SCHOOL OF COMPUTING & INFORMATION SCIENCES

Annual Assessment Summary 2015-2017
for the
Bachelor of Science in Computer Science

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Table of Contents

I. INTRODUCTION

This report is prepared in accordance with the intent of the Assessment Plan originally adopted by the School of Computing & Information Sciences (then the School of Computer Science) in spring 2003, and last version approved in spring 2015. Its purpose is to summarize the results of the various assessment mechanisms utilized by SCIS in support of the BS in Computer Science program, and to present the resulting findings and recommendations to the Undergraduate Committee, the Undergraduate Program Director, the Faculty of the School, and the Director.

Since the last Assessment cycle (Summer 2013 to Spring 2015), no modifications are made to the Assessment Mechanisms and Procedures.

The goals of the assessment process are to assess the extent to which the Student Outcomes and Program Educational Objectives of the BS in Computer Science program have been attained in the period under review, to identify specific areas of the program where a need for improvement is indicated, and to present a set of recommendations for achieving those improvements.

This review is conducted for the period from Summer 2015 to Spring 2017.

II. OVERVIEW

A. Terminology

The BS in Computer Science *Program Educational Objectives* (Appendix A-1) document describes the overriding goals of the program relating to the cumulative persistent effects of the students' educational experiences. The objectives are broad in nature and define expected general characteristics of the program's graduates within some years after graduation.

The BS in Computer Science *Student Outcomes* (Appendix A-2) are more specific in nature. These describe characteristics of students at the time of graduation, and define the specific knowledge, skills, and behaviors that they are expected to acquire as they complete the requirements of the program. Attainment of each Student Outcome enables the attainment of one or more of the Program Educational Objectives.

The program Educational Objectives were reorganized and the new set became effective in Fall 2015. The Student Outcomes were rewritten (mostly, reorganized) to match those prescribed by ABET, and the new ones became effective in Fall 2015. As these are being used for Assessment for the first time, therefore, in addition to including them in Appendices A-1 and A-2, they are reproduced below as Figure-1 and Figure-2 respectively.

Figure-1: Program Educational Objectives for the BS in CS Program

Graduates of the BS program in Computer Science or Information Technology will

1. Be successful in applying for entry level professional positions in computing-related fields, or for admission to graduate programs.

2. Be prepared for career accomplishment, responsibility and advancement in computing-related professions by virtue of having received in the BS program

    2.1. A high-quality technical education in computing,
    2.2. Communication and team-work skills,
    2.3. Awareness of the ethical and social responsibilities of their profession,
    2.4. An ability to engage in continued professional development activities.

Figure-2: Student Outcomes for BS in CS Program

Graduates of the BS program in Computer Science will attain, by the time of graduation

(a) An ability to apply knowledge of computing and mathematics appropriate to the program's student outcomes and to the discipline.

(b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.

(c) An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.

(d) An ability to function effectively on teams to accomplish a common goal.

(e) An understanding of professional, ethical, legal, security and social issues and responsibilities.

(f) An ability to communicate effectively with a range of audiences.

(g) An ability to analyze the local and global impact of computing on individuals, organizations, and society.

(h) Recognition of the need for and an ability to engage in continuing professional development.

(i) An ability to use current techniques, skills, and tools necessary for computing practice.

(j) An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.

(k) An ability to apply design and development principles in the construction of software systems of varying complexity.

The syllabus of each required and elective course of the BS in Computer Science program presents a set of *Course Outcomes*. The Course Outcomes identify specific knowledge units and levels of attainment (mastery, familiarity, awareness) expected of a student completing the course. Attainment by students of Course Outcome enables attainment of one or more of the Student Outcomes.

B. Assessment Mechanisms & Procedures

Consistent with current educational practice, SCIS follows a systematic process of collecting and utilizing data on the degree of attainment of the Student Outcomes and Program Educational Objectives. The *SCIS Assessment Plan* (Appendix B-1) specifies the participants and schedule for this process, and the means of evaluating the data and enacting program changes indicated by the evaluation. The *SCIS Assessment Mechanisms & Procedures* document (Appendix B-2) specifies the implementation of the Assessment Plan. The SCIS Assessment Plan and Assessment Procedures and Mechanisms were adopted in 2003, amended in 2010 to incorporate additional direct assessment measures, and last amended in spring 2015 to align better with our changed operations.

The following indirect assessment mechanisms have been employed in this assessment cycle:

Mechanism	**Target**	**Frequency**
Course Outcomes Survey by Students	Course Outcomes	Semester
Course Outcomes Survey by Instructors	Course Outcomes	Semester
Graduating Student (Exit) Survey	Student Outcomes	Semester
Alumni Survey	Program Educational Objectives	Continual
IAB Members and Employers Survey	Program Educational Objectives	Continual

The following direct assessment mechanisms have been employed since spring 2010:

Mechanism	**Target**	**Frequency**
Course Embedded Assessment	Course Outcomes and Student Outcomes	At least once in the Assessment Period
Capstone Project Assessment	Student Outcomes	Semester

Additional input is solicited and may be received from other program constituents including:

- ACM Student Chapter,
- Upsilon Pi Epsilon Honor Society Chapter,
- SCIS Women In Computer Science group,
- STARS Student Chapter,
- Programming Team, and
- SCIS Industry Advisory Board.

C. Process

The required and elective courses of the BS in Computer Science are each assigned, based on subject area, to one of six groups: Professional Development, Computer Organization, Computer Systems, Foundations, Programming, and Software Engineering.

Each subject area group is managed by a faculty Subject Area Coordinator (SAC). Periodically, the assessment data and comments from Student and Instructor Course Outcome Surveys are considered by the Subject Area Coordinators. These provide the information for the Subject Area Coordinators' reports.

The SAC reports and assessment data from all other sources are evaluated by the SCIS Assessments Coordinator whose evaluations and recommendations are presented in an assessment report.

The assessment report is considered by the SCIS Undergraduate Committee, and by the SCIS Undergraduate Program Director. The Undergraduate Committee's curricular recommendations are presented to the SCIS faculty for approval. Responsibility for enactment of approved recommendations rests with the SCIS Undergraduate Program Director.

III. DATA

A. Course Outcomes Survey by Students

This survey is completed by students in each section of a required or elective CS class. For each course outcome, the student states the extent to which (s)he agrees with the following two assertions:

1: *I believe that this is a valuable outcome for this course*, and
2: *The subject matter of this outcome was covered adequately in class*

To each assertion, the student responds on a 5-point scale as follows:

5: I agree strongly, 4: I agree moderately, 3: I am not sure, 2: I disagree moderately, 1: I disagree strongly

For each outcome, a weighted mean of the responses to each question is calculated. The means are provided for each course, cumulatively over all semesters of the period under review.

BS in Computer Science Required or Elective Course		# Responding	Value of Outcome	Coverage Adequacy
CAP 4710	Principles of Computer Graphics	8	4.20	3.48
CAP 4770	Introduction to Data Mining	49	4.59	4.32
CDA 3103	Fundamentals of Computer Systems	252	4.58	4.61
CDA 4101	Structured Computer Organization	180	4.63	4.52
CEN 4010	Software Engineering I	84	4.63	4.36
CEN 4021	Software Engineering II	10	4.60	4.40
CEN 4072	Software Testing	51	4.53	4.20
CEN 4083	Cloud Computing	6	4.88	4.75
CGS 1920	Introduction to Computing	1043	4.59	4.54
CGS 3095	Technology in the Global Arena	1596	4.72	4.78
CIS 4911	Senior Project	125	4.71	4.44
CNT 4713	Net-Centric Computing	154	4.62	4.36
COP 2210	Computer Programming I	337	4.42	4.18
COP 3337	Computer Programming II	368	4.55	4.30
COP 3530	Data Structures	260	4.75	4.59
COP 4226	Advanced Windows Programming	27	4.72	4.57
COP 4338	Computer Programming III	252	4.58	3.95
COP 4520	Introduction to Parallel Computing	10	4.88	4.88
COP 4521	Introduction to Comp. Geometry	2	5.00	4.73
COP 4534	Algorithm Techniques	39	4.52	4.01
COP 4555	Principles Programming Languages	133	4.55	4.52
COP 4604	Advanced Unix Programming	NOT	TAUGHT	
COP 4610	Operating Systems Principles	74	4.71	4.23
COP 4710	Database Management	119	4.70	4.55

COP 4722	Survey of Database Systems	107	4.55	4.38
COT 3541	Logic for Computer Science	151	4.59	4.46
MAD 2104	Discrete Mathematics			
MAD 3512	Theory of Algorithms			
		======	======	======
		5429	4.63	4.52

Table 1: Value & Adequacy of Coverage of Course Outcomes 05/15 – 04/17

Notes: (1) Unfortunately, data is not available for the reporting period for MAD 2104 and MAD 3512. These courses are taught by faculty of the Department of Mathematics and Statistics. Students in these sections complete the surveys on-line voluntarily, unlike students in most CS sections who do so in class. Note that in the next Assessment cycle, MAD 2104 will be replaced by our own COT 3100, and we will have data available for that course. (2) *The overall scores for Value of Outcomes (4.63) and Coverage Adequacy (4.52) are essentially the same as found in the last Assessment Report (4.59 and 4.42 respectively).* (3) COP 4604 was not taught during the period of this assessment.

The semester data for each course are presented here grouped under the six subject areas. The Subject Area Coordinator (SAC) reports are included in Appendix C.

Subject Area: Professional Development (SAC: Caryl Rahn)

CGS 1920 Introduction to Computing
CGS 3095 Technology in the Global Arena
ENC 3249 Professional and Technical Writing for CS (Taught by English Department)

CGS 1920 -- Introduction to Computing

	# Responding	Value of Outcome	Coverage Adequacy
FALL 2015	840	4.59	4.55
SPR 2016	63	4.66	4.52
FALL 2016	77	4.55	4.40
SPR 2017	63	4.65	4.62
	=======	=======	=======
	1043	4.59	4.54

Table 2-CGS 1920: Student Rating of Course Outcomes

CGS 3095 -- Prof. Ethics & Social Issues in Computing

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	408	4.62	4.63
FALL 2015	568	4.66	4.66
SPR 2016	184	4.91	4.91

SUM 2016	235	4.82	4.72
FALL 2016	128	4.91	4.91
SPR 2017	73	4.65	4.62
	=======	=======	=======
	1596	4.72	4.78

Table 2-CGS 3095: Student Rating of Course Outcomes

Subject Area: Computer Organization (SAC: Nagarajan Prabakar)

CDA 3103 Fundamentals of Computer Systems
CDA 4101 Structured Computer Organization
CNT 4713 Net-centric Computing
COP 4610 Operating Systems Principles

CDA 3103 -- Fundamentals of Computer Systems

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	25	4.66	4.63
FALL 2015	74	4.62	4.62
SPR 2016	68	4.43	4.55
SUM 2016	2	5.00	5.00
FALL 2016	71	4.60	4.64
SPR 2017	12	7.73	4.61
	=======	=======	=======
	252	4.58	4.61

Table 2-CDA 3103: Student Rating of Course Outcomes

CDA 4101 -- Structured Computer Organization

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	7	4.51	4.06
FALL 2015	42	4.54	4.52
SPR 2016	45	4.74	4.63
SUM 2016	18	4.53	4.30
FALL 2016	60	4.67	4.58
SPR 2017	8	4.57	4.43
	=======	=======	=======
	180	4.63	4.52

Table 2-CDA 4101: Student Rating of Course Outcomes

CNT 4713 – Net-Centric Computing

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	11	4.53	4.51

FALL 2015	26	4.78	4.61
SPR 2016	43	4.56	4.22
SUM 2016	10	4.74	4.60
FALL 2016	35	4.76	4.56
SPR 2017	29	4.40	3.98
	=======	=======	=======
	154	4.62	4.36

Table 2-CNT 4713: Student Rating of Course Outcomes

COP 4610 -- Operating Systems Principle

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	20	4.77	3.93
FALL 2015	8	4.68	4.85
SPR 2016	14	4.70	4.57
SUM 2016	3	5.00	3.67
FALL 2016	23	4.70	4.12
SPR 2017	6	4.47	4.30
	=======	=======	=======
	74	4.71	4.23

