THE UNIVERSITY OF UTAH

August 28, 2017

Ruth V. Watkins
Senior Vice President for Academic Affairs
205 Park Bldg.
Campus

Approved
R Watkins
9-7-17

RE: Graduate Council Review
School of Computing

D W Pershing
9-7-17

Dear Vice President Watkins:

Enclosed is the Graduate Council's review of the School of Computing. Included in this review packet are the report prepared by the Graduate Council, the School Profile, and the Memorandum of Understanding resulting from the review wrap-up meeting.

After your approval, please forward this packet to President David Pershing for his review. It will then be sent to the Academic Senate to be placed on the information calendar for the next Senate meeting.

Sincerely,

David B. Kieda
Dean, The Graduate School

Encl.

XC: Ross T. Whitaker, Director, School of Computing
Richard B. Brown, Dean, College of Engineering

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The Graduate School - The University of Utah

GRADUATE COUNCIL REPORT TO THE SENIOR VICE PRESIDENT
FOR ACADEMIC AFFAIRS AND THE ACADEMIC SENATE

April 24, 2017

The Graduate Council has completed its review of the School of Computing. The External Review Committee included:

Polina Golland, PhD
Professor, Department of Electrical Engineering and Computer Science
Massachusetts Institute of Technology

Gregory D. Hager, PhD
Director, Malone Center for Engineering in Healthcare
Mandell Bellmore Professor, Department of Computer Science
Johns Hopkins University

Elizabeth Mynatt, PhD
Executive Director, Institute for People and Technology
Professor, School of Interactive Computing
Georgia Tech University

The Internal Review Committee of the University of Utah included:

Jeffrey L. Coles, PhD
Professor
Department of Finance

Carol Sansone, PhD
Professor
Department of Psychology

Peter Trapa, PhD
Professor and Chair
Department of Mathematics

This report of the Graduate Council is based on the self-study submitted by the School of Computing, the reports of the external and internal review committees, and responses to the external and internal reports from the School Director and College Dean.

SCHOOL PROFILE

Program Overview

The School of Computing is part of the College of Engineering. It was founded by three engineering professors in 1965, became a department in 1973, and a school in 2000. The mission of the School is to tackle the problems of real-world complexity through excellence in research; produce computer and computational scientists with core knowledge that allows them to perform at the highest levels of industry, academics, and government; provide computer science knowledge to students across the University; and share the School's computer expertise and talent with industry, government, educators and the community.

The School is nationally and internationally recognized for its research activity. In addition to core research spanning the entire field of computer science (e.g., algorithms, computer architecture, programming, networking, human computer interaction, data science, visualization, security, robotics), the School has a number of strong interdisciplinary educational and research programs. It is closely affiliated with the University's Scientific and Imaging (SCI) Institute, a University research institute focusing on visualization, scientific computing, and image analysis applications (primarily in medicine but also manufacturing, defense and energy). The School offers a certificate in Entertainment Arts and Engineering (i.e., "computer gaming") within the Computer Science BS degree, developed jointly with the Department of Film and Media Arts in the College of Fine Arts. The School also interacts with the University's Center for High Performance Computing (HPC), which provides dedicated HPC support to the University.

The School offers several degrees and options, some jointly with other programs: BS degrees in Computer Science and Computer Engineering, a BS/MS in Computer Science, and MS and PhD degrees in Computer Science and Computing. Student interest in computer science and employer demand for computing skills has skyrocketed since the last review, and there is no end in sight. The School has been increasing admissions by about 10 percent a year. The School's faculty headcount has increased substantially since the last review, and declared undergraduate majors have increased by about 50%. Perhaps most striking is the appeal of computer science among non-majors; declared "pre-majors" increased by 160% since the last review. Computing skills are essential to many students across the University who will not graduate with computer science degrees, and the market is hungry for people with programming skills. Growth in the field has placed enormous pressure on the School to keep up with demand, and by all accounts, the School is responding admirably.

The School faces important challenges, especially with respect to its physical space, but otherwise seems well positioned to further enhance its national and international stature. Important to the School's future success will be developing a crisp vision of areas of strength to guide future growth. Because computing is penetrating just about every field of inquiry, clarifying its place within the University and further institutionalizing relationships with the rest of the University will also be important.

