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www.sfu.ca/vpacademic**MEMORANDUM**

ATTENTION Senate **DATE** December 11, 2013
FROM Jon Driver, Vice-President, Academic and Provost, and Chair, SCUP **PAGES** 1/1
RE: Faculty of Science: External Review of the Department of Statistics and Actuarial Science (SCUP 13-69)

At its December 4, 2013 meeting, SCUP reviewed and approved the Action Plan for the Department of Statistics and Actuarial Science that resulted from its External Review.

Motion:

That Senate approve the Action Plan for the Department of Statistics and Actuarial Science that resulted from its External Review.

c: R. Lockhart
C. Cupples

A handwritten signature in black ink, appearing to be "Jon Driver", written in a cursive style.



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MEMORANDUM

ATTENTION	Jon Driver, Chair, SCUP	DATE	November 26, 2013
FROM	Gord Myers, Associate Vice President, Academic and Associate Provost	PAGES	1/1
RE:	Faculty of Science: External Review of the Department of Statistics and Actuarial Science		

Attached are the External Review Report and the Action Plan for the Department of Statistics and Actuarial Science.

Excerpt from the External Review Report:

"Upfront we want to emphasize that this department greatly enhances the reputation of SFU and that it is well worth investing in... We would like to commend the department with the many excellent contributions that it makes to its mission and to that of the university. The department is very productive in terms of research and teaching, provides an excellent working environment for most of its members, and has built an excellent reputation in both the statistics and actuarial science communities."

Motion:

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

Following the site visit, the Report of the External Review Team* for the Department of Statistics and Actuarial Science was submitted in June 2013. 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, Faculty of Science, the Chair of the Department of Statistics and Actuarial Science and the Director, Academic Planning and Budgeting (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 Department and the Dean.

SCUP recommends to Senate that the Department of Statistics and Actuarial Science be advised to pursue the Action Plan.

*External Review Team:

John Stufken, Department of Statistics, University of Georgia (Chair, Review Team)
Sheldon Lin, Department of Statistics, University of Toronto
Jane Pendergast, Department of Biostatistics, University of Iowa
Tom Archibald (internal), Simon Fraser University

Attachments:

1. External Review Report (June 2013)
2. Department of Statistics and Actuarial Science Action Plan

cc Claire Cupples, Dean, Faculty of Science
Richard Lockhart, Chair, Department of Statistics and Actuarial Science

External Review Report: SFU Department of Statistics and Actuarial Science

Sheldon Lin, University of Toronto; Jane Pendergast, University of Iowa,
and John Stufken, University of Georgia (Chair)

6/28/2013

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**EXTERNAL REVIEW REPORT
DEPARTMENT OF STATISTICS AND ACTUARIAL SCIENCE
SIMON FRASER UNIVERSITY**

Sheldon Lin, Jane Pendergast and John Stufken
June 28, 2013

I. Overview

The review team for the Department of Statistics and Actuarial Science at Simon Fraser University (SFU) consisted of Tom Archibald (SFU), Sheldon Lin (University of Toronto), Jane Pendergast (University of Iowa), and John Stufken (Chair; University of Georgia). All members of the team had access in advance of their visit to an extensive self-study prepared by the department, including multiple appendices with data, plans and CVs. The external members of the team arrived in Vancouver on April 9, 2013, and met with university administrators and members of the department during three full days on April 10-12, 2013. The local team member, Tom Archibald, was invaluable as a resource by being able to provide information about practices and policies at SFU during the visit, but did not participate in the writing of this report. The findings in this report are primarily based on information obtained from the self-study and the meetings.

Upfront we want to emphasize that this department greatly enhances the reputation of SFU and that it is well worth investing in. We will address some of the department's strengths in this report, but there is a natural tendency in reports like this to focus on issues that need attention or improvement. After all, attention to such issues is critical for a department to become better. This report is no exception, but we urge the reader to keep in mind that the team's positive overall impression of the department cannot be overstated.