Table 2-COP 4610: Student Rating of Course Outcomes

Subject Area: Computer Systems (SAC: Shu-Ching Chen)

CAP 4641 Natural Language Processing [NEW]
CAP 4710 Principles of Computer Graphics
CAP 4770 Introduction to Data Mining
CDA 4625 Introduction to Mobile Robotics [NEW]
CEN 4083 Cloud Computing
COP 4604 Advanced UNIX Programming
COP 4710 Database Management systems
COP 4722 Survey of Database Systems

CAP 4710 – Principles of Computer Graphics

	# Responding	Value of Outcome	Coverage Adequacy
SPR 2016	7	4.30	3.64
SPR 2017	1	3.50	2.38
	=======	=======	=======
	8	4.20	3.48

Table 2-CAP 4710: Student Rating of Course Outcomes

CAP 4770 -- Principles of Data Mining

	# Responding	Value of Outcome	Coverage Adequacy
FALL 2015	16	4.74	4.71
SPR 2016	6	4.31	3.71
FALL 2016	22	4.63	4.21
SPR 201T	5	4.30	4.30
	49	4.59	4.32

Table 2-CAP 4770: Student Rating of Course Outcomes

CEN 4083 – Cloud Computing

	# Responding	Value of Outcome	Coverage Adequacy
FALL 2016	6	4.88	4.75
	6	4.88	4.75

Table 2-CEN 4083: Student Rating of Course Outcomes

COP 4604 -- Advanced UNIX Programming

	# Responding	Value of Outcome	Coverage Adequacy
NOT AVAILABLE			

Table 2-COP 4604: Student Rating of Course Outcomes

COP 4710 -- Database Management Systems

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	7	4.35	4.35
FALL 2015	4	5.00	5.00
FALL 2015	24	4.77	4.55
FALL 2015	5	4.97	3.71
SPR 2016	16	4.75	4.69
SPR 2016	7	4.90	4.92
SUM 2016	3	4.10	3.90
FALL 2016	6	4.81	4.80
FALL 2016	22	4.62	4.64
FALL 2016	11	4.56	4.46
SPR 2017	7	4.92	4.92
SPR 2017	7	4.57	4.04

	119	4.70	4

Table 2-COP 4710: Student Rating of Course Outcomes

COP 4722 -- Survey of Database Systems

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	10	4.66	4.38
SUM 2015	22	4.37	4.31
SUM 2015	6	4.62	4.41
SPR 2016	9	4.51	4.50
SPR 2016	15	4.49	4.30
SUM 2016	12	4.55	4.43
FALL 2016	3	4.73	4.00
FALL 2016	18	4.76	4.50
SPR 2017	6	4.37	4.55
SPR 2017	3	4.60	4.40
SPR 2017	3	4.60	4.13
	=======	=======	=======
	107	4.55	4.38

Table 2-COP 4722: Student Rating of Course Outcomes

Subject Area: Foundations (SAC: Xudong He)

CAP 4506 Introduction to Game Theory [NEW]
COP 4534 Algorithm Techniques
COP 4555 Principles of Programming Languages
COT 3100 Discrete Structures [NEW]
COT 3541 Logic for Computer Science
COT 4521 Introduction to Computational Geometry
MAD 2104 Discrete Mathematics (No data is available)
MAD 3512 Introduction to Theory of Algorithms (No data is available)
Set 2 (Math) Electives (**MAD 3305**, **MAD 3402**, **MAD 4203**, **MHF 4302**)

COP 4534 – Algorithm Techniques

	# Responding	Value of Outcome	Coverage Adequacy
FALL 2015	9	4.37	3.42
SPR 2016	10	4.80	4.80
FALL 2016	12	4.19	3.43
SPR 2017	8	4.83	4.54
	=======	=======	=======
	39	4.52	4.01

Table 2-COP 4534: Student Rating of Course Outcomes

COP 4555 -- Principles of Programming Languages

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	6	4.42	4.91
FALL 2015	19	4.65	4.69
FALL 2015	16	4.66	4.80
SPR 2016	14	4.06	3.14
SPR 2016	20	4.70	4.69
SUM 2016	18	4.51	4.59
FALL 2016	18	4.56	4.62
FALL 2016	13	4.64	4.83
SPR 2017	5	4.47	4.47
SPR 2017	2	4.75	4.00
SPR 2017	2	4.50	4.67
	=======	=======	=======
	133	4.55	4.52

Table 2-COP 4555: Student Rating of Course Outcomes

COT 3541 -- Logic for Computer Science

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	22	4.59	4.69
SUM 2015	13	4.79	4.63
SUM 2015	6	4.96	5.00
SPR 2016	20	4.75	4.72
SPR 2016	23	4.39	4.02
FALL 2016	25	4.61	4.52
FALL 2016	3	4.33	4.17
FALL 2016	23	4.73	4.74
FALL 2016	11	4.05	3.11
SPR 2017	4	5.00	5.00
SPR 2017	1	3.25	4.25
	=======	=======	=======
	151	4.59	4.46

Table 2-COT 3541: Student Rating of Course Outcomes

COP 4521 – Introduction to Computational Geometry

	# Responding	Value of Outcome	Coverage Adequacy
FALL 2015	2	5.00	4.73
	=======	=======	=======
	2	5.00	4.73

Table 2-COP 4521: Student Rating of Course Outcomes

Set 2 (Math) Electives
MAD 3305 Graph Theory
MAD 3402 Numerical analysis
MAD 4203 Introduction to Combinatorics
MHF 4302 Mathematical Logic

The Set 2 Elective courses are taught by faculty of the Mathematics Department. There are no assessment data for these courses.

Subject Area: Programming (SAC: Tim Downey)

COP 2210 Computer Programming I
COP 3337 Computer Programming II
COP 3530 Data Structures
COP 4226 Advanced Windows Programming
COP 4338 Computer Programming III
COP 4520 Introduction to Parallel Computing

COP 2210 – Computer programming I

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	42	4.47	4.29
FALL 2015	72	4.34	3.86
SPR 2016	100	4.45	4.17
FALL 2016	123	4.42	4.35
	=======	=======	=======
	337	4.42	4.18

Table 2-COP 2210: Student Rating of Course Outcomes

COP 3337 -- Computer Programming II

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	34	4.59	4.04
FALL 2015	114	4.71	4.56
SPR 2016	90	4.37	4.13
SUM 2016	15	4.49	4.37
FALL 2016	106	4.51	4.26
SPR 2017	9	4.76	4.21
	=======	=======	=======
	368	4.55	4.30

Table 2-COP 3337: Student Rating of Course Outcomes

COP 3530 -- Data Structures

	#	Value of	Coverage

	Responding	Outcome	Adequacy
SUM 2015	27	4.80	4.45
FALL 2015	81	4.74	4.61
SPR 2016	65	4.74	4.65
SUM 2016	22	4.89	4.60
FALL 2016	58	4.70	4.56
SPR 2017	7	4.61	4.38
	=======	=======	=======
	260	4.75	4.59

Table 2-COP 3530: Student Rating of Course Outcomes

COP 4226 -- Advanced Windows Programming

	# Responding	Value of Outcome	Coverage Adequacy
FALL 2015	13	4.69	4.35
FALL 2016	14	4.74	4.77
	=======	=======	=======
	27	4.72	4.57

Table 2-COP 4226: Student Rating of Course Outcomes

COP 4338 -- Computer Programming III

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	13	4.78	4.82
FALL 2015	55	4.63	3.77
SPR 2016	87	4.46	3.60
SUM 2016	16	4.71	4.29
FALL 2016	70	4.58	4.27
SPR 2017	11	4.96	4.14
	=======	=======	=======
	252	4.58	3.95

Table 2-COP 4338: Student Rating of Course Outcomes

COP 4520 -- Introduction to Parallel Computing

	# Responding	Value of Outcome	Coverage Adequacy
SPR 2016	10	4.88	4.88
	=======	=======	=======
	10	4.88	4.88

Table 2-COP 4520: Student Rating of Course Outcomes

Subject Area: Software Engineering (SAC: Monique Ross)

CEN 4010 Software Engineering I
CEN 4021 Software Engineering II
CEN 4072 Software Testing
CIS 4911 Senior Project
IDS 4918 VIP Program – C [NEW]

CEN 4010 -- Software Engineering I

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	18	4.40	4.34
FALL 2015	26	4.63	4.40
SPR 2016	23	4.77	4.34
SUM 2016	3	5.00	4.46
FALL 2016	9	4.49	4.01
SPR 2017	5	4.80	4.85
	=======	=======	=======
	84	4.63	4.36

Table 2-CEN 4010: Student Rating of Course Outcomes

CEN 4021 -- Software Engineering II

	# Responding	Value of Outcome	Coverage Adequacy
FALL 2015	5	4.80	4.50
FALL 2016	4	4.25	4.25
SPR 2017	1	5.00	4.50
	=======	=======	=======
	10	4.60	4.40

Table 2-CEN 4021: Student Rating of Course Outcomes

CEN 4072 -- Software Testing

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	8	4.55	3.82
FALL 2015	18	4.46	4.18
SPR 2016	4	4.75	4.64
SUM 2016	5	4.29	3.77
FALL 2016	14	4.74	4.69
SPR 2017	2	3.86	2.64

	=======	=======	=======
	51	4.53	4.20

Table 2-CEN 4072: Student Rating of Course Outcomes

CIS 4911 -- Senior Project

	# Responding	Value of Outcome	Coverage Adequacy
SUM 2015	1	5.00	5.00
FALL 2015	32	4.58	4.33
SPR 2016	26	4.69	4.41
SUM 2016	14	4.99	4.84
FALL 2016	26	4.66	4.35
SPR 2017	26	4.77	4.47
	=======	=======	=======
	125	4.71	4.44

Table 2-CIS 4911: Student Rating of Course Outcomes

B. Course Outcomes Survey by Instructors

This survey, called the Instructor Course Appraisal (ICA), is completed by each instructor of a required or elective CS course section.

- The Instructor separately rates the individual course outcomes in respect of two criteria
  Appropriateness: *Essential* *Very Appropriate* *Appropriate* *Inappropriate*
  Coverage: *Extensive* *Adequate* *Not Enough* *Not At All*
- The Instructor separately rates the course prerequisites in respect of two criteria
  Relevance: *Irrelevant* *Incidental* *Useful* *Highly Useful*
  Student Mastery: *Good* *Adequate* *Deficient* *Non-existent*
- The Instructor rates the students' overall preparation for taking the course
  Student Preparation: *Good* *Adequate* *Deficient* *Non-existent*
- In addition, the Instructor may append general comments and suggestions specific to each course prerequisite or outcome.

These responses, comments and suggestions from the ICAs, together with the data from the Student Course Outcomes surveys (see **Table 1**), form the basis of the Subject Area Coordinators' reports. The summaries included in this section are mostly based on these SAC reports, with occasional augmentation directly from the ICAs. As noted in the preceding section, the complete SAC reports from which these observations are taken are included in Appendix C.
Note: The data here are qualitative; no numeric scores are assigned to responses.

Subject Area: Professional Development (SAC: Caryl Rahn)

CGS1920 Introduction to Computing

- More than half of the students in this course are not pursuing SCIS degrees (97% FA15, 89% SP16, 100% FA16, and 100% SP17), and view the outcome: "Be familiar with the scope of degree programs in the computing field" very favorably.
- The majority of the student comments were very positive and appear to have found this course valuable for their future college experience and future jobs.
- A small minority of the students felt that they wanted more of an introduction to coding, but this would be covered in a different class.

CGS 3095 Technology in the Global Arena

- A minority of SCIS students objected to the course and felt its position in their major was not adequately justified.
- The majority of the students strongly felt the course was beneficial.
- A few students felt that there were too many assignments and activities.
- A few students commented that a text was needed.

