S.20-136

SFU OFFICE OF THE VICE-PRESIDENT, ACADEMIC AND PROVOST

8888 University Drive, Burnaby, BC
DISC 1 | 1625
Canada V5A 1S6

TEL: 778.782.5731
FAX: 778.782.5876

vpacad@sfu.ca
www.sfu.ca/vpacademic

MEMORANDUM

ATTENTION	Senate	**DATE**	October 28, 2020
FROM	Jon Driver, Vice-President, Academic and Provost *pro tem,* and Chair, SCUP	**PAGES**	1 of 1
RE:	External Review of the School of Computing Science (SCUP 20-45)		

At its October 21st, 2020 meeting, SCUP reviewed and approved the Action Plan for the School of Computing Science that resulted from its External Review.

The Educational Goals Assessment Plan was reviewed and is attached for the information of Senate.

Motion
That Senate approve the Action Plan for the School of Computing Science that resulted from its External Review.

C: M. Hefeeda, E. Fiume, and G. Nicholls

SFU OFFICE OF THE VICE-PRESIDENT, ACADEMIC

SCUP 20-45

TEL +1 778 782 3925
FAX +1 778 782 5876
sfu.ca/vpacademic

Simon Fraser University
Discovery 1, Rm 1625
8888 University Drive
Burnaby BC
Canada V5A 1S6

MEMORANDUM

Attention: Jon Driver, Chair, SCUP

From: Wade Parkhouse, Vice-Provost and Associate Vice-President, Academic

Re: Faculty of Applied Sciences: External Review of the School of Computing Science

Date: September 29, 2020

Attached are the External Review Report and the Action Plan for the School of Computing Science. The Educational Goals Assessment Plan is included, for information only, with the Action Plan.

Excerpt from the External Review Report:
"The School of Computing Science offers a variety of programs at both graduate and undergraduate levels. All of these are of high quality and very much in line with those of other strong Canadian Computer Science departments. The educational goals are rock solid. There are a variety of options in the Computing Science major."

Following the site visit, the Report of the External Review Committee* for the School of Computing Science was submitted in April 2020. The Reviewers made a number of recommendations based on the Terms of Reference that were provided to them. Subsequently, a meeting was held with the Dean of the Faculty of Applied Sciences, the Director of the School of Computing Science, and the Director of Academic Planning and Quality Assurance (VPA) to consider the recommendations. An Action Plan was prepared taking into consideration the discussion at the meeting and the External Review Report. The Action Plan has been endorsed by the School and the Dean.

Motion:

That SCUP approve and recommend to Senate the Action Plan for the School of Computing Science that resulted from its external review.

---

*External Review Committee:
Ian Munro, University of Waterloo (Chair of External Review Committee)
Paul Beame, University of Washington
Ming Lin, University of Maryland College Park
Carman Neustaedter (internal), Simon Fraser University

Attachments:
1. External Review Report (April 2020)
2. School of Computing Science Action Plan
3. School of Computing Science Educational Goals Assessment Plan

cc Eugene Fiume, Dean, Faculty of Applied Sciences
Mohamed Hefeeda, Director, School of Computing Science

School of Computing Science
Simon Fraser University
External Review Committee Report

The review committee, consisting of Dr. Paul Beame[1], Dr. Ming Lin[2], Dr. Ian Munro[3] and Dr. Carman Neustaedter,[4] was provided with various forms of documentation including a detailed 83 page self-study report of the School of Computing Science. Over a three-day period, the committee met with administration and most of the faculty and staff of the school, as well as representatives of graduate and undergraduate students. Meetings were held at both the Burnaby and Surrey campuses of SFU. Having an internal committee member from a related department was particularly valuable, though the findings and opinions expressed below are primarily those of the external members.

In writing this report, we do not attempt to speculate on any aspects related to the Covid 19 epidemic. Any detailed discussion of its impact on our part would be premature.

This report follows the topics and questions given in the terms of reference. Recommendations are made in the sections where they are relevant and then summarized in the final section.

1. Quality of the Unit's Programs

The School of Computing Science offers a variety of programs at both graduate and undergraduate levels. All of these are of high quality and very much in line with those of other strong Canadian Computer Science departments. The educational goals are rock solid. There are a variety of options in the Computing Science major. These are centred at the Burnaby campus, though courses are available at both campuses and, in light of enrolment pressures, efforts are being made to make it easier for students to pick up courses at either location. The Software Systems program, at the Surrey campus, is very much in line with Software Engineering programs at many Canadian universities, though most of these SE programs require a few more courses to meet the requirements of attaining Professional Engineering status. Similarly, the dual degree program with Zhejiang University is much like Waterloo's program with Tsinghua – both are excellent vehicles in attracting top students from China.

At the graduate level, the M.Sc. has admission only for the thesis option, with a project and course-work-only options essentially as "escapes". The Ph.D. program is, again, much like others with admission either directly from the bachelor's degree or from an M.Sc. The Professional Master's Program differs from, say, the Toronto program in that it focuses on two specializations: Big Data and Visual Computing. There is also a plan to introduce a third stream on Cybersecurity. The "non-research" focus does mean that there is not a lot of sharing of courses with the other graduate programs. Indeed, over half of these programs consist of courses aimed exclusively at students in the PMP program. More will be said about the benefits of this program and its demand on resources below.

[1] University of Washington
[2] University of Maryland College Park
[3] University of Waterloo, Committee Chair
[4] Simon Fraser University, School of Interactive Arts and Technology, Internal Member of Committee

At the undergraduate level, each of these programs and options has been well thought out and is of high quality. The only difficulty has been the School's ability to deliver the courses. *There have been too many instances in which students (in particular Computing Science majors) have been unable to take required courses in a timely manner. Steps have been taken to rectify this situation, but it remains a concern*.

Student progress is a related concern. At the graduate level, improvements have been made over the past five years to reduce the time taken for completion, though we do recognize the "commuting delay"[5]. The M.Sc. thesis program still takes an average of close to 2½ years, which is longer than most other Canadian universities. The typical Ph.D. program, taking between five and six years, is quite long, especially for students entering with a Master's degree. The introduction of milestones at the end of each of the first three years of the program is an attempt to "get students going". We expect this mechanism to help.

The more serious problem is with the undergraduate programs, especially with the Computing Science major. The average number of terms to complete this program is 17.3 terms[6]. This is almost six years, over two years longer than the nominal eight terms for a regular student and one year longer than the nominal for a co-op student. More telling is that the average number of courses taken by a "full-time" student[7] was about 3½. This number is not out of line with the School of Interactive Arts and Technology; however, it is out of line with other top Computer Science programs in the country. At Waterloo the average number of courses taken is about 4½ and at UBC it is similar. Why is SFU different? Two causes were noted above. First, required courses were unavailable, either by not being taught in a given term, or by being full. The other reason is that Simon Fraser is a "commuter university", the mean commute time, each way, is often an hour or more. A third reason, that came out in discussions with undergraduates, is attitude. None of the students with whom we spoke was taking a full five course load. One student described taking five course as "insane". A concern is that a prospective employer, comparing the SFU candidate with one from UBC, may feel that if this person in not up to taking a full load at university, then he/she may not be up to a full load as an employee. It was suggested that many students have part-time jobs, but this is true for many other institutions. The notion of delaying a degree in a subject with such high employment prospects as Computing Science by a year or two to avoid a student loan is indicative of rather odd financial planning.