Faculty

Faculty size has increased substantially since the last review (about 25% according to the external review team and 30% according to the internal review team). The faculty is composed of 41 tenure-line faculty members and eight career-line faculty. There is a large junior faculty (15 members), and both review teams observed that they are extremely happy, engaged, and committed. The faculty is somewhat bottom heavy, which creates a larger than desired service burden on tenured professors, but that situation should resolve as junior faculty are promoted.

The Scientific Computing and Imaging (SCI) Institute is associated with the School. SCI is a flagship research organization that includes about nine faculty who are counted as regular School of Computing faculty for all purposes. However, SCI faculty are not part of the School's budget, and they are housed in a separate building. SCI coordinates its faculty hiring with the School.

The faculty is extremely productive. Research expenditures have more than doubled since the last Graduate Council review (from $10.8M to $21.3M), and the current level of funded research on a per faculty basis compares favorably with top 20 computer science departments. The external review team feels that the School's visibility is not in line with the quality of its research program. To increase its public presence, it encourages greater involvement in national and international advisory boards, professional societies, and funding agencies (CCC, CRA, PCAST, NSF, NIH, ACM, IEEE, NAS) and/or creating a national academic advisory board. The School is already acting on this recommendation; the School Director reports that the faculty has agreed to form an Award Committee, to better promote and increase visibility of the faculty's achievements.

The School relies heavily on its career-line faculty to deliver instruction in its undergraduate courses. Career-line faculty will continue to be essential to supporting expanding enrollments, particularly in computer science courses for non-majors. The School implemented new titles and promotion paths for career-line faculty since the last review. Career faculty are positive about these revisions. However, they continue to express uncertainty about the standards for promotion. Some lecturing career faculty members told the internal review team that they feel undervalued. To improve this situation and prepare for the inevitably increasing role of career-line faculty in the School's educational mission, the external review team suggests that the School should disaggregate expectations of research versus instructional career-line faculty to create clear paths and expectations for promotion, put in place structures for mentoring and career development of career-faculty, and clarify the role of career-line faculty in faculty governance. The internal review team also picked up these concerns and concurred that it is in the best interest of everyone involved to establish a professional identity and clear role of lecturing faculty members in the School. The Dean of the College states in his response letter that the College of Engineering resolved these issues by drafting guidelines for the promotion of career-line faculty, yet it seems that there may be remaining issues that need to be investigated and addressed.

Diversity of the faculty continues to be a challenge, although the external review team explains that this is a common issue for computer science departments. Based on OBIA data provided in the self-study, the School's faculty is 88% male, 12% female and 76% white, 12% Asian, and 12% unidentified ethnicity. The demographics of the tenure-track faculty, which is often a useful gauge of a department's future demographic profile, is similar: 87% male, 13% female; 73% white, 20% Asian, 7% unidentified. Perhaps the most promise is apparent from data on the School's new hires since 2009: 11 were white men (61%), 4 were Asian men (22%), 2 were white women (11%), and 1 was an Asian woman (6%). This breakdown suggests that the School is on par with national trends in hiring Asians and slightly behind in bringing in women. (Asians accounted for 27.6% and women 20.3% of new hires nationally in 2014-2015). The School's future demographic profile will also depend on retaining diverse faculty members. The self-study reports that two Hispanic tenured professors resigned in 2011 (a female and a male). In addition, three women declined tenure-track offers since 2009. Despite the clear challenges, improving diversity, in particular increasing the number of female faculty, should continue to be a goal according to the external review team.

Students

Overall, both undergraduate and graduate students are very happy and feel they receive the information and support they need to succeed in the program.

In the undergraduate program, there has been an explosive increase in demand for computer science classes. Enrollments have increased. The School has managed the increased demand through well-thought-out admissions criteria, and it continues to fine tune its admissions criteria based on GPA and graduation statistics of current students to predict who will succeed in their program. The School works hard to accommodate schedules of undergraduates who commute, which is a large percentage. Overall, students interviewed by both teams are extremely happy with the program and the faculty, and the job market for School of Computing undergraduates is strong. Many undergraduate students would like to be more involved in research, and the external review team made several suggestions that would support integration of undergraduates in the School's research mission (e.g., creating a website posting research opportunities, research fairs, adding research-focused seminar courses, etc.).