ENC 3249 Professional and Technical Writing

- There was no CES Assessment data for this course – the course is taught by the English department.
- Since technical writing is required in the CGS 3095 course, and since the research paper requirement was well received by the students in that course, it appears that the outcomes of ENC 3249 were adequately met from the students' perspective.
- However, CGS 3095 instructors were surveyed each term regarding prerequisites. Their assessment was that although ENC 3213 Professional and Technical Writing was highly useful to useful, students were deficient to adequate in writing skills.

Subject Area: Computer Organization (SAC: Nagarajan Prabakar)

CDA 3103 Fundamentals of Computer Systems

- For all five outcomes of the course, most of the students (more than 80%) agree either strongly or moderately.
- There is no significant concern expressed in the Students Suggestions section.

CDA 4101 Structured Computer Organization

- For all five outcomes of the course, most of the students (more than 80%) agree either strongly or moderately.
- There is no significant concern expressed by the students or faculty.

CNT 4713 Net-centric Computing

- For all seven outcomes of the course, most of the students (more than 80%) agree either strongly or moderately.
- There is no significant concern expressed by the students or faculty.

COP 4610 Operating Systems Principles

- For all five outcomes of the course, most of the students (more than 80%) agree either strongly or moderately.
- There is no significant concern expressed by the students or faculty.

Subject Area: Computer Systems (SAC: Shu-Ching Chen)

CAP 4710 Principles of Computer Graphics
- *Summary of Assessment: This course has eight outcomes. No assessment is possible as the instructor did not submit the course appraisals.*

CAP 4770 Principles of Data Mining
- *Summary of Assessment: This course has six outcomes, all of which have been indicated by the instructors as either essential or appropriate.*

CDA 4625 Introduction to Mobile Robotics
- *Summary of Assessment: This course has no outcomes set up yet.*

CDA 4641 Introduction to Natural Language Processing
- *Summary of Assessment: This course has four outcomes, all of which have been indicated by the instructors as essential.*

CEN 4083 Cloud Computing
- *Summary of Assessment: This course has four outcomes. No assessment is possible as the instructor did not submit the course appraisals.*

COP 4604 Advanced UNIX Programming
- *Summary of Assessment: It is not available. No outcomes are specified.*

COP 4710 Database Management systems
- *Summary of Assessment: This course has seven outcomes, all of which have been indicated by the instructors as either essential or appropriate.*

COP 4722 Survey of Database Systems
- *Summary of Assessment: This course has five outcomes, all of which have been indicated by the instructors as either essential or appropriate. However, the objective "Object-Oriented Database" and "Spatial and Multimedia Databases" has once been indicated as inappropriate by the instructor.*

Subject Area: Foundations (SAC Xudong He)

COP 4534 Algorithm Techniques
- The overall student evaluations were between good and very good. Comments for an instructor's teaching included structuring the course contents based on the textbook, and assigning homework to help understanding and exams, and for another instructor, the student rated both the course and professor, excellent.

- Student comments for one instructor's teaching included following textbook more closely, and providing additional resources (references) for contents not covered in the textbook.
- Students' preparation for this course ranges from deficient (Spring 16 and Fall 16) to adequate (Fall 15 and Spring 2017). One instructor commented to have basic calculus and combinatorics, linear algebra, probability, and discrete math as prerequisites.

COP 4555 Principles of Programming Languages

- The overall student evaluations were very good. Comments with one instructor's teaching included providing more examples, using a different functional programming language, adding a TA, and requiring Algorithm Techniques as a prerequisite. Comments with the second instructor included using online homework submission, giving simpler problems to solve and additional ungraded homework, using a textbook, and using quizzes. Comments with the third instructor's teaching included a very interesting and great course, well formatted and comprehensive and detailed class notes. Comments with the fourth instructor's teaching were quite negative, including more preparations in teaching the course. Comments with the fifth instructor's teaching included doing more in-class practices, and requiring graded homework assignments.
- Some student suggestions included using a different language instead of F#, providing more practice problems for F#, using smaller and more homework assignments, and practicing questions for exams.
- Students' preparation for this course ranges from deficient (Summer 15, Spring 17), adequate (Summer 16, Fall 15, Spring 16, Spring 16, Fall 16), to good (Fall 15, Fall 16, Spring 17). One instructor commented on there were two groups of students – one group doing very well and the other did badly. It was not clear whether there would be a solution to this. He was concerned about the class attendance around 50%, liked the idea of developing a lot of on-line quizzes for student to practice, and noted the positive effect of grading based on effort. He was unhappy about the student quality and effort in Spring 2017 class. Another instructor commented that the students in summer 2015 were deficient and only one 'A' range grade was given in a class of 11 students. Using quizzes helped students to better learn concepts; however the homework assignments did not help students to understand recursion much since many students just using existing solutions. Overall students performed better in summer 2016.

COT 3541 Logic for Computer Science

- Overall the evaluations are excellent. Comments with one instructor's teaching were very positive and several students mentioned him as an excellent professor. Some suggestions included more practice problems, more sample problems with solutions, more programming assignments, more projects, more time for assignments, and better homework for exam reviews. Some student mentioned significant overlap between this course and the discrete math course (a prerequisite).
- Comments with the second instructor's teaching were requiring homework assignments, using less complicated examples, providing more in depth explanations, and using a good textbook.
- Comments with the third instructor's teaching were needing a textbook, providing more homework assignments, having more consistent grading, and providing quicker responses to emails.

- One instructor commented that this course has effectively challenged students to think and informed students about the wide applicability of logic in many computer science areas; and he put much effort in applying the theory to formally solve problems in Prolog.
- Two instructors noted that the students did not have adequate preparation.

COT 4521 Introduction to Computational Geometry
- The overall student evaluations were excellent, though the sample was really small. The only comment with the instructor's teaching was to use less power points and providing more compact lectures.
- The instructor commented to require data structure and linear algebra as prerequisites, and to use term projects related to real applications.

MAD 2104 Discrete Mathematics
- *…there are no instructor appraisals*

MAD 3512 Theory of Algorithms
- *…there are no instructor appraisals*

Set 2 (Math) Electives (**MAD 3305**, **MAD 3402**, **MAD 4203**, **MHF 4302**)
- *(Assessments Coordinator :) These courses are taught by the Math department faculty and consequently are not subject to the School's assessment mechanisms.*

Subject Area: Programming (SAC: Tim Downey)

COP 2210 Computer Programming I
- For the outcomes of the course, most of the students (more than 80%) agree either strongly or moderately.
- The exception was in Fall 2015 when a flipped classroom was tried. The coverage was only rated at 73%.

COP 3337 Computer Programming II
- For the outcomes of the course, most of the students (more than 80%) agree either strongly or moderately.
- The exceptions were in Summer 2015 and Spring 2016, when coverage was only rated at 77% and 75%.
- There is no apparent reason for the lack of coverage.

COP 3530 Data Structures
- For the outcomes of the course, most of the students (more than 80%) agree either strongly or moderately.
- There is no significant concern expressed in the Students Suggestions section.

COP 4226 Advanced Windows Programming
- For the outcomes of the course, most of the students (more than 80%) agree either strongly or moderately.

- There is no significant concern expressed in the Students Suggestions section.

COP 4338 Computer Programming III

- For the outcomes of the course, most of the students (more than 80%) agree either strongly or moderately.
- The exceptions were in Fall 2015, Spring 2016 and Fall 2016, when coverage was only rated at 68%, 60% and 75%.
- Many students commented on an outdated book.

COP 4520 Introduction to Parallel Computing

- For the outcomes of the course, most of the students (more than 80%) agree either strongly or moderately.
- There is no significant concern expressed in the Students Suggestions section.

Subject Area: Software Engineering (SAC: Monique Ross)

CEN 4010 Software Engineering I

- This course was taught in every semester during the past two years. According to all the instructors of this course, the relevancy of the prerequisites was rated from useful to highly useful and mastery of the students was rated from adequate to good.
- Students' preparedness was indicated as deficient, good, or adequate.

Instructors' comments:
General:

- Team work continues to be a challenge for faculty – evaluation of individual contributions and navigating challenges of collaborative work
- Uniformity with regards to programming skill set

Prerequisites:

- There are concerns about the assessment tool not adequately reflecting all of the prerequisites for the course namely, COP4710, (CGS 3092 or CGS 3095)
- Faculty suggest the re-evaluation of the necessity of CNT4713 being a co-requisite to the course

Students' comments:
Regarding the homework assignments and exams:

- More in-class examples
- Students express concern over the workload – normal course load (e.g., reading, homework, exams) compounded by semester-long project

Regarding the syllabus and textbook:

- The text is seldom used
- Concerns regarding alignment between priorities in the class and grade distribution (i.e., working product is emphasized but only weighted as 20% of the course)

Regarding the prerequisites:

- Express concerns over preparedness; pre-requisites are not aligned with the expectations of the course (i.e., class project requiring web development knowledge)

Regarding the lectures:

- Would like more opportunities to practice the material presented in class (i.e., time in-class to work in teams on content presented in class)

Regarding the projects:

- More in-class group time
- Appreciate the practical nature of the course
- Would like more exposure to SCRUM or other agile methods

CEN 4021 Software Engineering II

- This course was taught three times the past two years. However, there were no assessments on file for this course.

CEN 4072 Software Testing

- This course was taught six times during the past two years. According to the instructor of this course, the relevancy of the prerequisites was rated as useful and the mastery of the students was rated as good.
- Students' preparedness was indicated as adequate.

Instructors' comments:

- The debugging topic needs to be removed from the list of objectives since there is not enough time to cover this topic. An updated syllabus was submitted to the undergraduate committee for review.
- The course should include testing mobile applications using automated tools in the near future.
- Students are lacking knowledge of some mathematical concepts that helps with test generation. For example, equivalent classes.

Students' comments:

Regarding the homework assignments and exams:

- Students lacked an understanding of the importance of documentation associated with testing design

Regarding the syllabus and textbook:

- Students noted lack of support resources for tools leveraged in the course
- Students request additional software testing course to cover additional material in this domain

Regarding the prerequisites:

- Students expressed concern regarding Software Engineering not being a prerequisite for this course. It was articulated that some of the skills acquired in software engineering are critical to success in this course

Regarding the lectures:

- Students indicated they would have appreciated more in-class time to practice concepts presented in the class where they could get feedback

Regarding the projects:

- Students were not able to make explicit connections between course content and project required in the course
- Students requested access and exposure to more updated testing tools

CIS 4911 Senior Project

- This course was taught six times during the past two years. According to the instructor of this course, the relevancy of the prerequisites was rated from useful to highly useful and mastery of the students was rated from deficient to adequate.
- Students' preparedness was indicated from deficient to adequate.

Instructors' comments:

- Many students lack the knowledge and application of software engineering, especially how to use UML diagrams properly.
- We practice Scrum, a popular agile software development approach, in our senior project, which is not being taught in CEN 4010. So, our students do not know how to develop software using this new agile method.

Students' comments:

Preparation and Prerequisites:

- Students suggest that more application development courses be offered (even as electives) prior to completion of senior project. Overwhelmingly, the comments reflect the sentiment that they feel woefully underprepared for large scale application development prior to this course (i.e., web application or mobile application development).
- Students expressed the necessity of a software engineering course that directly aligns with senior project (i.e., if Agile is the expectation in senior project, then agile should be the process utilized in Software Engineering I)

Software Development Process:

- Students request that SCRUM be either incorporated in Software Engineering I or at least be reviewed in Senior Project

Projects and Deliverables:

- Students suggest more frequent feedback on deliverables to ensure they are meeting course expectations

IDS 4918 VIP Program

- There are no assessments or course evaluations for this course at this time.

C. Graduating Student (Exit) Survey of Student Outcomes

The Student Outcomes Survey is completed by students in the semester in which they expect to graduate. The student rates each outcome with respect to two criteria, attainment and relevance.

Attainment: *This program outcome has been met for me personally*

5: I agree strongly	*2: I disagree somewhat*
4: I agree moderately	*1: I disagree moderately*
3: I agree somewhat	*0: I disagree strongly*

Relevance: *How meaningful do you consider this outcome to be for you personally?*

5: Extremely meaningful	*2: Somewhat meaningless*
4: Moderately meaningful	*1: Moderately meaningless*
3: Somewhat meaningful	*0: Extremely meaningless*

Please note that as we could not change this survey until Fall 2017 (after the last ABET six-year-Evaluation year, 2016-2017), the data collected is for the questionnaire matching the pre-Fall 2015 Student Outcomes. The mapping matrix between the two sets of Student Outcomes is given below as Figure-3.