The department was founded in 2001 when it split off from the former Department of Mathematics and Statistics. While a relatively young department, it has been able to build an excellent reputation, both in Statistics and Actuarial Science, and was recently designated as a Centre of Excellence by the Society of Actuaries. Starting with 10 faculty in 2001, the department has now grown to 21 faculty, including an active emeritus professor. This growth occurred primarily during the first six years of the department. With increasing demands since that time, and ever increasing opportunities for collaborations in a data-driven era (including "Big Data" opportunities), it is thus no surprise that the department currently appears to be stretched to its limits. The fact that some major contributors have left SFU in recent years (Randy Sitter; Charmaine Dean) only compounds this problem. On the positive side, the department learned during the team's visit that its potential star, Jiguo Cao, will return to SFU, along with his wife. A changing funding environment in Canada, which will require major adjustments at SFU and in the department, will also provide major challenges. We will return to these issues later in the report.

Two of the department's faculty are housed on the Surrey campus and spend only one day per week on the Burnaby campus. These faculty nevertheless seem to be an integral and valuable part of the department, and with the current uncertainty about how the Surrey campus will develop, we strongly believe that it would be wise to maintain the department's presence in Surrey.

The department has multiple areas of focus, including statistics, biostatistics, and actuarial science. It has existing degree programs in statistics and actuarial science and wants to develop new degrees or streams in actuarial science and biostatistics. Areas of strength within statistics include design and analysis of experiments and environmetrics. Overall, the department's strength is especially in applied statistics, in a wide variety of areas of application. In that sense, the department takes advantage of the sentiment expressed by the famous statistician John Tukey: "The best thing about being a statistician is that you get to play in everyone else's backyard." With the enormous amount of data collected in virtually every discipline nowadays, we believe that there are even many more opportunities for interdisciplinary collaboration for the department, both in terms of teaching and research. But we also believe that the university and department face formidable obstacles in taking advantage of these opportunities.

Staff support appears to be good, but faces serious challenges in terms of handling the demand on their time. We believe that this is an issue that needs serious and urgent attention.

The atmosphere in the department is remarkably congenial. Faculty, staff and students seem to have excellent relationships. On issues with different opinions, there is discussion, often informally, and all live with the decisions that are made. We applaud the harmonious working atmosphere, which is rare and appears to benefit productivity. We do however believe that the department could in some instances benefit from a more formal governance structure. This could help with making some difficult choices that lay ahead, which should be addressed proactively, and could also benefit the growth of junior faculty in becoming the next leaders of the department.

II. Terms of Reference

We begin by briefly addressing specific questions in the Terms of Reference. A more substantive discussion on virtually all of these issues can be found in the remainder of the report.

- a) *The quality of the Department's teaching programs is high and there are measures in place to ensure their evaluation and revision.* Based on our examination and interviews, we believe that the department's teaching programs are of high quality. The faculty represent a broad variety of interests, and seem to be genuinely interested in teaching the students. Students are for the most part very happy with the instruction that they receive. There are some challenges in offering courses in a timely manner, and the fairly extensive use of sessional instructors also creates some challenges. The department is in the midst of reviewing its curriculum, with the review of some programs having been completed and others still in progress.

- b) *The quality of faculty research is high and faculty collaboration and interaction provides a stimulating academic environment to identify new or emerging areas that should be pursued.* There is ample evidence in the form of awards, grants and visibility in the profession that faculty have been very successful in their research endeavors. The department seems to encourage and value a wide variety of different research directions, with greater emphasis on applied than theoretical explorations. However, there appear to be obstacles for exploring new research directions and multidisciplinary or multi-institutional collaborations, both within the university and with the NSERC funding model for individual researchers. While the latter has seen some recent changes, some of these will present only greater challenges for Statistics. As presented in more detail later, we believe that there is a need for more discussion of funding opportunities and challenges for Statistics at SFU, both within the department and between the department and the university administration, especially the office of the VP for Research.
- c) *The Department members participate in the administration of the unit and take an active role in the dissemination of knowledge.* Multiple senior faculty have over the years served in positions of leadership for the department, and have, by all accounts, done so very successfully. Faculty who serve in these positions discuss issues with other members of the department, often informally, and then make decisions. This lack of formality in governance seems to serve the department well for the most part, but could create problems with future retirements or other changes in personnel. Junior faculty are very satisfied with the support and mentoring that they receive, and this is also true for most of the students. Many students observed that access to faculty is excellent, and that many of the faculty are very helpful in providing excellent advice. Nonetheless, closer monitoring of assignments of graduate students to faculty, which are confounded by financial considerations, could perhaps have identified a few assignments that apparently did not work out so well.
- d) *The environment is conducive to the attainment of the objectives of the Department.* The atmosphere in the department is remarkably congenial, which appears to benefit productivity and attainment of the department's objectives.