Financial support at the graduate level is another area of some concern. Current full-time Master's degree students have a minimum support of $20,000 per year for five terms, $1^2/_3$ years[8]. Ph.D. students are, at present, guaranteed a minimum of $22,000 per year for four years[9]. We understand that these amounts are being raised to $21,000 and $24,000 respectively, which is pretty much in line with UBC's currently listed rates (presumably for students being accepted for fall 2020). This is somewhat below the minimum level at Toronto or Waterloo[10]. At Waterloo, for example, the basic funding is almost $26,000 for Master's for two years and almost $27, 000 for Ph.D. students (for four years with Master's or five on entry from Bachelor's degree). *We recommend that the minimum graduate support be raised substantially, by at least another $2,000 to at least $23,000 and $26,000 for Master's and Ph.D. students respectively for the*

[5] Explained below.
[6] We understand that in the data we were given, a "term" means one in which the student took at least one course or was on a co-op work term.
[7] Provincial regulations define such a student as one taking at least three courses.
[8] Again we note the mean time to completion is about 2½ years.
[9] We recall the mean time to completion is almost six years
[10] Tuition in Ontario is substantially higher for international students than for Canadians; however, special awards as well as higher support levels are generally given to cover this, so the comparisons we make are fair.

upcoming year. We understand that TAs are often given in fractional amounts. Duties of, say, four or five hours per week should not impair the student's progress as does a full TA. Though these partial TA positions are an option that could enhance graduate support, we expect that most of the funds required will still need to come from research grants.

Another disturbing aspect of graduate support is complications in the process of continuing such support from one term to the next*. We found instances of graduate student payment being delayed for months, essentially a term.* This was to the point that more than one student with whom we spoke had to apply to the graduate student association for a card to acquire food. It seems that there are impediments preventing smooth transitions from term to term. *This problem must be solved!*

2. Faculty Research

The quality of faculty research is very high. The School has 48 research faculty plus a good number of adjunct (external) and associate (internal to SFU) appointments. Over the past seven years, 20 research faculty appointments have been made, though due to losses, the School has grown minimally. Nevertheless, the research quality seems to have risen. There are now three Fellows of the Royal Society of Canada (FRSC), an ACM Fellow, an IEEE Fellow and a SIAM Fellow, plus several others who should be nominated for such fellowships, though the fact that two of the FRSCs were elected in the past year may be an indication that the School is already taking a more proactive role in this respect. There are no members of the School in the Royal Society's College of New Scholars, Artists and Scientists, though this is probably because of the hiring drought for several years before 2013. Ten faculty researchers have Google H-indices over 40, which is a reflection of impact of their publications. The School is particularly strong in Computer Vision, Computer Graphics and Databases.

Faculty collegiality is excellent and appears to provide a stimulating and collaborative environment. Computing Science seems to be the strongest research department of any substantial size at SFU. Taking into account the measures presented in the self-study report and other data such as a more detailed look at NSERC grants, SFU is clearly among the top eight CS Programs in the country, perhaps in the top five or six. A problem is that SFU is not generally recognized to be as strong in Computing Science as it actually is, though recent elections as FRSCs and similar recognitions should help. This issue was brought up in the terms of reference and is addressed again below.

3. Members in Administration of the Unit

In general, the Administration team of the School of Computing Science (CS) was well informed and aware of the key issues in CS and have managed the challenges reasonably well, especially considering the resource constraints. The administration team consists of the Director, *Mohamed Hefeeda*, Associate Director of Research and Industry Relations, *Richard (Hao) Zhang*, Graduate Program Director, *Ghassan Hamarneh*, Undergraduate Program Director, *Valentine Kabanets*, Program Director of Software Systems, Kay Wiese, and Associate Director of Administration, *Brad Bart*. During our visit, the presentations by the administrative team showed excellent command of their respective administrative duties. Their presentations were informative and well-balanced, indicating mastery of their knowledge of the unit.

However, the Review Committee feels that *the composition of both the Administration Team and the faculty body can be made more gender diverse* to better reflect the wider perspectives and needs of the general student population.

3.1 Adequacy of the Administration Size

Although the faculty administration in the School seems very competent, we found the administrative staff support to be inadequate for its current size, which really requires more low-level administrative support. For example, the number of assistants currently does not seem to be commensurate with the needs for better financial/accounting support for students and faculty, program development, or support to organize more conferences and various activities aimed at raising the visibility of the SFU Computing Science (CS) Programs. Overall, the size of staff seems comparably small and insufficient given the number of the students and faculty in CS. Although there appears to be a sufficient administration structure to handle the complexity of the School of Computing Science, there is clearly a shortage of well-trained, experienced staff. Furthermore, the staff members are mostly new with very little corporate memory. The School Academic Program Manager, Janet Morton, is scheduled to retire soon. With less than a dozen of the administrative staff, it is clear that *the School would need to hire more administrative staff to manage all these different degree programs and a very large number of students.*

3.2 Effectiveness of Administration

The Director of CS and Associate Directors of the CS seem to be running the unit well – each with well defined responsibilities that complement each other well. They have a clear understanding of the budget and how the unit and individual programs run. The School is running as efficiently as it possibly can, in spite of all the financial, staffing, and other administrative challenges.

3.3 Space & Facilities

The limitations of the School's facilities and instructional and research labs are a significant factor in limiting its potential. Faculty are all housed in one corridor, which is good for closeness and research connections, but that corridor is full and there is no space available for faculty growth in their current footprint. Indeed, faculty who are visiting in the School for an extended period of time and may have considerable collaborative and advisory roles can only be housed at individual graduate student desks in large labs. The School's undergraduate instructional labs on the Burnaby campus are also quite small. The School has made excellent use of its graduate research lab space, investing money in new furniture systems that have made the space of high quality and allowed the School to make much more efficient use of the space available, but things are tight enough that lab locations need to be re-juggled every year in order to fit all the students as the numbers of students associated with each lab grows and shrink; this disruption has a cost of its own. *It is hard to imagine being able to support significant new research initiatives or even growth in either the PhD student population or faculty contemplated by the School without significant new space on the Burnaby campus*.

In contrast, the instructional facilities on the Surrey campus are beautiful and new, though in Surrey the School's access to necessary office and meeting space is extremely limited. While the instructional labs and facilities are excellent, the offices in Surrey are very small and sometimes dysfunctional with layouts that are interrupted by large pillars. (Issues that make things worse such as inaccessible placements of whiteboards in offices will surely need to be corrected as part of building shake-out. Nonetheless, these

would not be suitable for meetings involving more than two participants who needed to work together, and so would not support research meetings well.)

While growth of the Software Systems program at the Surrey campus and the potential cross-departmental Quantum Initiative there are both desirable, space on that campus is not a substitute for housing faculty and graduate students working in other research areas on the Burnaby campus in close proximity to the other researchers and graduate students in Computing Science. Under the current system, there are some lecturers whose primary focus is on the Surrey campus while tenure-track faculty teaching courses in Surrey come for the half-day to teach their classes and hold office hours and return to the Burnaby campus for their research interactions. This seems to work well, and similar arrangements have been shown to be effective at other institutions. On the other hand, the close proximity of researchers to each other is a critical factor in their success. While the exact location of instructional space can be flexible, it very important that the research space and offices be in good proximity to each other. At other institutions, we have seen that relationships between researchers who are widely separated, even on the same campus, suffer from the isolation and atrophy. *The proximity of faculty offices is particularly important in Computing Science* where there are very fluid boundaries between research areas.

4. Environment

The School, as a whole, is, and has been, under a large amount of stress. Enrollments have grown dramatically over the time period since the last review. This has resulted in more than a 50% increase in the annual number of Bachelor's degrees and more than a 100% increase in the annual number of graduate degrees awarded over the last 5 years. Given the impact and demand for Computing Science as a discipline, it is not surprising that course enrollment demands by non-majors have also grown dramatically over the same time period. This impact and increased demand naturally has, and will continue to put pressure on the School to grow enrollments.

Meanwhile, the FTE faculty and FTE equivalent teaching resources have changed little. Even the current level of faculty FTE is at substantial risk because of a large number of impending retirements and potential departures of faculty currently on leave. We are concerned that there will be a major exodus in the next year or two; salaries are a significant issue that we address in section 6.4 below, as are levels of other forms of support from the university. With all of the increase in responsibilities, paradoxically, in the last couple of years, the School has suffered a severe cut in permanent staff[11], and has also had a demoralizing loss of autonomy.

We met with a cross section of faculty, almost all the staff, as well as representative groups from each of the four major categories of students on campus: undergraduates in CS at Burnaby and in Software Systems at Surrey; graduate students in the research graduate program and in the Professional Master's Program (PMP).