Figure-3:

Mapping between Pre-Fall 2015 and Beginning-in-Fall-2015 Student Outcomes

Mapping Between Pre-Fall-2015 and Beginning-in-Fall-2015 Student Outcomes									
	Pre-Fall 2015 Student Outcomes								
	Outcome (a)	Outcome (b)	Outcome (c)	Outcome (d)	Outcome (e)	Outcome (f)	Outcome (g)	Outcome (h)	
Beginning-in-Fall-2015 Student Outcomes									**Pre-Fall-2015 Student Outcomes**
a) Ability to apply knowledge of Computing and Mathematics	X								*a)* Demonstrate proficiency in the foundation areas of Computer Science - discrete structures, logic, algorithms.
b) Ability to analyze a problem, and define its computing requirements		X	X						*b)* Demonstrate proficiency in various areas of CS including data structures, programming languages and computer systems.
c) Ability to design, implement, and evaluate a computer-based system	X	X	X	X					*c)* Demonstrate proficiency in problem solving and application of software engineering techniques.
d) Ability to function effectively on teams						X			*d)* Demonstrate mastery of at least one modern programming language and proficiency in at least one other.
e) Understanding of professional, ethical, legal, security, and social issues					X				*e)* Demonstrate understanding of the social and ethical concerns of the practicing computer scientist.
f) Ability to communicate effectively							X		*f)* Demonstrate the ability to work cooperatively in teams.
g) Ability to analyze local and global impact of computing					X				*g)* Demonstrate effective communication skills.
h) Recognizing the need to engage in continuing professional development					X			X	*h)* Have experience with contemporary environments and tools necessary for the practice of computing
i) Ability to use current techniques, skills, and tools necessary for computing practice		X	X					X	
j) Ability to apply mathematical foundations of computing in designing computer-based systems	X		X						
k) Ability to apply software engineeringt principles to develop software			X						

Data was collected (number of responses is in parenthesis) for Summer 2015 (26), Fall 2015 (33), Spring 2016 (33), Fall 2016 (21), and Spring 2017 (14) for a total of 127 responses during the period of this Assessment. Raw data and calculation of statistics for each semester is presented in Appendix D-1. The summary of the whole is presented in Appendix D-2.

The following table summarizes the responses of 127 graduating students completing the survey between summer 2015 and spring 2017. The mean responses are expressed as percentages of 5, the maximum rating.

Exit Survey (Graduating Students) 127 Respondents	*Outcome Attainment*		*Perceived Relevance*	
Student Outcomes	*Mean*	*Percentage*	*Mean*	*Percentage*
a: Proficiency in foundation areas	4.56	91.2	4.54	90.8
b: Proficiency in core areas	4.49	89.8	4.74	94.8
c: Proficiency in problem solving	4.40	88.0	4.75	95.0
d: Proficiency in a programming language	4.48	89.6	4.78	95.6
e: Understanding of social & ethical issues	4.17	83.4	4.18	83.6
f: Ability to work cooperatively in teams	4.35	87.0	4.63	92.6
g: Effective communication skills	4.22	84.4	4.58	91.6
h: Experience with contemporary environments & tools	4.03	80.6	4.62	92.4
	====	====	====	====
Average Ratings of Student Outcomes	4.34	86.8	4.60	92.0
	====	====	====	====
Overall Satisfaction for CS Areas, Outcomes 'a' to 'e':	4.42	88.4	4.60	92.0

Table 3: Exit Survey of Attainment & Relevance of Student Outcomes

The Average Rating Scores of Student Outcomes with respect to attainment (4.34) and perceived relevance (4.60) are almost identical to those found in the previous Assessment cycle (4.34 and 4.61 respectively).

D. Alumni Survey of Program Educational Objectives

Alumni responding to the survey are asked to rate the contribution of their broad educational experience at FIU to their personal growth, capacity for life-long learning, communication skills, social and ethical awareness, career preparation, and preparation for graduate study. They rate their preparation in the major areas of the BS-CS curriculum. The respondents also provide "overall" ratings of their FIU educational experience and the student's preparation at graduation. Finally, the alumni provide a rating of their overall satisfaction with the BS in CS program.

Responses to the survey questions are on a the following scale

4: Excellent, 3: Good, 2: Satisfactory, 1: Poor and 0: Unsatisfactory

Please note that as we could not change this survey until Fall 2017 (after the last ABET six-year-Evaluation year, 2016-2017), the data collected is for the questionnaire matching the pre-Fall 2015 Program Objectives. The mapping matrix between the two sets of Student Outcomes is given below as Figure-4.

Figure-4:

Mapping between Pre-Fall 2015 and Beginning-in-Fall-2015 Program Objectives

	Beginning in Fall 2015 - Program Objectives					
Pre-Fall 2015 Program Objectives	**1**	**2.1**	**2.2**	**2.3**	**2.4**	**Beginning in Fall 2015 - Program Objectives**
1. To provide our graduates with a broad-based education that will form the basis for personal growth and life-long learning.					X	1. Be successful in applying for entry level professional positions in computing-related fields, or for admission to graduate programs.
2. To provide our graduates with a quality technical education that will equip them for productive careers in the field of Computer Science.		X				2. Be prepared for career accomplishment, responsibility and advancement in computing-related professions by virtue of having received
3. To provide our graduates with the communication skills and social and ethical awareness requisite for the effective and responsible practice of their professions.			X	X		2.1 A high-quality technical education in computing,
4. To prepare students for BS level careers or continued graduate education.	X					2.2. Communication and team-work skills,
						2.3 Awareness of the ethical and social responsibilities of their profession,
						2.4 An ability to engage in continued professional development activities.

The table below summarizes the responses to this survey. The means for the current survey cycle, 4/19/2017 through 10/30/2017 are compared with corresponding means for earlier cycle, 5/7/2015 through 10/30/2015. The numbers in the first column refer to the BS-CS Program Objectives included in Appendix A-1. The raw data for the current cycle along with the statistical results for the current assessment period are presented in Appendix E-1.

		4/19/2017 10/30/2017		5/27/2015 10/30/2015	
	Alumni Survey of Program Objectives	211 Respondents		117 Respondents	
		Outcome Attainment		*Outcome Attainment*	
	Program Educational Objective (pre-Fall 2015)	*Average*	*Percentage*	*Average*	*Percentage*
1	Capacity for personal growth	3.25	81.25	3.21	80.25
1	Capacity for life-long learning	3.31	82.75	3.25	81.25
3	Development of communication skills	3.04	76.00	2.92	73.00
3	Awareness of social, ethical responsibility	2.95	73.75	3.00	75.00
4	Preparation for career in CS	2.94	73.50	3.01	75.25
4	Preparation for graduate study	2.95	73.75	2.88	72.00
4	Overall preparation upon graduation	3.06	76.50	2.90	72.50
2	Computer Programming	3.16	79.00	3.04	76.00
2	Systems Development	2.89	72.25	2.67	66.75
2	Data Structures & Algorithms	3.21	80.25	3.10	77.50
2	Computer Architecture & Organization	2.96	74.00	2.78	69.50
	Overall FIU educational experience	3.07	76.75	3.04	76.00
	Overall satisfaction with BS-CS program	3.10	77.50	3.02	75.50

Table 4: Alumni Survey of Attainment of Program Educational Objectives

E. Employer Survey of Program Educational Objectives

Beginning in the last cycle of the Assessment, we initiated a survey of the Employers of our students and the members of the Industrial Advisory Board of the School (many employ our graduates). The survey instrument is included in Appendix E-2. The raw data along with statistical results is included in the table below.

Employer Survey of Program Objectives	(22-9) Respondents
	Outcome Attainment

	Program Educational Objective (pre-Fall 2015)	*Average*	*Percentage*
1	Ability to learn new Emerging Concepts (an important component of Capacity for life-long learning)	3.00	75.00
2	Mastery of CS concepts & ability to solve problems	3.10	77.50
3	Ability to communicate verbally	2.91	72.75
3	Ability to communicate in written form	2.36	59.00
3	Understanding of social, ethical concerns	2.90	72.50
4	Ability to work cooperatively in a team (an important aspect of Preparation for a career in CS)	3.30	82.50
4	(Will you consider hiring our graduates – 10-YES, 1-NO) (an important gauge of Preparation for career in CS)	3.64	91.00
	OVERALL ATTAINMENT OF PROGRAM OBJECTIVES	2.92	

Table 5: Employer Survey of Attainment of Program Educational Objectives

F. Course Embedded Assessment

SCIS began applying course-embedded assessment of the BS in CS program in fall 2010 in order to supplement the direct measures obtained via capstone assessment in the Senior Project (see the following section). This strategy was applied using either multiple-choice (M-C) quizzes or observing student assignments and/or projects. Appendix-F contains the Direct Assessment Summaries for all courses subject to this direct assessment excluding the Senior Project. Most of the student ratings are based on their performance in M-C quizzes and a few observations are derived from their assignment work.

The evaluation of these assessments is included in section IV.B (Evaluation – Student Outcomes).

G. Capstone Project Assessment

Current requirements of the BS in Computer Science include completion of a capstone course, CIS 4911, Senior Project. Beginning with the first offering of CIS 4911, SCIS has performed assessment of all Student Outcomes via evaluation of the presentations and artifacts of all completed projects. Each project is rated by 2 or more evaluators (exactly 2 in this assessment cycle) according to a rubric *Senior Project Assessment of Student Outcomes of the BS in Computer Science,* and scored on the following scale:

Rating	**Criterion**
n/a	The project does not provide clear evidence about this particular outcome
1	The project demonstrates **poor** attainment of this outcome
2	The project demonstrates **fair** attainment of this outcome
3	The project demonstrates **good** attainment of this outcome
4	The project demonstrates **very good** attainment of this outcome
5	The project demonstrates **excellent** attainment of this outcome

The current version of the rubric was finalized in spring 2015, and these Direct Measurements apply to the Student Outcomes effective in Fall 2015. [Note that Summer 2015 measurements were performed using both rubrics.] The rubric and associated check-list and score grid are included as Appendix G-1 of this report.

The data from these semester-wise assessment events are summarized in Appendices G-2 through G-7. The summary evaluation of these assessments is included in Appendix G-8, and is presented in Section IV.B (Evaluation – Student Outcomes).

IV. EVALUATION

In this section of the report, the data presented in the previous section are evaluated. For quantitative data, the threshold value at which SCIS deems a measured item to satisfy its criteria is 75% of the maximum attainable rating.

Measured Item	Scale	Threshold
Course Outcomes	1 to 5	3.75
Student Outcomes	0 to 5	3.75
Program Objectives	0 to 4	3.00

A. Course Outcomes

The Subject Area Coordinator (SAC) reports (Appendix C) present the data obtained for each course via surveys by students and instructors. The Course Outcomes for each required or elective course of the BS in Computer Science program are evaluated for relevance and attainment by the SAC. Their evaluations are contained in the SAC reports.

The evaluation of the Course Outcomes by the Assessment Coordinator (AC) is based on the student ratings of the course outcomes summarized in Table 1.

AC-Evaluation-01: The data for Course Outcomes by Student Surveys for COP 4604 (Advanced UNIX Programming – taught only once during the period of evaluation) and the MAD courses (2104 and 3512) are not available. Note that SCIS began offering its own Discrete Mathematics course (COT 3100) in Spring 2017 to replace MAD 2104, and hence, that course data will be included in the future Assessment Reports.

AC-Evaluation-02: The Value of Course Outcomes rating of every course for which data are available, exceeds the 3.75 acceptability threshold. In fact, students ascribe at least **high** value (4.00 or higher) to the outcomes of every course with the rating of the Value of Course Outcomes of a over 90% of courses (23 out of 25) is **very high** (4.50 or higher). The overall rating for the Value of Course Outcomes is 4.63 which is essentially the same as observed in the last Assessment cycle (4.59).