A. Issues of Interest to the Department and University

We now turn to the more specific questions included in the Terms of Reference document.

- 1) **Evaluate the Department's teaching resources, particularly for the Actuarial Science group to adequately sustain its growing level of activity.** In order to teach its courses, the department must rely fairly heavily on sessional instructors. This can benefit the students at times (for example, it is actually essential that some of the Actuarial Science courses are taught by sessional instructors with industry experience), but can also cause major problems. In Statistics, using a sessional instructor may mean having to use someone with limited teaching

experience. In Actuarial Science, sessional instructors have demanding industry positions with salaries that will always make their pay from SFU seem trivial. Courses must at times be replaced, as a result of a particular sessional instructor being unavailable to teach that term. We strongly support the department in its request for hiring a Lecturer to teach Statistics courses; this would reduce the reliance on sessional instructors in that area. For Actuarial Science, it would seem wise to build as large a pool of potential sessional instructors as possible, although this will be challenging because the number of companies with a large pool of actuaries is very limited in the Vancouver area. If the department is to expand in various new directions (see also item 2 below), while simultaneously meeting the growing interest in statistics (which is not just an SFU phenomenon as demonstrated by a 2013 Amstat News article by the Director for Science Policy of the American Statistical Association; [link](#)), then it would also be imperative to recruit new faculty who can lead efforts in these new directions. A Tier 1 Canada Research Chair could be instrumental for accomplishing this.

- 2) **Evaluate the Department's hiring strategy.** Hiring opportunities for the department have been limited during the last years. With possible retirements in its near future, this is a good time for the department to discuss a hiring strategy. We do not believe that the department can be successful in pursuing all of the various new directions that it has been considering, such as a 4+1 BSc/MSc program in Statistics, a PhD program in Actuarial Science, an MSc stream in Biostatistics coupled with becoming a major player in SFU's expansion in the health sciences, and entering the "Big Data" arena. Choices will have to be made, and targeted hires, in some cases at the senior level, will be critical. It does not appear that these issues have seen a sufficiently broad discussion within the department.
- 3) **Suggest strategies for accommodating the actuarial students' need for access to Finance courses.** In view of the current number of actuarial faculty and the demands on their time, we discourage the department from developing its own finance courses at this time. There appear to be two challenges. First, access to some of the currently offered finance courses is limited for the actuarial students. Second, in order to take the finance courses that the actuarial students need, they also need to take prerequisite courses that they don't really need for the actuarial program, thereby unnecessarily delaying their time to graduation. If the Business School is unable to accommodate the need of the actuarial students within the current curriculum, then the department should work with the Business School to develop and teach new courses and reach a solution that is mutually agreeable. This may require decanal discussions, but in view of the already high reliance on sessional instructors, it seems less than ideal to develop new finance courses specifically for the actuarial students unless that is the only solution to the problem.
- 4) **Evaluate the quality of the graduate program from the perspective of student experience, enrollments, completion times/rates, financial support and specialization areas in relation [to] student placements and access to courses outside the department (e. g. finance courses in Beedie School). Should the department explore expansion of its streams to**

include Biostatistics, a course-based one year master's degree and strengthening the course requirements for the PhD? Do the students in [...] the actuarial program have any difficulties [?]

It is impossible to give a brief response to this set of questions, but the issues raised here have been addressed elsewhere in this report.

5) Suggest possibilities for the future evolution of the Department at the SFU Surrey campus.

At this point in time, there is considerable uncertainty about how the SFU Surrey campus will develop. At the moment there are few programs that are exclusively based at Surrey, but if the Surrey campus becomes the primary home of Health Sciences, for example, then it would be imperative for Statistics to expand its presence there as well. For now, we recommend that the current presence be maintained. Faculty members at the Surrey campus are heavily involved in teaching and consulting there, and consistently spend one day per week at the Burnaby campus, where they have an opportunity to interact with other members of the department.