The students we met with were generally quite positive about their programs and the environment in the School. (We understand that the Software Systems program at Surrey had been in some question at the

[11] We understand that the latter point is being, a least partially, rectified.

time of the previous review. We can report that the Software Systems students were particularly happy with the quality and environment in their program.)

There were some significant exceptions to this: the undergraduate students at both Burnaby and Surrey reported that undergraduate academic advising (which had previously been housed in the School and was moved to the Faculty of Applied Science in the last couple of years) was not very helpful, and they learned much more from their peers, because advisors did not have local CS information and constantly had to switch between supporting the requirements of the programs of the four units in FAS. We heard similar complaints from students in the newer Visual Computing track of the PMP program, who said that the university Co-op placement office was not helpful in getting them their positions; they instead had found their own positions through other students in the program.

As a result, we recommend that *an appropriate portion of the FAS advisors (ideally commensurate with the proportion of undergraduate FAS students in Computing Science) be dedicated solely to Computing Science advising.* Our experience in our own units has been that a close working relationship between dedicate undergraduate advisors and our faculty has been critical to getting advising issues for our students resolved quickly.

The other significant issue was the problem of the level of graduate student support for those in the research graduate program that we highlighted earlier. Students reported real financial hardship overall, especially international students in their first couple of years in the program and students whose payments were sometimes months late because of administrative delays. They also expressed a desire for more of a departmental social culture among graduate students, which is made particularly problematic because the difficulty of finding affordable housing forces students to disperse widely throughout the area.

Overall, faculty and staff in the School seem to get along well and to be very supportive of each other. However, faculty and staff both consistently reported major problems in dealing with the bureaucracy in FAS and other administrative units at the university, and their sense of frustration was palpable.

The staff situation merits much more specific discussion. The staff seems a cohesive and energetic group. However, most have been in the School for a relatively short time. We learned that for roughly 18 months, while awaiting university-level approval of new staff responsibilities, some staff positions supporting core School functions have been by temporary placements that have been required to rotate on a 3-month basis. This has been extraordinarily debilitating, as a significant amount of time of already stressed staff has been taken up in repeatedly training new staff members on the same tasks every 3 months.

While we heard that this situation is finally beginning to change, and the staff complement will grow somewhat, another critical issue remains: As noted above, Janet Morton, the one senior active member of (non-technical) staff with the institutional memory and perspective on the full range of staff activities in the School is retiring with an effective date in early April. Training a replacement before that date seemed out of the question during our visit, since, because of a failed search, none had been identified at the time. This loss of institutional memory and experience is a very high risk for the School. *It is urgent to appoint a good manager with experience, who not only will learn quickly, but will also nurture the positive interpersonal environment that we observed.*

We heard from both faculty and staff that the impacts of the staffing issues in the School have been made much worse by the ways that the bureaucracies of the Faculty of Applied Science (FAS) and SFU overall have been interacting with School in the last few years. We heard that the bureaucracy has taken on the role of gate-keeping rather than facilitation. It seems that many more things now require direct FAS-level approval or written requests to FAS for funding, which leads to uncertainty and delay. We wonder the extent to which this environment might discourage potential staff manager candidates. We heard of cycles of correction requests being sent by bureaucratic email (for example, in response to errors made in filling out forms by inexperienced temporary employees or by students) that went on for many weeks while expenses were unpaid rather than making direct telephone contact and coaching the corrections.

More generally, in the past few years the School seems to have lost a substantial amount of its autonomy. This is certainly contributing to decreasing morale. (This is a problem in itself, independent of the significant issue of the overall level of financial return to the School from the tuition and government support that its students bring in.) The School is dealing with substantial growth and change in its programs and therefore needs some flexibility to be able respond to changing needs throughout the year without having to go back through a formal re-budgeting process. (This includes even simple flexibility that typical departments take for granted such as the ability to use money recaptured from faculty leaves to do more than hire temporary teaching replacements.)

As we discuss in section 6.5 below, this recent lack of autonomy, as well as some of the issues of financial return, rather than any fundamental cultural issue, appear to be the primary reasons that the School's Self-Study focuses on leaving FAS and establishing a separate Faculty of Computing Science.

Finally, there is the matter of recognition of faculty and staff by SFU. Though, as noted earlier, the School has been working to gain more external recognition for its faculty, we heard some grumbling about the lack of internal recognition at SFU. In particular, it seems that the FAS Awards of Excellence have lapsed in recent year.

This kind of recognition can be important for morale. It can also help provide positive role models for others to follow. Along these lines, some faculty felt that there should be more formal recognition within Computing Science of the value of high quality teaching. An annual teaching award within Computing Science, potentially run in cooperation with the undergraduate student association and required to rotate, would go a long way to visibly emphasizing its importance.

5. Future Plans

5.1 Research and Faculty

The School has been quite successful in hiring strong, predominantly junior, faculty since the last review in 2014 and it has ambitious and aspirational plans for major growth. Having these high aspirations is a good focus for the School. That said, the expectation for the rate of substantial growth in the near future needs to be tempered with knowledge of the upcoming retirements and the strong competitive environment for CS faculty, including potential departures of faculty. Our estimate is that the School will need to *hire into at least five tenure-track positions per year for the foreseeable future* to maintain strength and to begin to grow. The areas for growth suggested are good ones, but it is likely more

important for the School to be opportunistic when the possibility arises to hire excellent people who don't quite fit into these areas. *The key issue is to hire top-notch people.*

One of the consequences of an earlier period of lack of investment and losses of junior faculty is that the number of tenure-track faculty at the Associate level in the School is proportionately quite small. This may leave the School somewhat short of experienced leadership in the future. It would be useful in faculty recruiting to include the possibility of *some strategic hiring of suitable faculty at the Associate level*, provided they are strong and have the appropriate cultural and technical fit. Any new hiring at either level will need creativity of the sort that the School has already done (and more) to make offers competitive.

5.2 Undergraduate Programs

The School's self-study identifies a number of current issues, particularly with the Computing Science undergraduate program: These include, quite low gender diversity at 17% women. Another issue is that a number of weak students in an otherwise very competitive major is one factor that contributes to the time-to-graduation issue we highlighted earlier, and issues with specific courses and course structure. It also discusses some good plans to address them.

5.2.1 Diversity

17% women undergraduates in the major looks particularly low compared to a number of other Computer Science departments, though at SFU the presence of the Interactive Arts and Technology program probably does draw a proportionately larger number of women who would choose CS elsewhere. Nonetheless, we agree that the former admissions structure and course alignment likely exacerbated the problem.

The planned admissions criteria revision to make room for internal transfers and the realignment of first year programming courses are both very important for reducing this imbalance. Our experience with internal transfers is that a much higher percentage of women who end up as Computer Science majors at university did not originally intend to major in CS when compared to men. (For one of our institutions, this ratio was more than half of all women CS majors.) *A well-taught and organized introductory sequence that is accessible to majors and non-majors is critical for improving the diversity of the student body.* Moreover, the broadening of high school science course requirement beyond Physics has been long overdue. Greater gender diversity in faculty should also help.

5.2.2 Student quality

This is of concern to us and we heard anecdotal stories of students failing and having to repeat courses more than once. This is a drain on everyone. Unless we misunderstand the figures, the time to degree from high school cannot simply be the result of weak college transfer students. The revised admission criteria and allowance for internal transfers should be monitored to ensure that the internal transfer students are stronger than those who would previously have been admitted out of high school or via other transfers. Care will have to be taken to strike the balance between these admission streams so that the overall number of students does not grow unintentionally.

5.2.3 Curriculum

The first-year programming course realignment is important both because it will make things better for "interest changers", who can add to the department's diversity, and because it puts the material from the standard ACM curriculum CS1 and CS2 courses into the first two terms, which should allow students to progress more quickly.