AC-Evaluation-03: The student rating of the Adequacy of Coverage of Course Outcomes for every course except one (CAP 4710 – Computer Graphics – 3.48) exceeds the acceptability threshold of 3.75. In fact, students ascribe at least **high** value (4.00 or higher) to the adequacy of coverage of all except two courses (CAP 4710 and COP 4338) with the rating of **very high** (4.50 or higher) for eleven out of 25 courses. The overall rating for the Adequacy of Coverage of Course Outcomes is 4.52 which is higher than that observed in the last Assessment cycle (4.42).

B. Student Outcomes

Evaluation of the level of attainment of the BS in CS Student Outcomes utilizes data obtained via several direct and indirect assessment mechanisms listed below:

Indirect Mechanisms:

- The Graduating Student (Exit) Survey,
- Course Outcomes Surveys by Students and by Instructors.

Direct Mechanisms:

- Capstone Project Assessment via CIS 4911 Senior Project presentations,
- Course-embedded Assessment by multiple-choice questions in several required courses taken by the BS-CS majors: MAD 2104 (Discrete Mathematics), MAD 3512 (Theory of Algorithms), COP 3337 (Programming II), COP 4338 (Programming III), COP 3530 (Data Structures), COP 4710 (Database Management), COP 4555 (Principles of Programming Languages), COP 4610 (Operating Systems), and CEN 4010 (Software Engineering I).
- Course-embedded Assessment by portfolio inspection in CGS 3095 (Ethics and Social Issues in Computing).

The direct assessment events performed from summer 2015 to spring 2017 are documented in the summary provided in Appendix F. The rating sheet and the rubric used for evaluation of Senior Project for assessment of Student Outcomes is provided in Appendix G-1.

a) An ability to apply knowledge of computing and mathematics appropriate to the program's student outcomes and to the discipline.

Indicators

1.	Graduating Student Ratings [pre-Fall-2015 --- a)]	Relevance 90.9%	Attainment 91.2%	Sample: 127
2.	Course Outcomes COP 4521	Value: 100.0%	Coverage: 94.6%	Sample: 2
3.	Course Outcomes COP 4534	Value: 90.4%	Coverage: 80.2%	Sample: 39
4.	Course Outcomes COT 3541	Value: 91.8%	Coverage: 89.2%	Sample: 151
5.	Course Outcomes MAD 2104	Data Not Available	Next Assessment (COT 3100)	
6.	Course Outcomes MAD 3512	Data Not Available		

7. Course-Embedded Assessment - MAD 2104

   Fall 2015 Event: 28 students completed a 16-question multiple choice quiz.
   Criterion: At least 75% of students should score 75% or higher.
   Observation: 15 out of 28 (53.57%) students scored at least 12 points.
   Summary Observation: 15 out of 28 (60.7%) students demonstrated proficiency in Discrete Mathematics. This is almost 8% worse than the previous assessment, and almost the same as the assessment before that.

8. Course-Embedded Assessment - MAD 3512

   Fall 2016 Event: 15 students completed a 10-question multiple choice quiz.
   Criterion: At least 75% of students should score 75% or higher.
   Observation: 9 out of 15 (60.0%) students scored at least 7.5 points. This is substantially better than 41.4% we observed in the last assessment. 11 out of 15 (73.3%) students scored at least 7 points (70% or higher).

   Summary Observation: 9 out of 15 (60.0%) students demonstrated proficiency in Theory of Algorithms. The result in the previous assessment was substantially lower, equal to 41.4%.

9. Senior Project Assessment

   Event: Artifacts of all completed Senior Projects are assessed, by application of the *Senior Project Assessment of Student Outcomes of the BS in Computer Science* rubric, for attainment of outcome a). This event was replicated in all semesters from summer 2015 to spring 2017.
   Criterion: Attainment should be rated at **75% or 3.75** on a 1—5 scale, or better.
   Observation: Summer 2015: 3.00 Fall 2015: 3.11 Spring 2016: 3.00
   Summer 2016: 3.00 Fall 2016: 3.10 Spring 2017: 3.00
   Weighted over the entire assessment period (96 projects): 3.05

Outcome Evaluation: Graduating students consider this Student Outcome highly relevant, and almost 91% believe that they have attained it. Indicators 2, 3, and 4 substantially exceed the acceptable threshold for the Value and the Coverage of Course Outcomes for COP 4521, COP 4534, and COT 3541. Indicators 7 and 8 clearly show that students do not attain the desired acceptable level of proficiency for MAD 2104 and MAD 3512 although the performance has improved in MAD 3512. Mad 2104 will be substituted by our own course, COT 3100, and we definitely expect to do better in the future. Finally, indicator 7 shows that although the results are substantially better than the previous assessment (overall weighted score = 1.98), our Senior Projects have not quite incorporated this curriculum component to a significant level. Attainment of Student Outcome (a) is rated as **not acceptable**.

b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.

Indicators

1.	Graduating Student Ratings [pre-Fall 2015 --- b)]	Relevance 94.8%	Attainment 89.8%	Sample: 127
2.	Graduating Student Ratings [pre-Fall 2015 --- c)]	Relevance 95.0%	Attainment 88.0%	Sample: 126
3.	Course Outcomes CAP 4710	Value: 84.0%	Coverage: 69.6%	Sample: 8
4.	Course Outcomes CDA 3103	Value: 91.6%	Coverage: 92.2%	Sample: 252

5.	Course Outcomes CDA 4101	Value: 92.6%	Coverage: 90.4%	Sample: 180
6.	Course Outcomes CEN 4010	Value: 92.6%	Coverage: 87.0%	Sample: 84
7.	Course Outcomes CEN 4021	Value: 92.0%	Coverage: 88.0%	Sample: 10
8.	Course Outcomes CEN 4083	Value: 97.6%	Coverage: 95.0%	Sample: 6
9.	Course Outcomes COP 3530	Value: 95.0%	Coverage: 91.8%	Sample: 260
10.	Course Outcomes COP 4338	Value: 91.6%	Coverage: 79.0%	Sample: 252
11.	Course Outcomes COP 4555	Value: 91.0%	Coverage: 90.4%	Sample: 133
12.	Course Outcomes COP 4610	Value: 94.2%	Coverage: 84.6%	Sample: 74
13.	Course Outcomes COP 4710	Value: 94.0%	Coverage: 91.0%	Sample: 119

14. Course-Embedded Assessment – CEN 4010

    Fall 2015 Event: 21 students were evaluated for their Project Documentation.
    Criterion: 75% of students should score at least 75% or higher.
    Observation: **100%** of the students answered at least 8 questions correctly.

15. Course-Embedded Assessment - COP 4555

    Fall 2015 Event: 33 students completed a 10-question multiple choice assessment quiz.
    Criterion: 75% of students should score at least 75% or higher.
    Observation: **42.4%** of the students answered at least 8 questions correctly. 18 out of 33 (**54.5%)** students scored at least 7 points (70% or higher).

16. Course-Embedded Assessment - COP 3530

    Fall 2015 Event: 32 students completed a 16-question multiple choice assessment quiz.
    Criterion: 75% of students should score at least 75% or higher
    Observation: 18 (56.25%) of the students answered at least 12 questions correctly.

17. Course-Embedded Assessment - COP 4710

    Fall 2015 Event: 29 students completed an 15-question multiple choice assessment quiz.
    Criterion: 75% of students should score at least 75% (11.25) or higher.
    Observation: 65.5% of the students (19 out of 29) answered at least 12 questions correctly. 20 out of 29 (**69.0**%) of the students answered at least 11 questions correctly.

18. Course-Embedded Assessment – COP 4338 (Computer Systems – Processes)

Fall 2015 Event: 14 students completed a multiple choice assessment quiz worth 8 points.
Criterion: 75% of students should score at least 6 points.
Observation: **78.6%** of the students answered at least 6 questions correctly.

19. Course-Embedded Assessment – COP 4610 (Systems – Storage Management)

Fall 2016 Event: The artifacts (submitted programs/projects) of 56 students were evaluated against the appropriate rubrics with the maximum possible score being 12.
Criterion: 75% of students should score at least 9 points.
Observation: **57.1%** of the students scored at least 9 points. In the previous assessment, this figure was 100%.

20. Course-Embedded Assessment – COP 4610 (Systems – Memory Management)

Fall 2016 Event: The artifacts (submitted programs/projects) of 59 students were evaluated against the appropriate rubrics with the maximum possible score being 12.
Criterion: 75% of students should score at least 9 points.
Observation: **83%** of the students scored at least 9 points.

21. Senior Project Assessment

Event: Artifacts of all completed Senior Projects are assessed, by application of the *Senior Project Assessment of Student Outcomes of the BS in Computer Science* rubric, for attainment of outcome b). This event was replicated in all semesters from summer 2015 to spring 2017.
Criterion: Attainment should be rated at **75% or 3.75** on a 1—5 scale, or better.
Observation: Summer 2015: **5.00** Fall 2015: **5.00** Spring 2016: **5.00**
Summer 2016: **5.00** Fall 2016: **5.00** Spring 2017: **5.00**
Weighted over the entire assessment period (96 projects): 5.00

Evaluation: Graduating students consider this Student Outcome [combination of measured pre-Fall 2015 Outcomes b) and c)] highly relevant, and almost 90% believe that they have attained it. Indicators 3 through 13 comfortably (rating of **Very High)** meet the acceptable threshold for the Value and the Coverage of Course Outcomes for all relevant courses (sole exception – Coverage in CAP 4710). For two of the six course-embedded assessments for relevant courses (Indicators 14 through 19) the students attained the desired level of proficiency (78.6 and 83% of students pass the criterion). We are frankly surprised by this result. Finally, our Senior Projects Assessment (Indicator 20) shows that the students have achieved the highest level of proficiency for this outcome. Although the Course-Embedded assessments do not meet our strict criteria, the performance of students in the Capstone Project is exceptionally good for this criteria. Attainment of Student Outcome (b) is rated as **very good.**

c) An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.

Indicators

1.	Graduating Student Ratings [pre-Fall 2015 --- a)]	Relevance 90.8%	Attainment 91.2%	Sample: 127
2.	Graduating Student Ratings [pre-Fall 2015 --- b)]	Relevance 94.8%	Attainment 89.8%	Sample: 127
3.	Graduating Student Ratings [pre-Fall 2015 --- c)]	Relevance 95.0%	Attainment 88.0%	Sample: 126
4.	Graduating Student Ratings [pre-Fall 2015 --- d)]	Relevance 95.6%	Attainment 89.6%	Sample: 9126
5.	Course Outcomes CEN 4010	Value 92.6%	Coverage: 87.2%	Sample: 84
6.	Course Outcomes CEN 4021	Value 92.0%	Coverage: 88.0%	Sample: 10
7.	Course Outcomes COP 2210	Value: 88.4%	Coverage: 83.6%	Sample: 337
8.	Course Outcomes COP 3337	Value: 91.0%	Coverage: 86.0%	Sample: 368
9.	Course Outcomes COP 3530	Value: 95.0%	Coverage: 91.8%	Sample: 260
10.	Course Outcomes COP 4338	Value: 91.6%	Coverage: 79.0%	Sample: 252
11.	Course Outcomes COP 4610	Value: 94.2%	Coverage: 84.6%	Sample: 74

12. Course-Embedded Assessment – CEN 4010

    Fall 2015 Event: 21 students were evaluated for their Project Documentation.
    Criterion: 75% of students should score at least 75% or higher.
    Observation: **100%** of the students answered at least 8 questions correctly.

13. Course-Embedded Assessment – COP 3337 (Inheritance)

    Fall 2015 Event: 36 students completed an 8-question multiple choice assessment quiz.
    Criterion: 75% of students should score at least 6 points.
    Observation: **77.8%** (28 out of 36) of the students answered at least 6 questions correctly.

14. Course-Embedded Assessment – COP 3337 (Exceptions)

    Fall 2015 Event: 36 students completed an 8-question multiple choice assessment quiz.
    Criterion: 75% of students should score at least 6 points.
    Observation: **86.1%** of the students (31 out of 36) answered at least 6 questions correctly.