III. Teaching

A. Undergraduate Programs in Statistics

1. Overview of Current Programs

The department offers an honours program, a major program, and a minor program in statistics. All three of these programs have recently been revised, partly following recommendations by the American Statistical Association. It is too early to judge the success of the revisions, but by all appearances these programs appear to be well designed and cover a wide variety of topics in statistics. We have no suggestions for changes, but do recommend that the department carefully monitors the effectiveness of the changes that have recently been made. This also applies to service courses, which have also seen large increases in enrollments. It would not be uncommon that some of the students in the service courses would choose to pursue a minor or even major in statistics.

The undergraduate major program has seen an enormous increase in students over the past years, going from 153 approved majors in 2007/08 to 213 in 2011/12 (Table 2 in Appendix 1). The number of minors has also seen a large percentage jump, but the head counts are more modest. There is almost certainly potential for an even larger increase, but this would severely challenge the department's capacity. While some of the increases may be due to the recent program revisions and/or policy changes regarding declaration of a student's major, it is likely that there are other contributing factors. The increases are consistent with growth in statistics seen at many universities in North America because of an ever increasing demand for graduates with strong quantitative skills. This has led to more media exposure for "Big Data" and statistics (e.g. Google's Hal Varian's 2009 statement: "I keep saying the sexy job in the next ten years will be statisticians") and more exposure for statistical issues (e.g. the

2010 Canadian debate on the long-form census). In the US, and perhaps also in Canada, statistics has become much more prominent in high school education (and before), in part through the enormous growth of Advanced Placement (AP) Statistics and other “data-centric” math courses, and more exposure to statistics and probability in mathematics textbooks. As a result, more students know about statistics as a possible discipline by the time that they come to college.

Co-op education appears to be less popular, and probably less needed, among statistics students than among actuarial science students. While we can imagine situations in which a co-op experience would be useful for statistics majors, including to broaden their perspective in making choices for further graduate study in statistics, given the wide array of statistical techniques for different types of data, it may be more beneficial for students who are seeking a bachelor’s degree to take as many courses as is reasonable to acquire greater breadth in the discipline. In addition, it appeared that finding good matches in co-op positions for statistics majors was somewhat problematic, in that the experience did not allow them ample opportunities to use their statistical skills. In order not to increase time to graduation further (this is an issue is rightfully given some attention by the department), and to provide students with a broad education, we believe that it is best for undergraduate statistics majors to forego the co-op experience, unless there is a truly unique opportunity.

2. Statistics Minors Program and Service Teaching in Statistics

It is hard to distinguish between the courses required for a minor in statistics and the courses the department would consider “service courses”, since a number of courses fulfill both purposes simultaneously. Enrollments in these courses consist of a mix of students planning to receive a minor in statistics and students from other disciplines who want or need some exposure to statistics.

The department added new courses in 2012 to facilitate the pursuit of a statistics minor without the historical emphasis on mathematical underpinnings. This will help students from other disciplines to consider obtaining a minor in statistics even if they do not have a strong background in mathematics. Minors with a stronger background in mathematics still have the option to choose from courses that are mathematically more challenging. Among the new courses that require less mathematics are courses on multivariate analysis, time series analysis, and statistical programming. These courses have just been offered for the first time, and had healthy enrollments of 50 to 100 students. This is quite high for courses beyond the typical first and second introductory statistics courses. We applaud these changes, which are consistent with guidelines by the American Statistical Association, and note that versions of it have been implemented at other universities. The statistics minor degree exposes students to a wide variety of important topics. The number of approved statistics minors is listed as 17 for 2011/12, which is larger than before. While this number is still small, we expect that there is excellent potential for growth once that students in other departments learn about the changes that were made.