The School has two graduate degrees, one in Computing and one in Computer Science, with master's and PhD options in both programs. Applications have about doubled in the last five years and the quality of incoming graduate students has increased. Whereas most of the PhD students are fully supported, only a small percentage of master's students receive funding. Both teams noted this situation but neither flagged it as one for concern, as master's students generally complete the program to obtain a better job and salary boost than they could have otherwise. Like the undergraduate students, graduate students are extremely happy, well trained, and rewarded with excellent jobs upon graduation; their main challenge is high quality lab space (discussed below).

Every student has a staff advisor who tracks the student's progress; advisors are available to help students navigate degree requirements and course selection. Students uniformly praise the advising they receive, and both review teams commended the School for its outstanding advising for all students even as the School is operating at capacity.

There are 40 undergraduate TAs in the department, as well as graduate TAs (number unspecified), selected through a competitive process. The TA program is quite professionalized. The School has developed an online system to recruit, assign, and evaluate TAs. All TAs attend training sessions and international TAs must pass an English proficiency test. Before serving as a TA, undergraduate students must also complete a course on teaching methods covering topics such as classroom demeanor, presentation skills, time management, helping students in different contexts such as labs, email, office hours, and grading. Students interviewed who had served as TAs report that these are very valuable experiences and suggest that TA opportunities should be expanded.

The external review team notes that the PhD program is relatively small compared with the size of the faculty and that the size of the program has remained flat (about 125 students each year since 2009). It notes that the School will need to grow the size of the PhD student body to support growth of the School's research activities. This should be attainable as the School's visibility catches up with its impressive academic profile. There is excellent financial support for the PhD students. The School recently implemented a graduate fellowship program through which all incoming PhD students are supported by a fellowship in their first year, allowing them to explore different areas of research early in their program. In return, they serve as "teaching mentors" (TMs) in courses typically taught by their research advisors and aligned with their PhD topic later in their studies. The external review team praised the School for smart leveraging of this University resource, and the internal review team reports that graduate students were generally positive about the new fellowship/TM program. Students would appreciate a more organized mechanism for matching TMs with faculty members. The School has a thoughtful PhD advising system whereby all PhD students must report annual progress in writing, and these reports are then reviewed by the Director of Graduate Studies. The external review team suggests further improvement to PhD advising through faculty review and discussion of the progress reports. (Presently, only graduate advisors read the progress reports.)

The School has made substantial progress in achieving student diversity. For example, the percentage of women and underrepresented minorities enrolled in the undergraduate program has approximately doubled in the past seven years. Still, only 11% of the School's undergraduates were women and 10% underrepresented minorities in 2015-2016. This is below the national average across all categories. (According to the self-study, 15.7% of Computer Science degrees nationally are awarded to women and 13.4% to underrepresented minorities. Because the self-study compares the School's *enrollment* data with national *degrees awarded* data, the discrepancy may be understated.) The challenge is in both admission and retention. Less than one-half of students achieve a high enough grade in the initial required pre-major courses to advance to full major status, and OBIA headcount data comparing pre-majors and majors suggest that the attrition rate is higher for women and certain underrepresented minorities (e.g., African Americans, Latinos). The School is acutely aware of the retention problem. For the self-study, it gathered and analyzed some course-specific enrollment data to get a clearer picture of the pipeline. From this analysis, it concludes, "classes are not sufficiently diverse from the first course, and at every course level, the percentage of women and minority students drops."

Both teams commended the School for its efforts to retain underrepresented students. For example, the School raised the GPA threshold triggering advising. It is working to establish a slower lane leading to a degree in the field, beginning with a gentler "on-ramp" course, Foundations of Computer Science (CS 1030), for students who have no background in computing. It is also considering creating a BS in Computing that would be distinct from the BS in Computer Science. On the recruitment front, the School has dedicated significant energies to a range of activities to attract women, and to some extent, underrepresented minorities, including two new scholarships for women (as of 2011) and several summer camps and outreach programs designed to enhance K-12 appreciation and understanding of computer science. Both teams urge the School to continue its efforts to improve diversity. The external review team notes the competitive environment in the pre-major courses, which may intimidate students who were not exposed to the subject before college (disproportionately women and underrepresented minorities), and the internal review teams characterize the intro courses as a "weed-out" process. Making introductory courses more accessible so as to attract and retain a broader range of students is encouraged by the external review team. That may be achieved, for example, by increasing the number and diversity of TAs[1] adding classes that connect software programming to subjects like biology; and emphasizing real world, meaningful applications. Understandably, the School does not wish to substantially reduce its academic standards, and neither team suggested this course of action.