The discrete mathematics course MACM 101 seems appropriate in content and not far from other such courses in CS departments elsewhere, but the content of MACM 201 does seem an odd mix with topics such as generating functions and recurrence relations of minimal utility; material on graph and trees that already tends to be well covered in typical data structure courses and optimization and matching material that belongs better in a more advanced algorithms course. Required courses such as CS 109 at Stanford or CSE 312 at the University of Washington would be good models of replacement material suitable for the topics relevant to AI, machine learning, and probability mentioned in the self-study.

We applaud the School's move to the 2-year course plan so students have predictability in course offerings. During our visit we heard that the process of producing this schedule has also eliminated previously unidentified bottlenecks that were causing delayed graduation.

5.2.4 Target Major Size

The plan to keep the Computing Science major roughly the same size (though graduating more students with shorter time to degree) and to focus any growth on the Software Systems major in Surrey does seem appropriate, but this needs to be tempered by the ability of the School to grow its faculty complement and to obtain sufficient additional teaching resources. In particular, *the current level of support reported for teaching assistantships (one full TA per 90 students in existing courses) is not adequate. It has to be dramatically improved before any increase in enrollment should be contemplated*. Another significant issue with the Surrey location is that there is currently only one full-time staff member there doing IT support who also needs to double as a receptionist. This is not a workable situation, since this provides no back-up at all.

5.2.5 Computer-Based Testing

The self-study discusses the vision of creating a dedicated facility for computer-based testing for students to write their midterm and final exams. Multiple reasons are given, including the ability to ask students to write code, and to monitor them in order to avoid cheating. Dedicating a facility to this purpose is quite costly in terms of commitment of School and university resources. This plan seems an unnecessary luxury and, no matter what size such a facility is built, its limitations will inherently limit the growth in the School's degree programs and service courses. While all universities are currently operating in a purely online environment, in normal times other institutions have been able to run exams satisfactorily at significantly larger scale than at SFU by implementing a number of simple measures: a single common exam time for all sections (which requires coordinated lectures between sections), assigned seats during exams, and tiled variant exams, so that students taking the same version of the exam are not next to each other.

5.3 Graduate Degree Programs

The School is looking to expand, strengthen and diversify its PhD program. The current size of this program is a little small on a per faculty-member basis (for 45 tenure-track faculty) compared to other CS

programs, but not far out of line given the number of M.Sc. Thesis students. Overall, the gender diversity of the program has been improving and, though far from ideal, seems relatively good in comparison with programs at other institutions and vastly better than in the SFU CS undergraduate program. The main lack of diversity is in student background, with very few domestic students coming from outside of SFU. *While it will be appropriate to have the number of PhD students grow with the number of faculty, we feel that working on getting stronger applicants from a broader pool is more important than any specific increase in the ratio of PhD students to tenure-track faculty. Stronger students should also help improve time to degree.*

The Professional Master Program has been highly successful in attracting very large numbers of international applicants and has helped build a strong international reputation for SFU and the School. The program has ramped up quite successfully, with a quite satisfied group of students, and is in the process of adding a Cybersecurity Specialization. This will no doubt also be quite popular. However, there are some core issues raised in the self-study with the trade-offs between the effort in running the program and the return to the School in doing so that we discuss in section 6.3.

5.4 Advancement/Named Building Initiative

The School has recently dramatically improved its external fund-raising. This is very good, and continued success in this area will be essential for addressing some of the structural issues of faculty recruitment and retention. The Faculty and the University can help by engaging with local industry to make the case at the provincial level for the importance of the technology and graduates in CS for the future economic health of the province. This is the kind of public relations campaign that has been successful in other regions in providing targeted support for CS. However, any such support is likely far from coming close to providing building funds, especially given the building maintenance backlog we learned about during our visit. Working with donors is quite a long and drawn out process. In the meantime, the School definitely does need additional space to allow initiatives and modest growth, both for offices and labs adjacent to their current space on the Burnaby campus and office/meeting space on Surrey campus.

6. Issues of Special Interest

6.1 Strategies for Improving School Reputation

Nominating more faculty for prestigious awards/ fellowships would help in increasing the visibility of the School. The fact that two members of the School were elected as FRSC last year is definitely an indication of recognition of excellence in CS at SFU. We note that there are no sabbatical visitors in the School this year, and have not been many in the past. This, at least to some extent, due to the lack of suitable space (as previously noted). Sabbatical visitors are indicative of the intellectual vibrancy of the unit, enhance that vibrancy, and can provide strong support for the reputation on the unit for many years. Clearly, *such visitors should be encouraged*. Other ways to increase the visibility of the faculty may include organization of major conferences, leadership in professional societies, professional M.Sc. programs that help placing the students with nearly 100% success rates, exchange programs with other top universities around the world, etc.

6.2 Increasing the Quality and Diversity of Undergraduate and Graduate Students

We have already discussed a number of the issues related to undergraduate student quality and diversity in section 5. Much of that discussion is related to better selection of students from British Columbia, and particularly from the Lower Mainland, who are already applying to SFU. Given the desirability of CS, this seems the best way to increase the quality at SFU. Without knowing the preferences in the province, it is difficult to comment further. At the national level, much is based on overall university reputation and desirability as reported on in the MacLean's guides. Here SFU has the disadvantage of being less well known than its longer-established neighbour, UBC, and being further from Vancouver amenities.

At the graduate level, we hope that the strong recent hires will boost the reputation of the School and improve the number of applications. At the moment the overwhelming number of applications are international, indeed mostly from China and Iran. The Canadian graduate students we met with seemed mostly to have undergraduate degrees from SFU. Increased recognition of SFU faculty through FRCSs and other comparable distinctions should also begin to boost the School's reputation, both among Canadians and internationally. However, we see the potential for more direct action to improve the quality and diversity of applicants.

6.2.1 Significantly increase the level of guaranteed graduate support.

At the moment, this is planned to match the level at UBC at $24K for the PhD program, and the current stipend is significantly lower than the level at other major programs in the country, despite very similar tuition and fees and higher cost of living (than in Waterloo for example). We have already recommended that *the level be raised to at least $26K for the PhD program*, which would come close to match those at the other top Canadian universities outside of BC. However, we note that the English department at SFU has the following on their website:

"*Eligible PhD students in English are offered funding based on a combination of teaching assistantships and internal fellowships of at least $28,000 per annum for up to four years of doctoral studies*."

This difference in the level of funding may indeed produce extra interest and applicants, both inside and outside Canada.

6.2.2 Graduate Student Recruiting

One way to further increase the visibility of the program and to improve the quality of graduate students is to encourage faculty give research talks at institutions in Canada with strong CS undergraduate programs and ask to speak to small groups of 3rd/ 4th year undergraduates during those visits.

The personal touch can make a notable difference. The number of such institutions in Canada is small enough that a few faculty going to each institution could yield very nice coverage.

6.3 Professional Master Degree Program

The Professional Masters Degree (PMP) Program receives an extraordinary number of applications and clearly is helping build international visibility for SFU. However, much of our discussion necessarily centered on the revenue sharing from this program. It is clear that CS did not receive the profit sharing as originally promised to the School and it is currently trending a loss based on the most recent financial analysis. The University has taken a far larger share of the tuition, leaving CS unable to adequately sustain the Professional Master Program, while demoralizing the CS faculty.

We recommend that either the University return a much larger portion of the tuition from the PMP, or the program be terminated, as it is currently not sustainable, given the revenue returned to CS. However, the termination of the PMP will likely be neither favorable to the international visibility of SFU or of School of Computing Sciences at SFU. We strongly recommend that SFU respects the original agreement with CS in profit sharing to ensure the long-term sustainability of the PMP program for benefits of both SFU and CS.

6.4 Faculty and Staff Retention

Retention of faculty is a major problem. The school has hired 20 new faculty members in the past seven years, yet has managed to grow by only about one and this is largely due to the faculty retention problem. Furthermore, there are eight announced retirements to take effect by May 2021 and six more faculty members are currently on leave. It is not unreasonable to expect a dozen, or more, resignations within the next year.