The non-calculus undergraduate service courses that the department offers include STAT 100 (a “Science Breadth” course on Chance and Data Analysis), STAT 101 (general introductory course), STAT 201 (introductory course for the life sciences), STAT 203 (introductory course for the social sciences), STAT 302 (a second course on data collection and analysis), STAT 305 (a second course aimed at the

Health Sciences) and STAT 403 (a more specialized and advanced small class on design and sampling). STAT 101, 201 and 203 are also offered as online courses. These seven service courses, including the online offerings and offerings at both the Burnaby and Surrey campuses, have seen a large increase in enrollments over the past few years, going from a total of 1433 in 2007/08 to 2906 in 2011/12 (103% increase over five years). This growth has primarily occurred in STAT 100, 203, 302 and the new offering 305. STAT 270 is a calculus based introductory course to Probability and Statistics for majors, which is also taken as a service course by students from more mathematically oriented disciplines. It is hard to predict whether further increases in enrollment will occur, but it is safe to say that some knowledge of statistics will remain highly relevant for many disciplines, so that enrollments for service courses are expected to remain large.

Service courses are also being taught on the Surrey campus, for example as part of the Faculty of Science's interdisciplinary Management and Systems Science program, which is directed by statistics faculty member Tom Loughin. Sections of STAT 100, 201, 203 and 270 are routinely offered there, for a total of six courses per year. Based on enrollments, these courses provide an important service for a growing community on that campus. There is actually a demand for additional courses, including an engineering statistics course. If Health Sciences moves to Surrey, then the demand will only grow. The faculty who currently spend most of their time in Surrey (Tom Loughin, Dave Campbell and Marie Loughin) not only play an important role in teaching the courses, but also play a valuable role through their statistical consulting activities there.

3. Challenges

A commendable and critical component of service teaching on both the Burnaby and Surrey campuses (although with limited hours for the latter) is the Statistics Workshop, which is currently partially held in space shared with the Mathematics department. The Workshop, managed by Senior Lecturer Robin Insley, provides drop-in assistance for all students taking service courses. With at least one TA present at all times on the Burnaby campus, students can get assistance with understanding course material, homework problems or assignments, or with computing problems. The TAs also serve the instructors who teach the service courses by providing marking for homework assignments and exams. The Workshop appears to be working remarkably well and is highly beneficial for the students, TAs, and faculty. The available space for this activity is becoming very problematic with the enrollment increases in the service courses. Further increases will undoubtedly have a negative impact on availability of this valuable service. Moreover, given that Robin Insley will be looking at retirement within the next years, it is important for the department to prepare for a smooth transition.

In view of the significant increase in demand for the teaching of statistics, the department observes in its self-study that:

"We think our use of sessional instructors is too high and that the number of courses we actually offer is too low. We think that the way forward is to make a teaching appointment—a Lecturer or Senior Lecturer—a priority."

We concur with this assessment and path forward. Obtaining qualified sessional instructors is very challenging in statistics, and will at times inevitably result in the hiring of weak or inexperienced instructors. It also requires considerable faculty and administrative effort to identify and contract with them and to juggle course offerings to accommodate their availabilities. To assure continuity and a high level of quality of instruction, recruiting a Lecturer who is a devoted teacher will be very beneficial. To be competitive, we would advise aiming for a teaching load of 6 courses per year, in which case this individual can also be asked to make other contributions to the department. While the primary focus of such a hire should be on the quality of teaching, the department might want to give preference to an individual with an interest in statistics education, which is a growing area of emphasis in statistics. As an example, the ASA Section on Statistical Education ([link](#)) also includes lecturers among its officers.

B. Undergraduate Program in Actuarial Science

1. Overview of Current Program

The undergraduate and MSc programs in actuarial science are the only actuarial programs in the Province of British Columbia. The undergraduate program is a restricted program. Undergraduate students who intend to enroll in the program are admitted to the Department of Statistics and Actuarial Science during the first year as 'intended majors' and formally accepted into the actuarial program after they have met the program requirements. About 25 students are accepted into the program each year from a pool of over 50 students. Most graduates from the program are employed by the insurance industry across Canada and a few go to graduate schools in Canada and the U.S.A.

The program provides very solid actuarial education. Its curriculum offers all the necessary courses for the first 5 actuarial professional exams sponsored by the Society of Actuaries (SOA) in the preliminary education category and courses for the SOA's Validation by Education Experience (VEE) credits. The program also offers courses on practical topics such as pension and property and casualty insurance. The program has recently gone through a strict accreditation process by the Canadian Institute of Actuaries (CIA) under the University Accreditation Program (UAP) and is now accredited by the CIA. Students in the program can receive credits towards the Fellowship of the CIA (upon approval) when they pass certain university courses with minimal grades set by the UAP. The program and the graduate program are among 24 actuarial programs in the world designated by the SOA as a Centre of Actuarial Excellence (CAE).