The graduate student body is more diverse, in significant part because international students represent a larger fraction of the graduate admissions pool and affect the diversity of the graduate student body. International students comprise 74% and 55% of the School's MS and PhD programs, respectively. There has been an impressive increase in enrollments of women graduate students since the last review. For example, from 2009 to the present, the percentage of women in the MS program more than tripled (growing from 9% to 28% of MS students) and the percentage of women in the PhD program approximately doubled (growing from 13% to 22%). These figures compare favorably with national averages. The School has had less success in increasing the proportion of underrepresented minorities in its graduate program. Since 2009-2010, there have been two underrepresented minority PhD students (less than 1% average) and 26 underrepresented minority MS students (3% average). This is less than the national average for both degrees (reported as 4% in the self-study, although data from the national survey cited in the self-study indicate the figure is 14%).

Curriculum

The School's educational programs are well constructed and recent revisions to the curriculum are well executed. The School offers Bachelor of Science degrees in Computer Science and (jointly, with the Electrical and Computer Engineering Department) Computer Engineering, with further differentiation through electives into 12 tracks, leading to a certificate of completion in the chosen track upon graduation. Computer Engineering majors have a different set of electives specific to engineering. There is a unique optional emphasis for Computer Science majors in Arts & Engineering (EAE), an interdisciplinary emphasis in digital entertainment, which receives extremely positive reviews and takes advantage of synergies with other disciplines in the University such as engineering, film, and art. The School's programs of study are very structured, with the tradeoff of leaving little room for experimentation or late entry into the major. The curriculum provides many opportunities for professional development and exposure to the kinds of work graduates might encounter in the workplace. Importantly, students participate in a required yearlong senior capstone project in which they work in four-member teams to develop and complete a software project and communicate the project's ideas and outcomes to others.

The graduate program offers two degrees, Computer Science and Computing. Both degrees are available at the master's and PhD levels. The master's degree allows for course-only, project-based, or thesis-based degree completion. The Computing degree implements a track structure with eight tracks. There has been discussion of merging the two graduate degrees into a single degree in Computer Science with tracks. According to the external review team, this would be more consistent with other programs. Like the undergraduate program, the graduate program provides opportunities to further students' professional development. For example, the School encourages students to participate in summer internships, and it sponsors a distinguished lecture series in partnership with Goldman Sachs, where speakers from academia and industry share their research and work life with graduate students. According to the external review

[1] Enrollments in CS 5040, the required TA training course for undergraduates who teach large introductory-level courses, consisted of 100% white male students in 2014-2015 and 2015-2016, according to OBIA course enrollment profile data.

team, the PhD program is well constructed and on par with programs within top-ranked institutions, and both teams observed that the procedures for master's thesis defense and for submitting and defending a PhD dissertation are well documented, clear, and run smoothly.

Program Effectiveness and Outcomes Assessment

The School of Computing has developed learning outcomes and implemented a comprehensive set of processes for collecting data relevant to program effectiveness and outcomes. Data sources are many and varied and include course evaluations, internship feedback, the undergraduate and graduate student advisory councils, judges of senior capstone projects, exit surveys at the time of graduation, alumni surveys, two industry advisory boards, and external assessment of the Computer Engineering program, which is ABET accredited. The school has analyzed and interpreted the data and used this information to adjust the content and sequencing of the curriculum, as well as other important programmatic matters. For example, based on student feedback, the School decided to offer required courses more frequently to reduce class size and increase retention (students who must repeat a gateway course now do not have to wait a year). On the advice of industry advisors, the School added course offerings in several cutting-edge topics, particularly those related to data management and analysis ("big data"). The external review team noted that the School has not, however, systematically collected information on diversity and barriers to student success (e.g., the competitive environment of required introductory classes), and the faculty does not meet yearly to review PhD candidate progress.

In most years, the School's six-year undergraduate graduation rate has beat the University average by about 5 percentage points. The job market for the School's graduates is very strong, with projected growth in computer science and related fields of about 25% in the coming decade. Students feel they are well prepared for careers in computing and computer science, and data from Career Services suggests their salaries are above those of graduates from similar programs nationwide. The School reports that the median current salary for its graduates is $100,000. Alumni are also pleased with the School's graduates. Graduate students have obtained positions as research scientists, professors (of various categories and ranks), postdocs, design engineers, and software engineers. Thesis-based master's students and PhD students appear to complete rigorous, relevant theses and dissertations, as apparent from the titles and abstracts provided in the self-study.