Low salaries are certainly a major issue. The self-study shows a large gap in salaries between salaries at SFU and those at other top Canadian CS departments, including UBC, for faculty at all levels. This kind of gap is borne out in a broad survey of all aspects of academic computer science in North America that is run annually by the Computing Research Association (CRA). The survey has a separate category for faculty salaries in Canadian CS departments, with the latest data being for 2018 (see page 47 of https://cra.org/wp-content/uploads/2019/05/2018_Taulbee_Survey.pdf). The listed salaries for SFU Computing Science faculty in the self-study are generally below the 25th percentile for Canadian CS salaries reported in that survey. Whatever method enables it, possibly through a larger endowment, it is critically important for the continued success and growth of SFU Computing Science to *make faculty offers more competitive* and to help retain faculty as well.

The other aspect is the faculty morale. Again, better staff support, higher return of revenues from PMP, long-term commitment in space and other resources to Computing Science can and will significantly improve the faculty morale, providing a happier environment for both faculty and staff.

Another issue we sense is subtle unhappiness from instructional staff. Again, the inadequate level of staff support, and insufficient amount of lab space also contributed to the inadequate level of support for instructions. We recommend better coordination among the instructional faculty across multiple sessions of the same course to reduce the workload on each. In addition, better TA support can also address some of these problems. Better allocation resources from PMP income, more autonomy in operation and budgeting for entrepreneurial activities and new programs will also likely to help faculty retention.

6.5 A Faculty of Computing Science

This was the main point of the self-study; however, it was not explicitly brought up in the visit by any faculty members or staff, only by committee members from reading the self-study report.

It is in line with SFU's situation of having two large faculties (Arts and Science) and several small ones (the current Applied Science is certainly "in the middle" at least in terms of faculty members, CS makes it look larger in terms of students).

Computer Science, in Canada, has found itself in an Engineering faculty in over a half dozen universities. In general, this has been a very unhappy situation. For several, the solution has been to separate CS, forming a separate faculty from Engineering due to the culture differences. Such friction often arises due

to the differences between CS and Engineering, as well as disparity between CS and some traditional sciences. In addition, CS is a much more dynamic and rapidly changing field, thus often requiring innovation and financial flexibility to respond to market forces that older disciplines do not necessarily face.

At SFU, we have found no significant friction between CS and engineering disciplines. CS is the large and dynamic unit in the faculty. In general, we found little push among the faculty members to leave the Faculty of Applied Science. However, we sensed that the (sole) sources of concern were the recent changes that took considerable budget from the School and the inadequate financial return from PMP Program. If these problems can be addressed, we see no urgency for forming a separate faculty in the immediate future.

7. Recommendations

We conclude with a summary list of our recommendations. These recommendations are listed in the order of the first section in which the recommendation comes up. These sections are noted. The major points, however, are (a) *the need for more quality space, (b) the ability to make faculty salaries more competitive, and (c) improved overall budget including PMP return and flexibility.*

Curriculum

1. Ensure required courses are available to Computing Science majors in most terms. (Section 1)
2. Continue careful monitoring of undergraduate course offerings for degree bottlenecks. Coordinate content/materials and monitor workload for individual course offerings. (Section 1)

Students

3. The planned admissions criteria revision to make room for internal transfers and the realignment of first year programming courses are both very important for improving diversity and student quality. Definitely proceed with these, taking care not to have an overwhelming number of majors. (Section 5.2)
4. Raise minimum support levels for graduate students to at least $23,000 for M.Sc. student and $26,000 Ph.D. students. (Sections 1 and 6.2)
5. Spread fractional TA positions to multiple/more students to reduce impact on time to graduate degrees and to assist with higher graduate support levels. (Section 1)
6. Streamline the process by which graduate support continues from one term to the next, so that support is not delayed. (Sections 1 and 4)

Faculty & Staff

7. Diversify faculty members involved in administration, and diversify faculty overall. (Section 3)
8. Increase number of support staff. (Sections 3.1 and 4)
9. Academic advisors be dedicated to Computing Science, ideally as part of the School support staff (Section 4)
10. More faculty lines, with the recognition that all may not be filled in a given year. This should include more hiring at the Associate Professor level to help smooth the current gap at that level due to the lack of positions several years ago. (Sections 4 and 5.1)

11. Nominate more faculty for major awards and fellowships. (Section 6.2)
12. Encourage sabbatical visitors, in part, to develop the School's international reputation. (Section 6.2)
13. Make the salaries of faculty offers competitive with other top departments in Canada, most notably UBC. (Section 6.4)

Environments

14. The School definitely needs additional space to allow initiatives and modest growth, both for offices and labs adjacent to their current space on the Burnaby campus and office/meeting space on Surrey campus. (Section 3.3)

Budget & Governance

15. Increase budgeted TA allocation to Computing Science to improve TA/student ratios. Significant improvement should be a precondition to any increase in undergraduate enrollment. (Section 5.2.4)
16. Greater budget independence/flexibility for the School. (Section 4)
17. SFU respect the original agreement with CS in profit sharing to ensure the long-term sustainability of the PMP program for benefits of both SFU and CS. (Section 6.3)

FACULTY OF APPLIED SCIENCES
School of Computing Science

MEMORANDUM

ATTENTION	Senate Committee on University Priorities	**DATE**	28 September 2020
FROM	Dr. Mohamed Hefeeda, Director, School of Computing Science		
RE:	Action Plan of the School of Computing Science in response to the External Review Report		

Greetings,

Please find attached the Action Plan of the School of Computing Science in response to the report of the External Reviewers. I would like to highlight a few main points in this cover letter.

First, the External Reviewers confirm the quality of all teaching programs offered by the School, stating that "The School of Computing Science offers a variety of programs at both graduate and undergraduate levels. All of these are of high quality and very much in line with those of other strong Canadian Computer Science departments. The educational goals are rock solid."

Second, the quality and quantity of the research outputs of our research faculty are excellent, and the amount and diversity of their research funding have been continually increasing. The Reviewers mention that "The quality of faculty research is very high." and "… SFU is clearly among the top eight CS Programs in the country, perhaps in the top five or six."

The Reviewers, however, identify multiple challenges facing the School and stifling its progress, especially regarding space, autonomy, and faculty recruitment and retention. For example, the Reviewers state that "… the School definitely does need additional space to allow initiatives and modest growth …" We note that the School has been using the same undergraduate teaching labs since 2005, where it had 1/3 of its current students. As a long term solution, the Reviewers observe that "The School has recently dramatically improved its external fund-raising …," and they agree with our suggestion that SFU should capitalize on this momentum to eventually construct a new building for CS, stating "The Faculty and the University can help by engaging with local industry to make the case at the provincial level for the importance of the technology and graduates in CS for the future economic health of the province. This is the kind of public relations campaign that has been successful in other regions in providing targeted support for CS."

The Reviewers also emphasize the critical issue of faculty recruitment and retention, mentioning that "We are concerned that there will be a major exodus in the next year or two; salaries are a significant issue." and "… it is critically important for the continued success and growth of SFU Computing Science to make faculty offers more competitive and to help retain faculty as well."

We aim to build on the School's excellent performance and aspire to achieve higher levels of distinction. We encourage SFU to make computing science one of its strategic priorities and commit the needed resources to enable our School to realize its full potential. I am looking forward to discussing the External Review Report and our Action Plan with you.

Best Regards,
Mohamed Hefeeda, Ph.D.