The program is relatively small in size but has a very good reputation. It is able to attract top students with a strong quantitative background each year. The students have a high pass rate for the SOA exams, which help them find internships and full time jobs. We have met several students from the program. They are in general satisfied with the education they have received.

The program has a successful co-op program. It has the highest participation rate across all programs at the University. The majority of the students have at least one work term before graduation and the internships often lead to full time jobs afterwards.

2. Challenges and Concerns

The actuarial group has 4 full time faculty members: Gary Parker, Cary Tsai, Yi Lu and Barbara Sanders. Parker is the director for both the undergraduate and MSc programs and Sanders is the accreditation actuary required by the CIA to ensure compliance with the accreditation requirements. Both Parker and Sanders are heavily involved in academic advising, administration, and job placement for both the undergraduate and MSc programs and receive course deduction for those activities. Taking sabbatical leaves into account, there are essentially 3.0 FTE faculty members for teaching in any given semester, which is not enough to cover all the core actuarial courses. Two courses are currently taught by statisticians and two others by sessional instructors. As a result of the shortage of actuarial faculty, the program is unable to offer summer courses. Some students who have an internship during the Fall or Winter semester are unable to take certain required courses in order to graduate in a timely manner. The current solution is to replace such courses by either courses in statistics and economics or by reading courses. Given the importance of the internship experiences, a long-term solution for this situation would require hiring more actuarial faculty members.

As a professionally oriented program, a number of upper division courses on practical applications must be taught by sessional instructors who are senior actuaries from industry. Due to a relatively small pool of available qualified actuaries and their demanding professional schedules, the number and timing of these course offerings is adversely affected. Courses must at times be rescheduled on short notice to another semester, which can impact the students' program of study. The department has done an excellent job of juggling these courses to make sure the students' graduations are not delayed, but lack of control over the availability of the sessional instructors makes course planning difficult. Having a larger pool of interested and qualified actuaries from industry to function as sessional instructors is essential for stability of the program. To improve the situation, the department could consider raising stipends for these courses in order to attract more actuaries to teach. Hiring junior actuaries from insurance companies as teaching assistants could also help to build a long-term solution as they could potentially become future instructors for these courses.

A significant number of students in the program are foreign born. Some of them are hampered by weaker oral and written communication skills in English. Currently the department offers an actuarial section of STAT 300W. The course is taught by a part time sessional from industry and focuses on presentation and business reporting. However, several students and the representatives from the Co-operative education program that we spoke with felt that the course was insufficient to help students improve their communication and especially writing skills. In order to help students, the department should address this issue, possibly by working with experts at SFU in teaching English communication for foreign students. As this is undoubtedly a problem affecting students in many disciplines, we encourage the University administration to consider how best to provide the needed support/training (e.g., writing labs, access to self-paced online instruction, etc.). While individual departments can provide some training, it is likely to be both more efficient and more productive to have language experts engaged in it.

The department proposes in its self-study to offer a 100 level 'Breadth' course in actuarial science, similar to STAT 100, to introduce basic topics in insurance. We think that this is an excellent idea. Not only would the course serve as a recruitment tool to attract more mathematically talented students but also would give the intended majors in actuarial science an earlier exposure to actuarial science. The latter would help those students reassess their choice and possibly reduce the number of mismatches down the road.

3. Finance Courses

Two core financial subjects in the actuarial curriculum are Corporate Finance and Financial Derivatives. The former is required for VEE credit towards the Fellowship of the Society of Actuaries and the latter is required by the CIA accreditation and also part of the SOA exam M Financial Economics (MFE). A number of actuarial programs in Canada (Laval University, University of Toronto, University of Waterloo, Western University, for example) offer their own courses on these subjects, usually one course for each subject. At SFU, actuarial students take 3 courses from the Beedie School of Business to meet the program requirements in this area: BUSI 312 plus one of BUSI 315 or BUSI 316 for Corporate Finance and BUSI 419 for Financial Derivatives. As pointed out in the self-study document and by the actuarial faculty during the interview, in order to take BUSI 419, students must take a series of 6 courses, including three upper division (300-level) courses, from the Business School as prerequisites. Two issues arise: (i) due to the policy changes by the Business School in recent years, actuarial students have had great difficulty in getting access to the upper division business courses, and (ii) a significant portion of the material covered in these 6 courses is not critically important for actuaries. It would be more beneficial for actuarial students to replace the nonessential topics in these courses by some topics in mathematics and statistics.