Facilities and Resources

The School leadership has thoughtfully managed its budget and has wisely leveraged university resources (such as graduate fellowships) during a time of rapid growth. The School maintains state-of-the art computing facilities for instruction and research. Its technology resources include more than 550 machines, several labs, and several dedicated computing facilities. There is adequate staffing for now, and staff morale is generally good. Even though the staff is running at capacity, they feel they are part of a team and that there is a positive work environment. Staff are uniformly praised by students and faculty for the quality of support and services they provide. Increased staff will be necessary in the future with the inevitable growth of the School.

Reviewers identified two immediate resource needs. The external review team states that the student to teaching assistant ratio (40 to 1) is quite a bit higher than their institutions; resources are needed to fund additional teaching assistant positions. The external review team feels this is crucial to furthering the goal of diversifying the student body. They note that evidence suggests that with increased intellectual support and encouragement, students without prior exposure to the field learn that they can succeed through hard work and that they do not need esoteric knowledge or an innate gift. The School's self-study indicates that it is in agreement with the assessment and states that it is making efforts to improve student-TA ratios in several challenging, required classes. Both review teams identify limited physical space as a serious concern. The School currently borrows space from other units in the College of Engineering. There are fewer offices than faculty, and space for research labs is inadequate. These physical limitations inhibit productivity of the faculty and make it difficult to recruit faculty and graduate students. The School will need to expand the graduate student body (and research space) in order to increase its faculty size and build its research program. Given the massive projected growth of the student and degree population, the School's need for a new building is urgent.

COMMENDATIONS

1. The School is managing explosive growth in the field and demand for computer science courses exceptionally well. It has expanded enrollments substantially without sacrificing educational quality.

2. The School is an exceptionally well-run organization with a positive culture and thoughtful and clear policies and procedures. Students are supported and know what is expected of them; staff are very satisfied with their professional lives even though running at capacity; and faculty are extremely productive. This is a testament to the strength of the current leadership team.

3. The School's faculty maintains an extremely productive research program, comparing favorably to top-20 computer science programs. The School has excelled in recruiting and mentoring outstanding junior faculty, and there has been impressive growth in funded research since the last review.

4. The School's educational programs are top-notch. Undergraduate students benefit from individualized and accessible curricular advising, excellent classroom instruction, a current and well-designed curriculum with clear tracks, TA opportunities with excellent training, and a senior capstone experience. The graduate programs are well constructed and PhD students benefit from full support through a new fellowship system. The graduation rate of CS students is higher than the University's and graduates have excellent job and salary prospects.

5. The School has made impressive strides with regard to student diversity since the last Graduate Council review. The percentage of female and underrepresented minority undergraduate students has about doubled and the percentage of female graduate students has more than tripled.

RECOMMENDATIONS

1. The School needs to develop a strategic plan articulating its areas of strength and vision of its role in the larger University. This was recommended in the last review. In developing the plan, the School may want to consider, in coordination with the College and administration, building on the School's existing interdisciplinary strengths through new interdisciplinary programs, ABET accreditation of the undergraduate program, and financing a new building.

2. The School should continue to experiment with and adjust its undergraduate admissions criteria and process in order to get more students into the major while ensuring a high probability of success. The competitive entrance requirements for the School's major drive the program's outstanding reputation. At the same time, the severe restrictions have tradeoffs in the form of not fully meeting the demands of the regional and national economy, losing students to other educational institutions, reduced diversity, and the problem of satellite programs and courses popping up in other parts of the University.

3. The School should more clearly articulate career paths and expectations of career-line faculty. Toward that end, it should consider teasing apart the promotion standards for research and lecturer categories of faculty and provide mentoring for junior career-line faculty in a manner similar to the tenure-track faculty. The School should also clarify the role of career-line faculty in faculty governance, and more generally, be clear about what they are invited to attend and what they are not.

4. The School should work to increase undergraduate engagement with the faculty through more direct faculty advising and integration of undergraduates into faculty research. Along the same lines, it should convene an annual meeting to review and discuss the progress reports of PhD students.

5. The School should undertake efforts to establish greater visibility through expanded involvement in national and international advisory boards, professional societies, and funding agencies. Creating an academic advisory board, with members from other institutions, is also recommended to both promote visibility and obtain timely feedback on the School's activities.