15. Course-Embedded Assessment – COP 3530 (Abstraction)

    Fall 2015 Event: 33 students completed an 8-question multiple choice assessment quiz.
    Criterion: 75% of students should score at least 6 points.
    Observation: **78.8%** of the students (26 out of 33) answered at least 6 questions correctly.

16. Course-Embedded Assessment – COP 3530 (API Usage)

Fall 2015 Event: 33 students completed a 12-question multiple choice assessment quiz.
Criterion: 75% of students should score at least 9 points.
Observation: **93.94%** of the students (31 out of 33) answered at least 9 questions correctly.

17. Course-Embedded Assessment – COP 3530 (Linked Structures)

Fall 2015 Event: 31 students completed an 8-question multiple choice assessment quiz.
Criterion: 75% of students should score at least 6 points.
Observation: **58.06%** of the students (18 out of 31) answered at least 6 questions correctly.

18. Course-Embedded Assessment – COP 3530 (Recursion)

Fall 2015 Event: 33 students completed an 8-question multiple choice assessment quiz.
Criterion: 75% of students should score at least 6 points.
Observation: **90.91%** of the students (30 out of 33) answered at least 6 questions correctly.

19. Course-Embedded Assessment – COP 4338 (C Language)

Fall 2015 Event: 13 students completed a 12-question multiple choice assessment quiz.
Criterion: 75% of students should score at least 9 points.
Observation: **61.54%** of the students (8 out of 13) answered at least 9 questions correctly.

20. Senior Project Assessment

Event: Artifacts of all completed Senior Projects are assessed, by application of the *Senior Project Assessment of Student Outcomes of the BS in Computer Science* rubric, for attainment of outcome c). This event was replicated in all semesters from summer 2011 to spring 2013.
Criterion: Attainment should be rated at **75% or 3.75** on a 1—5 scale, or better.
Observation: Summer 2015: **4.35** Fall 2015: 4.16 Spring 2016: **4.00**
Summer 2016: **4.00** Fall 2016: **4.15** Spring 2017: **4.10**
Weighted over the entire assessment period (96 projects): 4.14

Evaluation: Except for two course-embedded assessments, all indicators suggest that attainment of Student Outcome c) is **excellent**.

d) Demonstrate the ability to work cooperatively in teams.

Indicators

1.	Graduating Student Ratings [pre-Fall-2015 --- f)]	Relevance 92.6%	Attainment 87.0%	Sample: 126
2.	Course Outcomes CEN 4010	Value: 92.6%	Coverage: 87.2%	Sample: 84

3. Course Outcomes CEN 4021 Value: 92.0% Coverage: 88.0% Sample: 10

4. Course Outcomes CIS 4911 Value: 94.2% Coverage: 88.8% Sample: 125

5. Senior Project Assessment

   Event: Artifacts of all completed Senior Projects are assessed, by application of the *Senior Project Assessment of Student Outcomes of the BS in Computer Science* rubric, for attainment of outcome d). This event was replicated in all semesters from summer 2015 to spring 2017.
   Criterion: Attainment should be rated at **75% or 3.75** on a 1—5 scale, or better.
   Observation: Summer 2015: **5.00** Fall 2015: **5.00** Spring 2016: **5.00**
   Summer 2016: **5.00** Fall 2016: **5.00** Spring 2017: **5.00**
   Weighted over the entire assessment period (96 projects): 5.00

   Evaluation: All indicators suggest that attainment of Student Outcome d) is **excellent**.

e) An understanding of professional, ethical, legal, security and social issues and responsibilities

Indicators

1. Graduating Student Ratings [pre-Fall-2015 --- e)] Relevance 83.6% Attainment 83.4% Sample: 126
2. Course Outcomes CGS 3095 Value: 94.4% Coverage: 95.6% Sample: 1596

3. Course-Embedded Assessment CGS 3095 (Social and Ethical Concerns in Computing)

   Fall 2015 Event: Individual projects for 25 students were graded on a 8-point scale.
   Criterion: 75% of students should score at least 6 points.
   Observation: 92.0**%** of the students received at least 6 points.

4. Senior Project Assessment

   Event: Artifacts of all completed Senior Projects are assessed, by application of the *Senior Project Assessment of Student Outcomes of the BS in Computer Science* rubric, for attainment of outcome e). This event was replicated in all semesters from summer 2015 to spring 2017.
   Criterion: Attainment should be rated at **75% or 3.75** on a 1—5 scale, or better.
   Observation: Summer 2015: **3.00** Fall 2015: **3.05** Spring 2016: **3.00**
   Summer 2016: **3.00** Fall 2016: **3.10** Spring 2017: **3.00**
   Weighted over the entire assessment period (96 projects): 3.04

   Evaluation: Existing students rate this outcome as extremely relevant and feel that they have attained it (Indicator 1). Current students find this outcome to be Highly Valuable and believe that it is Very-well covered in the classroom (Indicator 2). Evaluation of student

projects in CGS 3095 show that students demonstrate **excellent** understanding of social and ethical issues in computing (Indicator 3). Senior project assessment (Indicator 4) shows that there is not much in student projects that evaluates these topics. On balance, attainment of Student Outcome e) is rated as **good.**

f) ***An ability to communicate effectively with a range of audiences.***

Indicators

1.	Graduating Student Ratings [pre-Fall-2015 --- g)]	Relevance 91.6%	Attainment 84.4%	Sample: 125
2.	Course Outcomes CGS 3095	Value: 94.4%	Coverage: 95.6%	Sample: 1596
3.	Course Outcomes CEN 4010	Value 92.6%	Coverage: 87.2%	Sample: 84

4. Course-Embedded Assessment CGS 3095 (Effective Communication Skills)

   Fall 2015 Event: Presentation of projects for 63 students were graded on a 4-point scale.
   Criterion: 75% of students should score at least 3 points.
   Observation: 79.4**%** of the students received at least 3 points.

5. Senior Project Assessment

   Event: Artifacts of all completed Senior Projects are assessed, by application of the *Senior Project Assessment of Student Outcomes of the BS in Computer Science* rubric, for attainment of outcome g). This event was replicated in all semesters from summer 2015 to spring 2017.
   Criterion: Attainment should be rated at **75% or 3.75** on a 1—5 scale, or better.
   Observation: Summer 2015: **5.00** Fall 2015: **5.00** Spring 2016: **5.00**
   Summer 2016: **5.00** Fall 2016: **5.00** Spring 2017: **5.00**
   Weighted over the entire assessment period (96 projects): 5.00

   Evaluation: All indicators suggest that attainment of Student Outcome f) is **excellent**.

g) An ability to analyze the local and global impact of computing on individuals, organizations, and society.

Indicators

1.	Graduating Student Ratings [pre-Fall-2015 --- e)]	Relevance 83.6%	Attainment 83.4%	Sample: 126
2.	Course Outcomes CGS 3095	Value: 94.4%	Coverage: 95.6%	Sample: 1596

3. Course-Embedded Assessment CGS 3095 (Social and Ethical Concerns in Computing)

   Fall 2015 Event: Individual projects for 25 students were graded on a 8-point scale.
   Criterion: 75% of students should score at least 6 points.

Observation: 92.0**%** of the students received at least 6 points.

4. Senior Project Assessment

   This outcome is not rated by the Senior Project course.

   Evaluation: Existing students rate this outcome as extremely relevant and feel that they have attained it (Indicator 1). Current students find this outcome to be Highly Valuable and believe that it is Very-well covered in the classroom (Indicator 2). Evaluation of student projects in CGS 3095 show that students demonstrate **excellent** understanding of social and ethical issues in computing (Indicator 3). Attainment of Student Outcome g) is rated as **excellent.**

h) Recognition of the need for and an ability to engage in continuing professional development.

Indicators

1.	Graduating Student Ratings [pre-Fall-2015 --- e)]	Relevance 83.6%	Attainment 83.4%	Sample: 126
2.	Graduating Student Ratings [pre-Fall-2015 --- h)]	Relevance 92.4%	Attainment 80.6%	Sample: 125
3.	Senior Project Assessment			

Event: Artifacts of all completed Senior Projects are assessed, by application of the *Senior Project Assessment of Student Outcomes of the BS in Computer Science* rubric, for attainment of outcome g). This event was replicated in all semesters from summer 2015 to spring 2017.
Criterion: Attainment should be rated at **75% or 3.75** on a 1—5 scale, or better.
Observation: Summer 2015: **4.00** Fall 2015: 4**.00** Spring 2016: **4.00**
Summer 2016: **4.00** Fall 2016: **4.00** Spring 2017: **4.00**
Weighted over the entire assessment period (96 projects): 4.00

Evaluation: All indicators suggest that attainment of Student Outcome h) is **excellent**.

i) An ability to use current techniques, skills, and tools necessary for computing practice.

Indicators

1.	Graduating Student Ratings [pre-Fall-2015 --- b)]	Relevance 94.8%	Attainment 89.8%	Sample: 127
2.	Graduating Student Ratings [pre-Fall-2015 --- c)]	Relevance 95.0%	Attainment 88.0%	Sample: 126
3.	Graduating Student Ratings [pre-Fall-2015 --- h)]	Relevance 92.4%	Attainment 80.6%	Sample: 125

4. Senior Project Assessment

Event: Artifacts of all completed Senior Projects are assessed, by application of the *Senior Project Assessment of Student Outcomes of the BS in Computer Science* rubric, for attainment of outcome g). This event was replicated in all semesters from summer 2015 to spring 2017.
Criterion: Attainment should be rated at **75% or 3.75** on a 1—5 scale, or better.
Observation: Summer 2015: **5.00** Fall 2015: 5**.00** Spring 2016: 5**.00**
Summer 2016: **5.00** Fall 2016: **5.00** Spring 2017: **5.00**
Weighted over the entire assessment period (96 projects): 5.00

Evaluation: All indicators suggest that attainment of Student Outcome i) is **excellent**.

j) An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.

Indicators

1. Graduating Student Ratings [pre-Fall-2015 --- a)] Relevance 90.8% Attainment 91.2% Sample: 127
2. Graduating Student Ratings [pre-Fall-2015 --- c)] Relevance 95.0% Attainment 88.0% Sample: 126

3. Course-Embedded Assessment – CEN 4010

Fall 2015 Event: 21 students were evaluated for their Project Documentation.
Criterion: 75% of students should score at least 75% or higher.
Observation: **100%** of the students answered at least 8 questions correctly.

4. Senior Project Assessment

Event: Artifacts of all completed Senior Projects are assessed, by application of the *Senior Project Assessment of Student Outcomes of the BS in Computer Science* rubric, for attainment of outcome g). This event was replicated in all semesters from summer 2015 to spring 2017.
Criterion: Attainment should be rated at **75% or 3.75** on a 1—5 scale, or better.
Observation: Summer 2015: **3.45** Fall 2015: 3.11 Spring 2016: 3.05
Summer 2016: **3.00** Fall 2016: 3.00 Spring 2017: **3.05**
Weighted over the entire assessment period (96 projects): 3.10

Evaluation: Existing students rate this outcome as extremely relevant and feel that they have attained it (Indicators 1,2). Evaluation of student projects in CEN 4010 show that students demonstrate **excellent** understanding of this outcome (Indicator 3). Students do not demonstrate attainment of this outcome in their Senior project, but this is indicative more of

the non-application of theoretical concepts in their projects rather than their attainment. Overall, the attainment of Student Outcome j) is rated as **good.**

k) An ability to apply design and development principles in the construction of software systems of varying complexity.

Indicators

1. Graduating Student Ratings [pre-Fall-2015 --- c)] Relevance 95.0% Attainment 88.0% Sample: 126

2. Course Outcomes CEN 4010 Value: 92.6% Coverage: 87.2% Sample: 84

3. Course-Embedded Assessment – CEN 4010

   Fall 2015 Event: 21 students were evaluated for their Project Documentation.
   Criterion: 75% of students should score at least 75% or higher.
   Observation: **100%** of the students answered at least 8 questions correctly.