EXTERNAL REVIEW – ACTION PLAN

Section 1 – To be completed by the Responsible Unit Person, e.g., Chair or Director

Unit Under Review	Date of Review Site Visit	Responsible Unit Person	Faculty Dean
School of Computing Science	March 4-6, 2020	Dr. Mohamed Hefeeda	Dr. Eugene Fiume

Notes

1. *It is **not** expected that every recommendation made by the External Review Committee be covered by this Action Plan. The major thrusts of the Report should be identified and some consolidation of the recommendations may be possible while other recommendations of lesser importance may be excluded.*
2. *Attach the required plan to assess the success of the **Educational Goals** as a separate document (Senate 2013).*
3. *Should any additional response be warranted, it should be attached as a separate document.*

I. PROGRAMMING

1.1 Action/s (description what is going to be done):

1.1.1 Undergraduate:

- *Reduce Degree Completion Time*:
  - The current average completion time is 17.3 terms (~5.77 years) for the Computer Science (CS) major, which is too high even if most students do 1—3 terms of co-op. The main bottlenecks are course availability, lab space, and limited TA budget.
  - We plan to offer more sections of the required courses of our major programs.
  - We plan to introduce more elective courses, especially 3rd and 4th year courses to give students more options.
  - We have recently developed a 2-year teaching plan and made it available online so that students can plan the completion of their programs on time. We will continue analyzing and updating this plan to help students.
- *Update and Align Curricula of Various Programs:*
  - Two main programs are offered in the School: CS and Software Systems (SoSy) majors. SoSy is offered at Surrey. There were several complexities of the SoSy program that did not allow many CS students to take some of its core courses.
  - We have recently revised the SoSy curriculum and streamlined it with the CS curriculum, which will improve the efficiency of course offerings across the Burnaby and Surrey campuses, which will also help in reducing the degree completion time.
  - We plan to update various aspects of the CS major, including its first-year programming and mathematics courses.

- *Enhance Student's Experience:*
  - We plan to improve the TA support provided to our students, by for example adding tutorials to lower-division courses and reducing the number of students managed by each TA. We also plan to revise the process for selecting and evaluating TAs.
  - We plan to increase and improve the academic advising services provided to our students.
  - We plan to increase the engagement with the undergraduate students and their representatives through periodic meetings.

1.1.2 Graduate:

- *Recruit More and Stronger PhD Students:*
  - We plan to provide more and larger entrance scholarships to attract better and diverse students.
  - We plan to promote the PhD-Direct entry path for exceptional undergraduate students.
  - We plan to promote our Accelerated BSc/MSc program to recruit more domestic students into our graduate programs.
- *Improve Graduate Student's Experience:*
  - We plan to increase the financial support for graduate students, by for example allowing PhD students to augment their RA salary with partial TA and providing a salary ladder for PhD students as they progress through their program.
  - We plan to design and offer more core graduate courses to strengthen our PhD and MSc programs.
  - We plan to organize more social events for graduate students and engage in periodic discussions with their representatives.
- *Improve the Quality of the Professional Master's Program (PMP):*
  - Currently, we offer two concentrations in the PMP: Big Data and Visual Computing. A third concentration on Cybersecurity will start in Fall 2020. This premium program has grown from an intake of 13 students per year in 2014 to more than 130 in 2019.
  - We plan to develop a unified model for all PMP concentrations to efficiently support its growth and improve its quality. This model will aggregate essential skills and foundations in a few required courses for all concentrations. The domain-specific knowledge for each concentration will be emphasized in two 6-credit lab courses and elective courses.
  - We also plan to improve the students experience by providing more and better advising and co-op services.

1.2 Resource implications (if any):

- *5—6 New Faculty Lines per Year and Competitive Faculty Salaries:*
  - The demand for CS programs at SFU is substantial and growing. The number of CS majors has almost doubled since the last external review in 2013. Despite the multiple recent hires in the School, the capacity has not increased significantly, because of retirements, resignations, and leaves. Eight faculty members retired (or have confirmed to retire) between September 2019 and September 2021. Six faculty members are currently on partial or full leaves. And multiple faculty members have resigned.

- As highlighted by the external reviewers, while the quality of CS faculty at SFU is on par with top CS departments in Canada, their salaries are much lower, which creates a major risk of losing current faculty members and makes it very difficult to hire new ones.

- *Academic Advisers Moved back to the School:*
  - The academic advisers were moved from the School to the Faculty several years ago. As reported by the external reviewers and frequently mentioned by our students, this has created inefficiency and lack of attention to CS students' needs.
  - We propose to work with the Dean's office to move the academic advisers to the School to better serve our students.

- *Better Co-op Support for all Students (PMP and Undergraduates):*
  - We propose to work with SFU Administration and FAS to create a consolidated co-op team dedicated to serve all CS programs, including PMP and undergraduate programs. This will provide efficiency and flexibility in allocating co-op resources, since various programs have different periods of peak demand for their services.

- *Additional Teaching Lab Space:*
  - As highlighted by the external reviewers, the School does not have sufficient teaching lab space, nor does it have any reasonable space for students to work on collaborative projects. The School has been using the same lab space since 2005/2006, when it had less than one-third of its current students and fewer academic programs.

- *Sufficient* Support for the PMP:
  - Running a high-quality, hands-on, Professional Master's Program is very costly for the School, in terms of teaching resources, lab infrastructure, administrative support, and co-op services.
  - The revenue received in the last two years from the Faculty *was less than* the cost incurred by the School. This, as the external reviewers noted, makes it challenging for the School to sustain its PMP, while also having to support a large and growing undergraduate student population.
  - We propose to work with SFU and FAS on revising the cost and revenue sharing model of the PMP so that the School stays motivated to offer and improve such an important but demanding program. We note that the School's proposal to create the PMP, which was approved by SFU and FAS, specified that the School should receive 66% of the revenue to cover its costs. This has not happened. The external reviewers recommended terminating the PMP if the budget is not properly adjusted.

1.3 Expected completion date/s:

- All of the above actions will be implemented by the time of the review update in March 2024.
- Support and cooperation from SFU and FAS are critical to perform the proposed actions.

2. RESEARCH

2.1 Action/s (what is going to be done):

- *Form a Research Award and Advancement Committee in the School:*
  - The Committee will consist of senior members of the School who are well-connected and have received significant awards in the past. The mandates of the Committee: a) to promote our faculty members in competitions for national and international awards and recognitions, and b) to develop plans for advancement opportunities and initiatives to improve external recognition of the School, e.g., by organizing CS-sponsored events and by attracting prominent scholars to visit SFU.
- *Increase the Number of Chaired Professors in the School:*
  - Chaired professors will improve the quality and visibility of the research conducted in the School, as well as address the faculty retention challenge.
- *Establish an SFU AI Institute:*
  - The School and SFU in general have substantial experience in various aspects of AI. Consolidating all such experience in a university-wide AI Institute will improve the recognition of SFU researchers, help in recruiting top talents (faculty and students), and create more opportunities to attract major research funding to SFU.

2.3 Resource implications (if any):

- *Advancement Support:*
  - We would like the Advancement teams in FAS and SFU to support the creation of the SFU AI Institute.
- *Research Chair Creation:*
  - We propose to work with our Dean and the VPRI to establish Research Chairs backed by the significant ($4.5M) donation that has been recently secured by the School.
  - We propose to work with our Dean and the VPRI to secure additional Canada Research Chairs for the School.
- *ISA and VPRI Support for CFI:*
  - We would like to request the support of the ISA and VPRI's offices for the School's intended CFI proposal in AI. The School has not received any major CFI funding in many years, despite the quality of its faculty members. The School has submitted a CFI LOI in the last round, but it was not selected by the VPRI office, with little suggestions for improvements.
- *Additional Research Lab Space:*
  - As the external reviewers mentioned, the average number of PhD students per faculty member in the School is lower than comparable schools in Canada. One of the main reasons is the limitation on the available research space, despite the significant

investment that the School has made to densify its labs in the last few years. The School also lacks large open labs to conduct experiments in various areas of computing science research such as robotics, motion capturing, and virtual reality.

2.3 Expected completion date/s:

- The Research Award and Advancement Committee will be established by the end of 2020.
- The plan for creating various chaired professor positions will be set up by the end of 2020.
- The establishment of the SFU AI Institute is projected to be a two-year endeavor.

3. ADMINISTRATION

3.1 Action/s (what is going to be done):

- *Restore the Autonomy of the School:*
  - In the last two years, the School has become very dependent on the Faculty for many of its operational details. This occurred mostly because of the new (centralized) budget model introduced in the Faculty, in which budgeted items are given to the School, with very limited flexibility. The School lost control over important items such as the salary recovery of faculty on leave, which is substantial in our case. The School also was given much smaller amounts for TA and IT support than it needs. The School had to go to the Dean's office for basic operations such as hiring temporary staff and buying IT equipment to implement its well-established cycle of renewing the infrastructure of its teaching labs. This has created long delays and frustration in the School. This serious issue has been emphasized by the external reviewers.
- *Improve IT and Admin Support:*
  - The external reviewers commented on the very weak admin and IT support in the School. While the situation has improved since the site visit of the external reviewers, much needs to be done to bring the admin and IT support in the School close to its peer Canadian schools.