6. The School needs to improve diversity at all levels. The most urgent situation is the undergraduate student population. Toward this end, suggestions from reviewers are many and include: systematically collecting diversity data and using it to monitor efforts (which may require supplementing OBIA data with timely and accurate homegrown information); addressing the culture of competition in introductory classes; providing more flexible class scheduling; and expanding the number and diversity of undergraduate TAs. The School also indicated a plan to tweak admission requirements with an eye to increasing diversity. Hiring more female faculty should remain as a long-term goal.

Submitted by the Ad Hoc Committee of the Graduate Council:

Laura T. Kessler (Chair)
Professor, S.J. Quinney College of Law

Lien Shen
Associate Professor, Department of Film and Media Arts

Ryan E. Smith
Associate Professor, School of Architecture

Elizabeth Tashjian (Undergraduate Council Representative)
Associate Professor, Department of Finance

College Name
College of Engineering

Department Name
Computer Science

Program Name
All

Faculty Headcount

		2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
With Doctoral Degrees Including MFA and Other Terminal Degrees	Full Time Tenured Faculty	25	24	22	22	24	23	23
	Full Time Tenure Track	6	5	8	11	9	10	11
	Full Time Career Line/Adjunct Faculty	5	7	9	9	9	8	10
	Part Time Tenure/Tenure Track		2	3	1	1	3	2
	Part Time Career Line/Adjunct Faculty							
	Total	36	38	42	43	43	44	46
With Masters Degrees	Full Time Tenured Faculty	0	0	0	0	0	0	
	Full Time Tenure Track	0	0	0	0	0	0	
	Full Time Career Line/Adjunct Faculty	0	0	0	0	0	0	
	Part Time Tenure/Tenure Track		0	0	0	0	0	
	Part Time Career Line/Adjunct Faculty							
	Total	0	0	0	0	0	0	
With Bachelor Degrees	Full Time Tenured Faculty	0	0	0	0	0	0	
	Full Time Tenure Track	0	0	0	0	0	0	
	Full Time Career Line/Adjunct Faculty	0	0	0	0	0	0	
	Part Time Tenure/Tenure Track		0	0	0	0	0	
	Part Time Career Line/Adjunct Faculty							
	Total	0	0	0	0	0	0	
Total Headcount Faculty	Full Time Tenured Faculty	25	24	22	22	24	23	23
	Full Time Tenure Track	6	5	8	11	9	10	11
	Full Time Career Line/Adjunct Faculty	5	7	9	9	9	8	10
	Part Time Tenure/Tenure Track		2	3	1	1	3	2
	Part Time Career Line/Adjunct Faculty							
	Total	36	38	42	43	43	44	46

Cost Study

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Direct Instructional Expenditures	5,971,781	5,981,659	6,850,875	7,585,059	8,452,161	9,301,806	7,332,527
Cost Per Student FTE	10,943	10,287	10,703	11,325	10,315	12,556	9,226

FTE from Cost Study

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Full-Time Salaried	44	46	52	50	48	47	61
Part-Time or Auxiliary Faculty	0	1	1	2		0	13
Teaching Assistants	1	1		1			

Funding

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Total Grants	5,727,917	5,917,936	6,109,168	7,586,835	8,781,791	10,745,237	12,450,797
State Appropriated Funds	5,405,025	5,500,259	5,699,661	5,803,257	6,128,556	7,566,343	6,021,953
Teaching Grants	453,083	550,790	579,145	807,239	190,417	319	0
Special Legislative Appropriation*							
Differential Tuition*							

Student Credit Hours and FTE

		2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
SCH	Lower Division	4,608	4,743	5,259	5,436	6,458	6,871	7,261
	Upper Division	5,301	5,747	6,810	7,299	8,596	7,858	8,917
	Basic Graduate	2,461	2,736	3,123	3,389	4,731	3,581	3,742
	Advanced Graduate	1,848	1,901	1,634	1,518	1,621	1,417	1,368
FTE	Lower Division	154	158	175	181	215	229	242
	Upper Division	177	192	227	243	287	262	297
	Basic Graduate	123	137	156	169	237	179	187
	Advanced Graduate	92	95	82	76	81	71	68
FTE/FTE	LD FTE per Total Faculty FTE	4	3	3	4	5	5	3
	UD FTE per Total Faculty FTE	4	4	4	5	6	6	4
	BG FTE per Total Faculty FTE	3	3	3	3	5	4	3
	AG FTE per Total Faculty FTE	2	2	2	1	2	2	1