4. Senior Project Assessment

   Event: Artifacts of all completed Senior Projects are assessed, by application of the *Senior Project Assessment of Student Outcomes of the BS in Computer Science* rubric, for attainment of outcome g). This event was replicated in all semesters from summer 2015 to spring 2017.
   Criterion: Attainment should be rated at **75% or 3.75** on a 1—5 scale, or better.
   Observation: Summer 2015: **5.00** Fall 2015: 5**.00** Spring 2016: **5.00**
   Summer 2016: **5.00** Fall 2016: **5.00** Spring 2017: **5.00**
   Weighted over the entire assessment period (96 projects): 5.00

Evaluation: All indicators show that Attainment of Student Outcome k) is rated as **excellent.**

C. Program Educational Objectives

The principal means of assessing attainment of the Program Educational Objectives of the BS in Computer Science program are the Alumni and Employer Surveys of Program Objectives.

The alumni responses are summarized in Table 4 (Section III.D) showing the averages of the 169 responses in the period from May 2017 to October 2017. The alumni responses provide ratings of the specific facets of each objective, and overall ratings of some objectives. The Alumni Survey raw data are included in Appendix E-1.

The employer survey responses are summarized in Table 5 (Section III.E) showing the averages of the 22 responses in the period from May 2017 to November 2017. Please note that for any particular question of the survey, no more than 11 employers provided responses. These responses provide ratings of specific facets of each objective and the overall rating of their combination. The relevant data is included in Appendix E-3.

Attainment of Student Outcomes enables attainment of the Program Educational Objectives, and so some Student Outcome data are again noted in this section where relevant. Additionally, the other constituent groups within the SCIS umbrella; WICS, ACM, STARS, UPE, and Industrial Advisory Board (IAB) may provide indicators of the attainment of the program objectives. The activity reports of the student organizations are included in Appendix H, and the minutes of the IAB meetings during the assessment period are included in Appendix I. Since the beginning of 2015, we hold two Board meetings per year.

1. Be successful in applying for entry level professional positions in computing-related fields, or for admission to graduate programs.

Indicators

- Alumni Survey of Program Educational Objectives:
  Please rate how your educational experience at FIU contributed to your preparation for a career in computer science
  May 2017 TO October 2017: **73.52%** Previous cycle: **75.25%**
  Please rate how your educational experience at FIU contributed to your preparation for graduate study
  May 2017 TO October 2017: **73.66%** Previous cycle: **72.00%**

- Employer Survey of Program Educational Objectives:
  Please rate the following skill of our graduates: Will you consider employing our graduates in the future
  May 2017 TO November 2017: 91%
  This is at best a very indirect metric to gauge the overall attainment of this Program Objective from the employers' viewpoint.

- Student Chapter activities (Appendix H)

ACM Chapter Workshops, Hack-a-thons, programming team activities, and so on; Upsilon Pi Epsilon Information Sessions and Workshops; WICS workshops, programming team activities, Company Visits, Coding activities, etc.

Evaluation: Employers truly like the training provided to our students, and overwhelmingly indicate that they will continue to hire them. Our alumni observe that they are well equipped for their professional careers after graduation. And our student chapters are doing exceedingly well in holding workshops on a variety of topics of interest to their membership and providing them an opportunity to learn about new topics and participating in newer academic activities. Attainment of Program Educational Objective 1 is deemed **acceptable** with a rating of **good**.

2.1 Be prepared for career accomplishment, responsibility and advancement in computing-related professions by virtue of having received in the BS program, a high-quality technical education in computing.

Indicators

- Alumni Survey of Program Educational Objectives:
  Please rate the quality of your preparation upon graduation in Computer Programming
  May 2017 TO October 2017: **79.09%** Previous cycle: **76.00%**
  Please rate the quality of your preparation upon graduation in Systems Development
  May 2017 TO October 2017: **72.17%** Previous cycle: **66.75%**
  Please rate the quality of your preparation upon graduation in Data Structures & Algorithms
  May 2017 TO October 2017: **80.25%** Previous cycle: **77.50%**
  Please rate the quality of your preparation upon graduation in Computer Architecture & Organization
  May 2017 TO October 2017: **74.06%** Previous cycle: **69.50%**

- Employer Survey of Program Educational Objectives:
  Please rate the following skill of our graduates: Mastery of the fundamental computer science concepts and ability to solve computing problems using them
  May 2017 TO November 2017: **77.50%**

- Enabling Student Outcomes
  a) Proficiency in foundation areas – Graduating Student Rating: **91.13%**
  b) Proficiency in core CS areas – Graduating Student Rating: **89.71%**
  c) Proficiency in problem solving – Graduating Student Rating: **87.92%**
  d) Mastery of a programming language – Graduating Student Rating: **89.67%**

Evaluation: This Program Educational Objective is paramount. The ratings shown above for the current Alumni survey cycle are slightly lower but very close with those reported in the 2013 assessment report:

Alumni Survey Period	**5/17 to 10/17**	**5/15 to 10/15**
# Responses	**169**	**117**
Computer Programming	79.09	76.00

Systems Development	72.17	66.75
Data Structures & Algorithms	80.25	77.50
Architecture & Organization	74.06	69.50

The ratings for preparation in the Systems Development and Computer Organization & Architecture areas have been consistently slightly below acceptable while the ratings for Data Structures & Algorithms and Computer programming have consistently been high. Note that ratings are better than those received in the last assessment cycle. *It is interesting to note that when they graduate, the students feel that they have attained proficiency in essentially all CS areas at a very high rating, but it diminishes considerably when they have worked in the industry for a while.*

Attainment of Program Educational Objective 2.1 is deemed **acceptable** with a rating of **very good**.

2.2 Be prepared for career accomplishment, responsibility and advancement in computing-related professions by virtue of having received in the BS program, communication and team-work skills.

Indicators

- Alumni Survey of Program Educational Objectives:
  Please rate how your educational experience at FIU contributed to the development of your communication skills
  May 2017 TO October 2017: **75.89%** Previous cycle: **73.00%**

- Employer Survey of Program Educational Objectives:
  Please rate the following skill of our graduates: Ability to communicate verbally
  May 2017 TO November 2017: **72.75%**
  Please rate the following skill of our graduates: Ability to communicate in written form
  May 2017 TO November 2017: **59.00%**
  Please rate the following skill of our graduates: Ability to work cooperatively in teams
  May 2017 TO November 2017: **82.50%**

- Enabling Student Outcomes
  a) Effective communication skills – Graduating Student Rating: **84.4%**
  b) Ability to work cooperatively in teams – Graduating Student Rating: **87.0%**

Evaluation: As for the previous Program Outcome, it is interesting that the perspective on this outcome/objective should differ in the interim from graduation to employment. While the enabling outcomes are rated as high by seniors, the alumni and employers assign only acceptable ratings. In particular, employers rate the writing skills of our students much lower than we expect. It is reasonable to ascribe the adjustment to the real-world experiences of our graduates, but this is a conjecture. This circumstance underscores the need to have continuing communication and dialog with our alumni.

Attainment of Program Educational Objective 2.2 is deemed **acceptable** with a rating of **average.**

2.3 Be prepared for career accomplishment, responsibility and advancement in computing-related professions by virtue of having received in the BS program, awareness of the ethical and social responsibilities of their profession.

Indicators

- Alumni Survey of Program Educational Objectives:
  Please rate how your educational experience at FIU contributed to the development of your awareness of social and ethical responsibility
  May 2017 TO October 2017: **73.82%** Previous cycle: **75.00%**

- Employer Survey of Program Educational Objectives:
  Please rate the following skill of our graduates: Understanding of Social and Ethical Concerns
  May 2017 TO November 2017: **72.50%**

- Enabling Student Outcomes
  a) Understanding social and ethical concerns – Graduating Student Rating: **83.4%**

Evaluation: As for the previous Program Outcome, it is interesting that the perspective on this outcome/objective should differ in the interim from graduation to employment. While the enabling outcomes are rated as high by seniors, the alumni and employers assign only acceptable ratings. It is reasonable to ascribe the adjustment to the real-world experiences of our graduates, but this is a conjecture.

Attainment of Program Educational Objective 2.3 is deemed **acceptable** with a rating of **average.**

2.4 Be prepared for career accomplishment, responsibility and advancement in computing-related professions by virtue of having received in the BS program, an ability to engage in continued professional development activities.

Indicators

- Alumni Survey of Program Educational Objectives:

Please rate how your educational experience at FIU contributed to your capacity for personal growth
May 2017 TO October 2017: **81.36%** Previous cycle: **80.25%**

Please rate how your educational experience at FIU contributed to your capacity for lifelong learning
May 2017 TO October 2017: **82.84%** Previous cycle: **81.25%**

- Employer Survey of Program Educational Objectives:

Please rate the following skill of our graduates: Ability to learn new and Emerging Concepts and Technologies
May 2017 to November 2017: **75.00%**

- ACM Chapter activities (Appendix H)
  Organization of Workshops (Art of self-learning, Machine Learning, OS Architectures, Functional Programming principles, etc.), Coding activities (Code In The Dark, Mango Hacks, etc.), Social Events, etc.

- UPE Activities (Appendix H)
  Organization of Workshops (Web Development, Database Management, Mobile App development, Graphic Design, etc.), community service events (Google Ignite CS, CodeFest Miami), collaborative projects with other student organizations in SCIS, meeting of students with the School's administration and faculty, and so on.

- WICS Activities (Appendix H)
  Organizing Workshops (Game Development, Web Development, Soldering, PLUG Arduino, etc.), Holding various academic events (MLH Hackday, Github Lectures with ACM, LaunchCode@FIU information session, Lockheed Martin/Tech Talk, etc.), social events, and so on.

- STARS Activities (Appendix H)
  Providing Tutoring Services and mentoring students, Scheduling Midterm and Final Exam Review Sessions, Hosting an online gaming event for a popular Xbox console game, Organizing Outreach programs with Schools like **Rise Up 4 CS program** for tutoring and mentoring high school students from underrepresented groups who are taking the AP-CS A Exam, participation in Academic Integrity International Day of Action, and so on.

Evaluation: It is not clear that attainment of this objective is directly enabled by specific courses in the Computer Science major. Rather, it is the collective breadth represented by the entire BS in Computer Science program that may have an enabling effect. In addition, the breadth component common to all FIU majors, the Core Curriculum and non-major elective courses, is a principal contributor to any graduated student's realization of personal growth and capacity for life-long learning.

Alumni clearly feel that their education at FIU contributed greatly to their personal growth and lifelong learning experiences.

Involvement with the School's student organizations is another excellent enabler of this objective, but these experiences are voluntary and are not exploited by a majority of our graduates, particularly night students.

Attainment of Program Educational Objective 2.4 is deemed **acceptable** with a rating of **very good**.

V. RECOMMENDATIONS

A. Recommendations of the Subject Area Coordinators

Subject Area: Professional Development (SAC: Caryl Rahn)

CGS 1920: No changes are recommended.

CGS 3095: The course reports are excellent, and it is suggested that the Programming pre-requisite (COP 2210, or equivalent) be removed.

ENC 3249: No changes are recommended. However, technical writing should be emphasized more in this course as instructors found the students "deficient to adequate" in writing skills.

Subject Area: Computer Organization (SAC: Nagarajan Prabakar)

CDA 3103: From instructor course appraisals, students seem to be deficient in Boolean logic and problem solving skills. These deficiencies need to be addressed in introductory CS courses. Use of interactive textbooks (Zybooks) improves student learning, and this should be explored.

CDA 4101: From instructor course appraisals, additional course outcomes need to be revised with respect to Advanced Architecture topics.

CNT 4713: No change is needed on the course outcomes or syllabus.

COP 4610: No change is needed on the course outcomes or syllabus.

Subject Area: Computer Systems (SAC: Shu-Ching Chen)

CAP 4710: No changes are recommended.

CAP 4770: No changes are recommended.

CDA 4625: The course does not have Outcomes defined, yet.

CDA 4641: No changes are recommended.

CEN 4083: No changes are recommended.

COP 4604: No changes are recommended.

COP 4710: No changes are recommended.

COP 4722: No changes are recommended.