Under the current situation where the department does not have the teaching resources for the aforementioned two subjects, we would suggest that cooperative efforts be made to permit actuarial students to enroll in certain upper division business courses and to explore the feasibility of a "fast-track" series of fewer courses so that the students could access the required course (BUSI 419) more quickly. We understand that the actuarial students tend to be among the stronger students in these classes, and could easily handle a faster pace – as could some of the business students. Discussions at the Decanal level on this matter would be needed. Although students taking more business courses are to be encouraged, we agree with the department that the current arrangement on these two particular financial subjects is cumbersome and not ideal to serve actuarial students' needs in meeting their professional requirements. In the long term, the department might need to offer its own courses, as many actuarial programs do. They could be taught by instructors from the business school or by a fifth actuarial faculty member.

4. The Certificate Program

The undergraduate certificate program was the first actuarial program at SFU, but it is no longer viable. The current enrollment is very small, as only very few second-degree students will enroll in the program. Undergraduate students and most interested second-degree students enroll in the major program in actuarial science. The reason for the lack of interest from second-degree students is that the

program offers no degree and students cannot complete the program in one year if they want to have all the VEE credits and enough courses for preparing the SOA exams. Most second-degree students prefer the major program, even it takes longer to complete. The department plans to replace the certificate program with a one-year course-based post-graduate diploma program using the existing 300- and 400-level actuarial core courses. Eliminating the certificate program is definitely sensible, but we are not entirely convinced that the post-graduate diploma program is such a great idea. It might face similar enrollment problems as the certificate program, and strong students could always be encouraged to enroll in the current MSc program.

C. Graduate Programs in Statistics and Actuarial Science

1. The MSc and PhD Program in Statistics

Given that SFU is a Master's oriented institution, it is no surprise that the MSc program in statistics is considerably larger than the PhD program. At the time of the review, the MSc program is undergoing substantial revision. Besides course work, MSc students are required to participate in statistical consulting, have the option of participating in the co-op program, and must complete a written and orally defended project. We believe that the program provides the students with a very solid training. The department reports that 21 MSc students have graduated since 2010, with 4 having gone on to PhD programs and most others to positions in various areas of industry. The program appears to be very successful.

The PhD program does not require much formal course work beyond the MSc level, in contrast to requirements at many other institutions. (We understand that there is a difference between PhD degree requirements in Canada and the US, but, for example, the statistics PhD program at the University of Toronto requires the equivalent of 6 one-semester courses for its program.) The number of incoming PhD students is about 3 per year. With such a small number, it is important to bring in strong students. The department usually grooms its best MSc students to become PhD students. This is a sensible strategy, and the department appears to have been very successful in producing some outstanding PhD graduates.

For the MSc degree, SFU would like to see students finish in 2 years (or 6 semesters). Of the 21 students who graduated with an MSc in statistics since 2010, 8 students finished in 6 semesters, 10 students in 7 semesters, and 3 students in 8 semesters. A course based MSc, to which we will return later, might allow more students to finish within the desired 2 years. For the 11 students who graduated from the PhD program since 2010, 1 student graduated in 11 semesters, 2 students in 12 semesters, 2 students in 16 semesters, 1 student in 18 semesters, 2 students in 19 semesters, 2 students in 20 semesters, and 1 student in 21 semesters. Especially in view of the limited course work for the PhD program, the department should find ways to help reduce these times.

