c)			80%
(d) Use current skills, techniques, and tools necessary for computing practice.	d-1. Implement event-driven GUI applications.	CSC 133	84% (35)
	d-2. Demonstrate competence in using SQL.	CSC 134	86% (58)
	d-3. Demonstrate competence in programming in a variety of programming paradigms.	CSC 135	86% (33)
	d-4. Demonstrate competence in language scanning and parsing.	CSC 135	86% (33)
	d-5. Demonstrate the ability to use hardware design simulation tools.	CSC 137	79% (38)
	d-6. Demonstrate competence in system programming in Unix/Linux environments.	CSC 139	94% (48)
Average for Outcome (d)			86%

7. *As a result of this year's assessment effort, do you anticipate or propose any changes for your program (e.g. structures, content, or learning outcomes)?*

Although all outcomes assessed are satisfied, student performance in two courses, CSC 130 Data Structures and Algorithm Analysis (criterion a-2) and CSC 138 Computer Networks and Internets (criteria a-10, a-11, b-7, and c-7), are below standard and warrant further review to identify ways to improve student performance.

a. If so, what changes do you anticipate? How do you plan to implement those changes?

We plan to begin with a discussion by faculty members involved with these courses about why students performed at such a low level and what can be done to improve student learning.

b. How do you know if these changes will achieve the desired results?

We plan to re-assess criteria in CSC 130 and CSC 138 in 2013-2014 to determine if the changes recommended and implemented improve student performance.

8. *What program learning outcome(s) do you plan to assess next year? How?*

Next year, the Department plans to assess outcomes (e) through (i) according to our outcomes assessment plan (see Introduction).

Appendix A
Relationship Between CSC Student Outcomes and University BALGs

The relationship between the program nine (9) student learning outcomes and the University's BALG is reflected in the matrix below. Notably, each BALG is linked with one or more learning outcomes.

University BALG	Outcome (a)	Outcome (b)	Outcome (c)	Outcome (d)	Outcome (e)	Outcome (f)	Outcome (g)	Outcome (h)	Outcome (i)
1. Competence in Discipline	X	X	X	X					
2. Knowledge of Human Cultures & Physical & Natural Worlds	X								
3. Intellectual & Practical Skills	X	X	X	X	X		X	X	X
4. Personal & Social Responsibilities		X	X			X			
5. Integrative Learning		X	X	X	X				X

Student Learning Outcomes

Student learning outcomes are abilities a B.S. graduate from our program will possess at the time of graduation. A graduate is able to:

(a) Apply fundamental knowledge of mathematics, algorithmic principles, computer theory, and principles of computing systems in the modeling and design of computer-based systems that demonstrate an understanding of tradeoffs involved in design choices.
(b) Analyze a problem, specify the requirements, design, implement, and evaluate a computer-based system, process, component, or program that satisfies the requirements.
(c) Apply design and development principles in the construction of software systems of varying complexity.
(d) Use current skills, techniques, and tools necessary for computing practice.
(e) Function effectively as a member of a team to accomplish a common goal.
(f) Understand professional, ethical, legal, social, and security issues and responsibilities; analyze the impact of computing on individuals, organizations, and society both locally and globally.
(g) Write effectively.
(h) Give effective oral presentations.
(i) Recognize the need for, and an ability to engage in, continuing professional development

Appendix B
Results of Survey of Industry Advisory Council

Program Objectives for B.S. Graduates in Computer Science
California State University, Sacramento
Presented at April 19, 2013 Meeting

Number of respondents: 8

Ratings of the 10 characteristics listed below in terms of relative importance according to numerical score: 4 – Essential, 3 – Important, 2 – Desirable, or 1 – Not relevant.

Three to five years after graduation, a successful graduate from the computer science program will:	**Frequency of Score**			
	4	**3**	**2**	**1**
1. Make contributions to the development, maintenance, and support of real world computing systems.	7	0	1	0
2. Be an effective and contributing member of a project team, taking initiative and responsibilities.	7	1	0	0
3. Engage in professional development and maintain currency in the discipline.	4	2	2	0
4. Produce quality technical and non-technical documents and presentations for a variety of audiences.	1	3	3	0
5. Adhere to the ethical standards of the profession and understand the social and global implications of his/her professional activities.	4	2	2	0
6. Work independently and function in an environment with incomplete information.	6	0	2	0
Additional educational objectives which should also be included (please also rate their relative importance.)				
7. Able to communicate ideas clearly and concisely in both verbal and written forms to both technical and non-technical audiences. (Today, many of our meeting/team interactions are remote and done via tele-conference and using virtual classroom/desktop technologies. Inter-actions with non-technical users to gather requirements is common.)	2	0	0	0

Three to five years after graduation, a successful graduate from the computer science program will:	**Frequency of Score**			
	4	**3**	**2**	**1**
8. Ability to work in a culturally diverse environment with people around the world in different time zones.	0	1	0	0
9. Demonstrate flexibility and ability to 'go with the flow' as requirements and business or technology drivers can change mid-stream.	0	1	0	0
10. Be technical leaders.	0	1	0	0
11. Bring clarity to increasingly complex situations.	0	1	0	0
12. Take risks and accept failure as an opportunity to learn.	1	0	0	0
13. Have the ability to be creative and come up with innovative ideas/solutions. .	1	0	0	0
14. Have developed one or more specialties.	1	0	0	0
15. Have succeeded and advanced in professional careers in or related to computing or software.	1	0	0	0
16. Have the ability to take ownership of tasks and think of solutions holistically, including the support of hardware, software, maintenance cost, lifespan, expandability, performance, etc.	0	1	0	0
17. Be willing to take on any task, including business development, proposal writing, customer presentations, white papers, marketing presentations, etc.	0	1	0	0

Appendix C
Results of Survey of Program Objectives at Hewlett-Packard

Number of respondents: 7

Survey of Alumni and/or Managers
B.S. in Computer Science Program, CSUS

Name (optional) Alumni at Hewlett-Packard Date of Survey Completion May 22, 2013

Current Organization/Company (optional) _____

Alumnus (check one) Yes/No CSUS Degree _____

Year of Degree/Graduation _____

Manager (check one) Yes/No Degree _____

University (optional) _____

Please rate each of the 6 program educational objectives listed below in terms of relative importance by giving a numerical score:

4 – Essential, 3 – Important, 2 – Desirable, or 1 – Not relevant

Three to five years after graduation, a successful graduate from the computer science program will:	**Frequency of Score**			
	4	**3**	**2**	**1**
1. make contributions to the development, maintenance, and support of real world computing systems.	7	0	0	0
2. be an effective and contributing member of a project team, taking initiative and responsibilities.	5	2	0	0
3. engage in professional development and maintain currency in the discipline.	4	3	0	0
4. produce quality technical and non-technical documents and presentations for a variety of audiences.	5	2	0	0
5. adhere to the ethical standards of the profession and understand the social and global implications of his/her professional activities.	3	4	0	0
6. work independently and function in an environment with incomplete information.	7	0	0	0
Additional educational objectives which should also be included (please also rate their relative importance.)				
7. Ability to network (socially) to find right person for help.	1	0	0	0
8. Keep up to date with constantly changing standards in the area of industry or knowledge you are in.	1	0	0	0