Enrolled Majors

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Undergraduate Pre-Majors	184	204	272	353	471	597	665
Undergraduate Majors	313	366	414	421	453	466	505
Enrolled in Masters Program	100	127	128	131	151	165	131
Enrolled in Doctoral Program	123	127	121	121	129	122	134
Enrolled in First Professional Program							

Degrees Awarded

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Undergraduate Certificate							
Graduate Certificate				1			1
Bachelors	82	92	90	108	114	117	127
Masters	44	51	51	60	56	92	75
Doctorate	16	12	15	19	19	21	13
First-Professional							

Memorandum of Understanding
School of Computing
Graduate Council Review 2016-17

This memorandum of understanding is a summary of decisions reached at a wrap-up meeting on June 12, 2017, and concludes the Graduate Council Review of the School of Computing. Ruth V. Watkins, Senior Vice President for Academic Affairs; Richard B. Brown, Dean of the College of Engineering; Ross T. Whitaker, Director of the School of Computing; David B. Kieda, Dean of the Graduate School; and Katharine S. Ullman, Associate Dean of the Graduate School, were present.

The discussion centered on but was not limited to the recommendations contained in the review summary report presented to the Graduate Council on April 24, 2017. The working group agreed to endorse the following actions:

Recommendation 1: The School needs to develop a strategic plan articulating its areas of strength and vision of its role in relation to the larger University. This was recommended in the last review. In developing the plan, the School may want to consider, in coordination with the College and administration, building on the School's existing interdisciplinary strengths through new interdisciplinary programs, ABET accreditation of the undergraduate program, and financing a new building.

The group had an extended discussion of issues related to this recommendation, including the current administrative relationship between the School and the College, which the Director and Dean Brown agree is stable and mutually beneficial. Director Whitaker has a strategic plan underway and anticipates that it will be complete in Fall 2017. The group discussed the importance of making this plan dynamic and directional, rather than being overly prescriptive. With regard to the particular issues brought up in this recommendation, initiatives to achieve ABET accreditation and to finance a new building are already underway. The latter goal is urgent in order to accommodate the needs of student demand and this job market sector. Finding a naming donor for the building is a University priority. From the discussion, other components of the strategic plan will be goals for working with different entities on campus, key metrics to track, and a general plan for disciplinary areas of expansion, along with guiding principles to balance this with opportunities that arise.

Recommendation 2: The School should continue to experiment with and adjust its undergraduate admissions criteria and process in order to get more students into the major while ensuring a high probability of success. The competitive entrance requirements for the School's major drive the program's outstanding reputation. At the same time, the severe restrictions have tradeoffs in the form of not fully meeting the demands of the regional and national economy, losing students to other educational institutions, reduced diversity, and the problem of satellite programs and courses popping up in other parts of the University.

While the completion rate in the School of Computing is higher than the University average, understanding factors that contribute to attrition remains a priority. Director Whitaker is committed to delving into the data and will work with Mike Martineau (OBIA) to access data regarding student retention and completion. This should be useful both to evaluate progress and to devise new strategies. For instance, if a significant number of students are on track to finish, but leave abruptly, they may have found a good employment opportunity or otherwise had financial pressure to leave early. Making sure that students become more aware through advising that there are capstone options that could be completed in an industry setting may be helpful. Alternatively, offering completion scholarships for students near the finish line might be effective. Finally, if students are switching out of the major, but still finishing a degree at the University, this may still be a concern for the School, but is less detrimental as a whole. This population of students might benefit from 'CS + X' -- a new degree format that the School is beginning to experiment with that allows computer science to be combined with a particular discipline. Such a degree option may also address the issue of satellite programs and lead to exciting interdisciplinary opportunities. Likely, augmenting student success will require a multi-pronged approach, but prioritizing these and other options based on available data will be most efficient. See Recommendation 6 for further discussion about entrance requirements as they relate to student diversity.

Recommendation 3: The School should more clearly articulate career paths and expectations of career-line faculty. Toward that end, it should consider teasing apart the promotion standards for research and lecturer categories of faculty and provide mentoring for junior career-line faculty in a manner similar to the tenure-track faculty. The School should also clarify the role of career-line faculty in faculty governance, and more generally, be clear about what they are invited to attend and what they are not.