3.2 Resource implications (if any):

- *Better (Decentralized) Budget Model:*
  - Support from the Dean is critically needed to adjust the budget model to allow for more efficient operation of the School.
- *Sufficient TA Budget:*
  - We currently allocate 75—80 students per one TA, which results in high stress on TAs (graduate students) and poor experience for undergrad students. We need to allocate 40—45 students per TA, in order to approach the support offered in comparable CS schools in Canada and elsewhere.

- *Sufficient Admin and IT Support:*
  - Support from the Dean is needed to fully implement the organizational charts proposed by the School for its administrative and IT support teams. The skeletons of these organizational charts have been developed in close collaboration with the Dean's office. Significant parts of these charts have also been implemented. However, the number of administrative and IT staff approved for actual hiring is much less than what the School needs.

3.3 Expected completion date/s:

- All of the above actions will be implemented by the time of the review update in March 2024.
- Support and cooperation from FAS are critical to perform the proposed actions.

4. WORKING ENVIRONMENT

4.1 Action/s (what is going to be done):

- The School has a good and collegial working environment.
- The only major concern is the high workload on faculty and staff, because of the substantial demands for our programs and the large number of students we teach. Allocating the resources requested in other sections of this report will address this important issue.

4.2 Resource implications (if any):

4.3 Expected completion date/s:

The above action plan has been considered by the Unit under review and has been discussed and agreed to by the Dean.

Unit Leader (signed) hefeeda		**Date**
Name ……Mohamed Hefeeda……	**Title……Professor and Director ……..**	**……1 June 2020……**

Section 2 - Dean's comments and endorsement of the Action Plan:

Computing Science is a jewel of our faculty and of SFU, and it is one of the best CS departments in Canada. This view is supported by the external reviewers, who in their report described the successes, opportunities, and challenges that CS at SFU faces. These issues are shared by most good CS schools in the world. The demand for CS at all levels continues to grow, and in the post-COVID world will likely accelerate. The staff of FAS and I will continue to work closely with the Director of CS to support its ambitious vision. The Action Plan presents many supportable proposals regarding recruitment and retention of staff and faculty, improving the quality of graduate students, curriculum renewal, enrolment management, advancement, bi-campus growth, budgetary clarity, and greater administrative efficiency. Some of these will be supported by the growth in revenue due to the Faculty Allocation Model (FAM) as well as increased fund-raising. Other worthy goals, such as a new building, will require a collaborative effort across the university and beyond. In such cases, I will continue in my advocacy of CS so that we together can procure external funding for bold initiatives.

As the largest department/school at SFU, CS has enjoyed a unique degree of autonomy for many years. The effect of the FAM, together with significant downloading of function to faculties, however, has required changes to the way in which all faculties operate and are staffed; consequently, budget flow to schools has had to adapt. It was also essential to develop a budgetary planning process that sustains the academic mission of all units within the faculty. The consequence is that no group is left satisfied with their budgetary allocation, particularly CS. While it has been an uncomfortable budgetary transition, there is light at the end of the tunnel. Over the next one or two budgetary periods, I anticipate a more flexible process that, together with greater operational efficiencies, will help to diffuse the current concerns over lack of control.

CS at SFU has a very bright future, and I will support it in any way I am able.

Faculty Dean	**Date**
	**24 September 2020** ……

Assessment of Educational Goals
School of Computing Science

1. Undergraduate Programs

The School of Computing Science (CS) offers a range of undergraduate programs, the most popular of which is the vanilla B.Sc. CS Major (1863 current students), but also the strongly related Software Systems Major (255 current students)—a CS Major with a strongly applied focus on software engineering methodologies and computer systems. Several joint major programs combine CS with: Math (62 current students), Business (344), Molecular Biology and Biochemistry (19), Linguistics (2), and Geography (11).

a. Core Program Goals

The first 10 educational goals serve as a core set for all CS programs, but reduced in depth and/or breadth for joint major programs due to the 50-50 split. The Software Systems Major includes 3 additional program goals.

Goals are quantitatively assessed within the courses listed, using a collection of assessment tools (e.g., assignments, projects) at a range of levels (e.g., introductory, intermediate, advanced). For detailed course-level outcomes, please refer to the link: https://www2.cs.sfu.ca/~bbart/LO/pub/LOs.html. Qualitative assessment of each goal will be done via graduate exit surveys for the mid-cycle report.

Educational Goal	Description of Competencies	Assessment Tools
Technical understanding of computer science	Graduates should have a mastery of computer science, i.e., by applying ideas to solve problems from at least N of the core areas of computer science: algorithms and complexity, computer/systems architecture, computer/information security, data and information science, graphics/visualization, human-computer interaction, intelligent systems, information management, networked/ parallel/ distributed computing, programming languages, software requirements/ development.	Related courses: CMPT 120, 125, 127, 130, 135, 213, 225, 295, 300, 307, 308, 310, 318, 340, 353, 354, 361, 365, 371, 383, 384, 404, 405, 407, 412, 414, 419, 431, 433, 454, 464, 466, 470, 471, 473, 474, 475 Course assessment tools: assignments, labs, in-class activities, projects, exams
Problem solving skills	Graduates need to understand how to apply the knowledge they have gained to solve real problems, not just write code and move bits. They should be able to accurately assess problems and think about them creatively/conceptually/critically and to apply appropriate and efficient algorithms and mathematical models. They should realize that there are multiple solutions to a given problem and that selecting among them is not a purely technical activity, as these solutions will have a real impact on people's lives.	Related courses: MACM 101, CMPT 120, 125, 127, 130, 135, 213, 225, 295, 307, 308, 340, 353, 354, 361, 363, 365, 371, 373, 384, 404, 405, 407, 412, 414, 419, 431, 456, 464, 466, 471, 473, 474, 475 Course assessment tools: assignments, labs, in-class activities, projects, exams

Software development skills	Graduates should be able to apply good design principles for developing computer programs: elegance, simplicity, clear structure, flexibility, efficiency, usability, maintainability, and durability. They should be able to decompose simple application design problems into functional components, design/write/test/debug software solutions using appropriately chosen languages/tools for their implementation. Good design should be evident to both end users and other developers.	Related courses: CMPT 120, 125, 127, 135, 213, 225, 295, 340, 354, 361, 363, 365, 371, 373, 383, 384, 412, 414, 419, 431, 433, 456, 464, 466, 470, 471, 473, 474, 475 Course assessment tools: assignments, labs, in-class activities, projects, code reviews, exams
Mathematics: theory and practice	Graduates should have a core set of mathematical skills and the related formal reasoning skills that are broadly applicable to computer science. Induction, recursion, asymptotic analysis, computability and heuristics are fundamental themes that graduates should be able to apply in practice.	Related courses: MACM 101, CMPT 125, 127, 307, 308, 340, 361, 365, 384, 405, 407, 414, 419, 456, 466 Course assessment tools: assignments, exams
Project experience	All graduates should have been involved in at least one substantial project. In most cases, this experience will be a software development project. Such projects should challenge students by being integrative, requiring evaluation of potential solutions, and requiring work on a larger scale than typical course projects.	Related courses: CMPT 130, 135, 276, 353, 363, 365, 373, 414, 419, 433, 470, 471, 474 Course assessment tools: projects, code reviews, presentations
Commitment to professional responsibility	Graduates should recognize the social, legal, ethical, and cultural issues inherent in the discipline of computing. They must further recognize that social, legal, and ethical standards vary internationally. They should be knowledgeable about the interplay of ethical issues, technical problems, and aesthetic values that play an important part in the development of computing systems, including the burden of responsibility and the possible consequences of failure.	Related courses: CMPT 105W, 125, 130, 135, 276, 320, 340, 373, 376W Course assessment tools: journaling, projects, code reviews, presentations
Professional conduct	Graduates should embrace professional values like these: be honest and polite, take responsibility, meet obligations, be accountable, be dependable and consistent. They should perform work to high standards using all available best practices	Related courses: CMPT 127, 276, 373 Course assessment tools: projects, code reviews, presentations