Subject Area: Foundations (SAC: Xudong He)

MAD 2104 & MAD 3512: Neither student evaluations nor instructor appraisals are available for these courses. No changes are recommended.

COP 4555: The three instructors found that the student preparation for this class ranges from deficient to adequate. One instructor found two groups of students; one performing very well, and the other quite badly. All instructors covered F# in the first half of the course, and broad topics of programming language design and implementation in the second half. Student suggestions include: provide more F# examples, give more practice problems, conduct quizzes, and use a different functional programming language. The overall student evaluations are very good, and no changes are warranted.

COT 3541: Two out of three instructors who taught this course noted that the students did not have adequate preparation for the class. Student comments in one class include: give more practice problems, give additional programming assignments and projects, and give better homework for exam reviews. Second class student comments include: Use a better textbook, provide more in-depth explanations, and use less complicated examples. Students of the third instructor commented: provide more homework assignments, have more consistent grading, and provide quicker responses to emails.

COT 4521: Students suggest that instructor use less power point presentations and give more compact lectures. Instructor suggested that Data Structures and Linear Algebra should be required pre-requisites.

COT 4534: Instructors found students' preparedness for the class to be between deficient and adequate. One instructor noted the necessity of better mathematical background for the students. Student suggestions include: follow the textbook more closely, and provide additional resources for topics not covered in the book. No specific changes are recommended.

Subject Area: Programming (SAC: Tim Downey)

COP 2210: From instructor course appraisals, students seem to be deficient in mathematical preparation for the course. Adding a pre-requisite of Algebra might be considered. One instructor feels that outcomes for Javadocs and program style should be added to the course.

COP 3337: From instructor course appraisals, students seem to be deficient in algorithmic reasoning, problem solving, ArrayLists, Strings and methods. Instructors note a wide range of skills. COP2210 instructors should be encouraged to cover all course outcomes. A lab should be considered for this course.

COP 3530: From instructor course appraisals, students seem to be deficient in linked lists, stacks, collections and recursion. COP3337 instructors should plan their courses appropriately to leave time to cover these topics.

COP 4226: Neither the course outcomes nor the syllabus needs any changes.

COP 4338: From instructor course appraisals, students seem to be deficient in experience with algorithms and Unix. Several instructors did not cover the debugging outcome. Since Unix and debugging with GDB are not taught in our curriculum, the course outcomes need to be adjusted to make time to cover these topics. COP3530 is a co-requisite for the course, perhaps it should be a prerequisite. A newer book that covers more of the outcomes should be found.

COP 4520: Neither the course outcomes nor the syllabus needs any changes.

Subject Area: Software Engineering (SAC: Monique Ross)

CEN4010:

Observations:

- The software engineering course is loaded with a great deal of material – software process, documentation, and an overarching project (that at times requires new acquired skillset); however, the explicit connection between the material and the end product is lost amongst what is perceived by students as a huge disconnect between the text, exams, and expectations.
- Students and professors alike lack the understanding of the co-requisite Net-centric. Students believe it left them under-prepared, faculty think it is unnecessary. In either case, there exists an incongruence between the perceived goal of Net-centric and actual outcomes.
- It appears as if students both appreciate and loathe the project; namely because they understand the value and practicality but are largely overwhelmed by the expectations – new technology, process, exams, and working product.

Recommendations:

- Evaluate the co-requisite of Net-Centric – is there misalignment between expectations of the course and outcomes or should it be removed as a co-requisite to the course
- In order to stay aligned with the expectations of the workforce, explore the transition to Agile software development process. Such a transition would: 1) alleviate some angst by students on how to manage and execute a working executable at the conclusion of the course while developing meaningful documentation; 2) provide insight to current work practices
- Professors of this course should adopt an Agile/Scrum book; suggested text: Ashmore, S., Runyan, K. (2015). Introduction to agile methods. Boston: Addison –Wesley.
- UML supplemental materials can be provided through the use of alternative media – YouTube, websites, manuals
- Class lecture times should be spent more on practicing Agile software engineering development rather than just giving lectures.
- Learning by example and practice is the best way to transfer the knowledge and experience from the professor to the students

- **CEN 4021**: The following recommendation is made: Emphasize the importance of instructor assessment of course.

CEN 4072: The following recommendations are made.

- Test-driven development is one of the popular agile software development practices in industry. Students should be exposed to this approach.
- The lectures time should be spent more on practicing the testing methods using state-of-the-art tools.

CIS 4911: The following observations and recommendations are made by the SAC.

- Software Engineering I, should be evaluated and perhaps redesigned to ensure that students (in all section offerings) have the same tools or resources necessary to be successful in Senior Project including:
  - Students should have a stronger understanding of UML diagrams and the appropriateness of different diagrams for portraying different aspects of a product
  - Students should learn how to be a productive team member in a self-organizing Agile/Scrum development team
  - Students should be proficient in Agile/Scrum software development process

B. Recommendations of the Assessments Coordinator

1. Course Related:

AC-01: The Course Outcomes Surveys for MAD 2104 and MAD 3512 are not conducted. This is a continuing concern. However, it should be substantially diminished beginning in the next Assessment cycle because MAD 2104 will be substituted by COT 3100, the course offered and controlled by SCIS. If possible, some other assessment mechanism must be employed for MAD 3512 on a regular schedule.

AC-02: In the Course Embedded Assessment for MAD 2104 for this assessment cycle, only 15 out of 28 (53.6%) students demonstrated proficiency in Discrete Mathematics. This continues to be below the acceptable level. Also, the SAC recommendation for COT 3541 indicates that our students of MAD 2104 are not learning what they need to master the material taught in a subsequent course. Hopefully, this concern will be eliminated or at least diminished in the next cycle when our own COT 3100 replaces MAD 2104.

AC-03: Course Embedded Assessment results for MAD 3512 are also poor (only 9 out of 15 (60%) students demonstrated proficiency at 75% level. We need to examine the reasons for this inadequate performance of students, and then coordinate the content and delivery of this course better with the Department of Mathematics and Statistics.

AC-04: From the SAC reports of various courses (CDA 3103, COP 2210, and COT 3541), it is clear that the students are quite deficient in the concepts related to algorithmic process, programming, and problem solving. This is a continuing concern for which the suggestion made in the last Assessment Report is still valid: {one way to address this issue is to provide a pre-programming course focused on problem solving and logic skills. Students in COP 2210 should be evaluated in the first week of classes in order to recommend them to enroll in this pre-programming course before taking COP 2210. [**Important Note: We have already created COP 1000 but need to ascertain that it is more widely advertised to the student community through our advisers.]}**

AC-05: For CAP 4710, students indicate that the "Coverage Adequacy" is not good. This is a low enrollment course taught once during this assessment period. The instructor should heed this concern and make adjustments in teaching.

AC-06: Course Outcomes for CDA 4625 are undefined. These should be designed as soon as possible.

AC-07: Students of CEN 4010 expressed concerns over their preparedness for the class in the sense that the pre-requisites are not aligned with the expectations of the course (e.g., class project requires web development knowledge not covered earlier). The SAC should evaluate this concern and take prevent action if appropriate.

AC-08: Instructors of CEN 4072 indicate that due to lack of time, they are unable to cover "the details of debugging" in this course. If so, then it should be removed from the Course Outcomes.

Also, students indicate that knowledge of many topics covered in CEN 4010 is mandatory for this course, and hence, we should consider making CEN 4010 a pre-requisite for CEN 4072.

AC-09: Most of the projects undertaken in CIS 4911 use Scrum. Accordingly, Scrum should be used in the pre-requisite course CEN 4010, or at the least, reviewed in CIS 4911.

AC-10: The SAC reviewing CGS 3095 mentions that the programming pre-requisite (COP 2210, or equivalent) is not necessary for this course. This should be reviewed, and modified if deemed worthwhile.

AC-11: Although this suggestion was made by one SAC, it behooves us to evaluate the use of interactive textbooks to improve student learning in relevant courses.

2. Procedure Related:

AC-12: For a few courses, the Instructor Course Appraisals are not filed in. For example, in this cycle, they were missing for CAP 4710, CEN 4021, CEN 4083, and COP 4604. The Associate Director should ascertain that these are filled by the instructors every term.

AC-13: We have now used the Employer Survey to measure attainment of Program Educational Objectives of our students for the second time. This is wonderful. However, the number of response (10-11 responses per question although 22 participated) was very low. It is recommended that meaningful steps be taken in the future to increase this response rate.

AC-14: The following is not a major issue, but is noted here for future reminder purposes more than anything else. The style of Course Embedded Assessments of different instructors for the same course is sometimes quite different. SCIS should make Subject Area Coordinators responsible to maintain the consistency of this assessment. Before designing and conducting the assessment for a particular class, instructors should consult the SAC.

3. General:

AC-15: It is challenging to perform meaningful assessment of Student Outcome a) ***Demonstrate proficiency in the foundation areas of Computer Science including mathematics, discrete structures, logic and the theory of algorithms*** using the rubric of the Senior Project class because there are essentially no projects attempted by students that address the relevant topics. The point is made for discussion only; no recommendations are made.

AC-16: Employers tell us that the writing skills of our students are not good (rating of 59%). We need to find ways to improve this aspect of our curriculum.

AC-17: The student clubs continue to need additional space to conduct their activities. A couple of faculty advisors noted that due to the unavailability of space, the activities of their clubs are limited. SCIS administrators should seriously look into this and allocate some additional space for the student clubs. This is a recurring recommendation.

AC-18: For a few years now, the meeting of the Industrial Advisory Board is conducted at the end of the Fall and Spring semesters when selected students present their Capstone Projects. Members have been suitably impressed with their work, and many now act as mentors and/or judges for these projects. This has proven to be very beneficial for the students. Likewise, we need to find more and better ways to engage the Board members in student activities.

VI. CONCLUSION

The BS in Computer Science program continues to deliver high quality preparation for entry into the computing work-force, or admission to graduate programs in computing. The delivery of its required coursework continues to receive very high ratings from students as expressed in the Surveys of Course Outcomes (4.52/5, 90.4%, Table 1). Evaluations of attainment of its Student Outcomes (86.8%, Table 3) and Program Educational Objectives (77.5%, Table 4) uniformly meet or exceed the minimum acceptability criteria.

In continuing to strive to ensure students' educational experiences are relevant to the reality of the work-force they enter, SCIS continues to offer capstone experience in the Senior Project course. This has been a phenomenal success as indicated by the students (Value of Outcome 4.71/5, 94.2%, Table 1) and showed in the measurements using the rubrics for that course. We continue to improve our offerings in many of our focus areas. The evaluation of Student Learning by various topics as part of the Course Embedded Direct Assessment Mechanism in many courses (COP 3337, COP 3530, COP 4338, and COP 4610) is providing us useful information to fine-tune our curriculum. As we substitute MAD 2104 with COT 3100 taught by SCIS faculty, we expect to get further information with regard to our math-oriented curriculum.

The ACM, WICS, STARS, and UPE student chapters, along with the Programming Team activities have become very active (Appendix H) and continue expanding their sphere of influence among participating members. It is noteworthy that our industry partners Ultimate Software, IBM, State Farm, and others offer many opportunities to students to learn about industry jobs, skills necessary to be successful once they enter the workforce, and the importance of problem solving through their engagement in various student activities like support of Programming Teams, mentorship and/or evaluation of capstone projects, and the like. WICS has been partnering with the other student groups for the benefit of its membership.

The SCIS Industrial Advisory Board is increasingly involved in all facets of our operation as indicated by the minutes of its meetings included in Appendix I. This involvement will be enhanced in the future; both the Board members and the SCIS administration desire it very much.

In the last few years, and particularly in this assessment period, we have substantially increased student participation in internships and employer participation in job fairs on campus. With a full-time staff member looking after these activities, the student success has been nothing short of phenomenal.

The biennial assessment is working out exceedingly well, and gives us more meaningful information from one report to the next. The participation of the entire faculty is serious and meaningful, and we observe good modifications in our curriculum based on the recommendations made in this report.

The ABET Review of the BS in CS Program was conducted in Fall 2016, and we passed it with flying colors.