The group discussed the fact that career-line faculty are integral to the success of the School. Those involved in teaching play a very impactful role in the education arena. Overall it was felt that concerns raised during the review are addressed by new policies and procedures now in place, including the recent implementation of multi-year appointments. However, there may be opportunities to find additional ways to acknowledge the important role of these individuals, from further highlighting their accomplishments at the College level to finding chances to nominate outstanding career-line faculty for awards beyond the College boundary. Importantly, in the Director's written comments, he expressed the intention to "continue to engage career-line faculty directly to better understand issues relating to job satisfaction." This type of ongoing, open dialogue itself creates a positive environment, with the potential to further adapt as needed.

Recommendation 4: The School should work to increase undergraduate engagement with the faculty through more direct faculty advising and integration of undergraduates into faculty research. Along the same lines, it should convene an annual meeting to review and discuss the progress reports of PhD students.

Finding opportunities to get undergraduates involved in research is recognized as a priority. The external review report had several suggestions that could be implemented. The faculty will discuss this further at an upcoming retreat and in faculty meetings. With regard to faculty advising, particularly on career-related topics, a challenge is how to distribute this evenly and still have it be uniformly effective. One option brought up was to make a general policy that faculty office hours could be used both for class-related questions and as an opportunity to get input on advising topics, particularly career paths and preparation. Students would align more naturally with faculty and subdisciplines that match their interests. Regarding annual meetings to review and discuss PhD student progress, this is something that presently occurs and will continue. This is both a way to keep momentum toward completion for graduate students, and also an opportunity to mentor junior faculty on graduate student supervision.

Recommendation 5: The School should undertake efforts to establish greater visibility through expanded involvement in national and international advisory boards, professional societies, and funding agencies. Creating an academic advisory board, with members from other institutions, is also recommended to both promote visibility and obtain timely feedback on the School's activities.

Director Whitaker intends to form an advisory board comprised of academic leaders and perhaps nationally recognized leaders in industry as well. He is also planning to hire a staff member who would oversee initiatives to publicize the School of Computing and further raise its visibility. A faculty awards committee has been formed to make a more comprehensive effort to nominate peers for recognition. It is anticipated this will go hand in hand with expanded involvement and exposure of faculty at the national and international level. These initiatives build on effort that has already gone in to improving the School's web presence and outreach via both social media and an annual report. It is hoped that gaining higher visibility, which reflects the success and accomplishments of the School's faculty, will underpin growth in the graduate student program.

Recommendation 6: The School needs to improve diversity at all levels. The most urgent situation is the undergraduate student population. Toward this end, suggestions from reviewers are many and include: systematically collecting diversity data and using it to monitor efforts (which may require supplementing OBIA data with timely and accurate homegrown information); addressing the culture of competition in introductory classes; providing more flexible class scheduling; and expanding the number and diversity of undergraduate TAs. The School also indicated a plan to tweak admission requirements with an eye to increasing diversity. Hiring more female faculty should remain as a long-term goal.

This recommendation is intertwined with Recommendation 2 above. When collecting data on contributing factors to attrition, understanding how this overlays with student diversity will be informative and there may be specific way to tailor strategies to this population. The School is highly engaged in finding ways to bring a more diverse population of students into this area, which dovetails with broader goals of the Engineering Initiative. The potential benefit of a pre-test 'inventory' to aid in placement was discussed, and initiatives to create a softer on-ramp into the major were described in the self-study. Robust advising, as well as increased numbers of TAs (who themselves are eventually more diverse), are also identified as important factors in student success. The School has a well-developed system for TA training that provides an excellent base for growth. The group also discussed 1) making sure that the resources already in place (such as support given to female students to attend conferences, and organizations such as the Society of Hispanic Professional Engineers) are well-publicized, and 2) exploring ways to become integrated in the initiatives of UPSTEM, a recently funded program to bring diverse students into math and science. The School has a Diversity Committee that can help with these efforts, as well as devise further creative solutions to promote diversity among students and faculty.

This memorandum of understanding is to be followed by regular letters of progress, upon request of the Graduate School, from the Director of the School of Computing. Letters will be submitted until all of the actions described in the preceding paragraphs have been completed. In addition, a three-year follow-up meeting may be scheduled during AY 2019-20 to discuss progress made in addressing the review recommendations.

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August 28, 2017