	and will not sacrifice quality of work without the agreement of stakeholders.	
Communication and organizational skills	Graduates should have the ability to make effective presentations to a range of audiences about technical problems and their solutions, including why and how a solution solves the problem and what assumptions were made. This may involve face-to-face, written, or electronic communication. They should be prepared to work effectively within diverse groups of people toward common goals. Graduates should be able to manage their own learning and development, including managing time, priorities, and progress.	Related courses: CMPT 105W, 320, 353, 363, 376W, 414, 419 Course assessment tools: assignments, journaling, projects, code reviews, presentations, exams
Awareness of broad applicability of computing	Platforms range from embedded micro-sensors to high-performance clusters and distributed clouds. Computer applications impact nearly every aspect of modern life. Graduates should understand the full range of opportunities available in computing and be able to assess various technologies for use in a new development project.	Related courses: CMPT 120, 307, 308, 320, 340, 361, 363, 404, 405, 407, 419, 456, 466, 470 Course assessment tools: assignments, projects, presentations
Commitment to life-long learning	Graduates should realize that the computing field advances at a rapid pace: specific languages and technology platforms change over time. Therefore, graduates need to realize that they must continue to learn and adapt their skills throughout their careers. To develop this ability, students should be exposed to multiple programming languages, tools, paradigms, and technologies as well as the fundamental underlying principles throughout their education.	Related courses: CMPT 307, 308, 318, 320, 361, 404, 405, 407, 466 Course assessment tools: assignments, projects, presentations
b. Software System Major The goal of the Software Systems Major is to provide students with the necessary skills to develop large-scale software and computer systems in a realistic team setting, while developing strong fundamental computational skills. The CS Major educational goals are amended as follows:		
Software development methodologies	Graduates should be able to develop large-scale soft-ware within the software development life cycle, applying best practices within the spheres of: object oriented design and methodologies, collaborative and iterative software	Related courses: CMPT 135, 213, 276, 373, 433 Course assessment tools: assignments, labs, projects, code reviews, exams

	development processes, and software testing and reliability. They will be able to apply object-oriented concepts such as inheritance, polymorphism, interfaces and abstract classes, as well as object oriented de-sign patterns such as observer, iterator, and singleton. Graduates will focus on the best practices of collaborative software development including managing complexity, designing maintainable software, and requirements gathering. They should be capable of systematic software testing and quality assurance, including systematic methods for security vulnerability discovery.	
Computer systems	Graduates will have deep knowledge in several areas of computer systems including operating systems, database systems, embedded systems, networks, and distributed systems.	Related courses: CMPT 433, 471 Course assessment tools: projects, exams
Project experience	Graduates will have undertaken at least one semester long group project, refining their skills in communication, presentations, collaboration, and team dynamics. Many of the projects will have a real-world problem/partner as their basis.	Related courses: CMPT 130, 135, 276, 353, 363, 365, 373, 414, 419, 433, 470, 471, 474 Course assessment tools: projects, code reviews, presentations

c. Dual Degree Program Major

The unique Dual Degree Program Major (71 current students) is a partnership between the School of Computing Science at SFU and the College of Computer Science and Technology at Zhejiang University, China. Students complete the first two years of CS at Zhejiang University and the final two years at SFU. Non-Chinese students admitted at SFU also take a foundation year focusing on Mandarin language and mathematics at SFU, prior to travel to China. Upon completion, students are awarded two bachelor's degrees — a CS Major at SFU and an Electrical Engineering Major from Zhejiang University. In addition to meeting the core set of CS Major educational goals, successful students also meet the following educational goals:

Multicultural/multilingual experience	Graduates should have an understanding of cultural and linguistic issues in diverse work environments through in-depth experience studying and applying computing science concepts in both Eastern and Western cultures. They will appreciate cultural diversity in working environments, including extensive experience as a member of a cultural minority. Graduates will have a working ability to use two of the world's two most widely spoken languages.	No specific courses. Qualitative assessments only.

Personal growth	Graduates gain an understanding of their own abilities to work in diverse environments and how to overcome difficulties in new and challenging situations.	No specific courses. Qualitative assessments only.
Global leadership	Graduates have a solid foundational experience for career paths that lead to global technology leadership.	No specific courses. Qualitative assessments only.

2. Graduate Programs

The School of Computing Science offers a range of graduate programs, including course-based, project-based, professional and thesis-based MSc programs and a PhD program. The following foundational educational goals are shared by all programs:

Educational Goal	**Description of Competencies**	**Assessment Tools**
State-of-the-art knowledge in selected areas of computer science	Graduates will demonstrate state-of-the-art knowledge in selected areas of computer science of their choice. The School's graduate courses provide an introduction to the foundations and to the current research issues in a broad range of areas.	Assignments, quizzes, exams
Ability to study independently	Graduates will have the ability to independently study and master new areas of computer science, which will help them to continue their professional development.	Presentation of papers from the literature in oral and written form
Software development skills	Graduates will have the skills to apply state-of-the-art knowledge to design and implement software systems using current programming languages and software engineering tools.	Course projects
Industry experience	Graduates will possess relevant industry experience, including team work and project management experience, obtained through our graduate coop program.	Report of the industry supervisor of the coop student
Specific to PhD Programs		
Independent research	Graduates will have the ability to conduct research independently at the forefront of their research area.	PhD thesis, publications
Diversification of knowledge and skills	Graduate will be able to diversify their knowledge and experience beyond their immediate research field by exploring interdisciplinary connections to related research fields.	PhD thesis, collaborations with researchers beyond their own lab
Definition of research problems	Graduates will be able to identify and define promising, new research problems of significance.	PhD thesis, publications
Development of research prototypes	Graduates will show the knowledge and the skills to design, implement, and evaluate	Publications, submission of software to open source platforms such as GitLab

	principled and novel solutions to new research problems.	
Advanced communication skills	Graduates will demonstrate advanced communication skills to present and defend their research in written and oral form.	Publications, presentations at SFU and at conferences
Ability to publish research results	Graduates will be able to publish their research results in high-impact conferences and journals of their area.	Publications in high-impact venues
Specific to the MSc Thesis Program		
Guided research	Graduates will have the ability to conduct research at the forefront of their research area, with guidance by their superviser.	MSc thesis, publications
Development of research prototypes	Graduates will show the knowledge and the skills to design, implement, and evaluate principled and novel solutions to new research problems.	Publications, submission of software to open source platforms such as GitLab
Communication skills	Graduates will demonstrate good communication skills to present and defend their research in written and oral form.	Publications, presentations at SFU and at conferences
Ability to publish research results	Graduates will be able to publish their research results in conferences and journals of their area, with guidance by their supervisor.	Publications
Specific to Professional Master's Programs		
Ability to design and develop large-scale industrial projects to create business value	Graduates should have strong software development skills, gain a deep understanding of basic algorithmic concepts, and understand important topics such as parallel programming, GPUs, and cloud computing. They will conduct semester-long group projects, training their skills in system design, project management, communication, and collaboration.	Semester-long group projects
Master cutting-edge computing technology to drive innovation in important areas of society	Graduates should have a mastery of principles and fundamentals in an important strategic area of society (e.g., big data, visual computing, or cyber security). They need to understand how to apply the cutting-edge technologies in this area to solve practical problems. They should have a good understanding of the key concepts underlying these technologies.	Weekly assignments, quizzes, and exams
Advanced ability to tackle real-world challenges through a premium graduate co-op program	Graduates will gain real-world industrial experience through a 4-month or 8-month co-op. They will develop pre-employment skills (letter writing, resume development,	Supervisor evaluation and student reflective report

	interview skills), professional development while on a co-op semester, and lifelong learning skills to enable them to manage their career paths.	