2. Challenges and Concerns

Incoming students receive a support package that requires them to be assigned to a supervisor. The graduate program chair gives careful consideration to these assignments, aiming for reasonable

matches between incoming students and supervisors, and consults with potential supervisors prior to finalizing assignments. For the most part, this system seems to work well. It did however become clear during our discussions with graduate students that the quality of advice that students receive can differ. The graduate students were generally very positive about the graduate program chair and the faculty (quality of instruction, accessibility, interest in students), but a few students did not seem to get proper or timely advice. We believe that there is room for improvement by more actively monitoring that students receive adequate and consistent advice and are make the necessary progress. For example, if a faculty supervisor is on leave, it is important that the student knows who will substitute for the supervisor and provide the needed advice. Also, the annual review of graduate students is, according to some of the students, neither taken too seriously by their supervisors nor used as an opportunity by the department for receiving student feedback. Given that students depend on their supervisors for funding, it can be intimidating for students to be frank if there are problems with the supervisor-student relationship. The department should provide explicit information on formal and confidential ways for students to provide feedback.

Our meeting with graduate students was the only meeting in which we heard serious complaints. However, it is important to note that the vast majority of students appeared to be very happy with the program, and the complaints came from just a few very vocal students. A primary source for the complaints seemed to be the vast differences in background of students who entered the program. For example, some came from mathematics programs, and struggled with their course work because they were unfamiliar with basic statistical concepts. At the other end of the spectrum, some students seemed to struggle with basic mathematical tools, and expected a program that was more oriented towards computation and that would prepare them more directly for jobs in industry, rather than for a research-oriented degree. This is a challenging issue since students who are interested in statistics can have very different backgrounds. This diversity in backgrounds can be beneficial, and some statistics departments (but not all) encourage it through their admissions process. It seems that the department has struggled a bit with this issue, though it was not clear whether much discussion among all faculty has taken place. We feel that this should be a strategic planning issue, and thus strongly encourage all faculty to engage in a broader discussion on what type or mix of graduate students the department would like to attract. If a department decides to recruit students that span a broad spectrum in terms of their backgrounds, then students who are not adequately prepared for the first-year core courses should be directed to remedial courses, whether to an introductory statistics course or to a course that covers essential mathematical concepts, so that they can succeed in the program. Alternatively, one could try to attract a more homogeneous student body, with all students seemingly well prepared to handle the demands of the first year. We understand that the current graduate program chair makes a concerted effort to recruit students who appear to be ready to handle the first-year courses. We believe that this is a good strategy, but would recommend that students nonetheless be monitored closely during the first year and that the different recruiting strategies be discussed more broadly in the department – this is an issue that affects all faculty.

3. Graduate Service Teaching in Statistics

Just as for undergraduate students, basic knowledge of statistical methods is increasingly important for graduate students. The department offers graduate level service courses for some disciplines, primarily from Biology, Resource and Environmental Management (REM), and Biomedical Physiology and Kinesiology (BPK). However, these courses tend to be combined with undergraduate applied and service courses. This is not an uncommon model, usually driven by a lack of resources that would be required for separate courses, but not ideal. The number of graduate students in these service courses is relatively low. The department also feels that the courses do not meet the sometimes more specialized needs of graduate students. To address this, the department proposes the use of smaller modules, in which specific topics are taught in a relatively short period of time, just like short courses. This is an interesting idea, although it is not clear to us how successful it can be. For most students, statistical thinking is not natural, and material taught during the relatively short duration of a module may give them just enough knowledge to be dangerously over-confident in their statistical abilities, but not enough to have a real understanding of concepts and issues. Nonetheless, the idea of the use of modules is original and, in view of the lack of resources, worth a try. There will be issues with implementation of this plan, such as in deciding which modules should be taught, prerequisites for each module, when they should be taught, how much credit a faculty member receives for teaching a module, and so on. It might also be that some of these are best team-taught, possibly with a faculty member from another discipline who can provide a perspective in terms of applications that cannot be provided as easily by a statistician and that may provide important insights to students from that other discipline.

It is unfortunate that the university does not provide a proper incentive for the department to meet the service teaching needs at the graduate level. Graduate students often see the direct relevance of statistics to their work, are highly motivated, and can move through material at a much faster pace. The current resource flow would not support or reward the department for developing more graduate level service courses. We believe it to be critically important that this be changed, and expect that it is an issue with other graduate programs as well. This would have many benefits for the university. It would provide students in other disciplines with critical knowledge and understanding in a data-driven era, would help to foster interdisciplinary collaborations, and would improve research quality across campus and improve competitiveness for external funding. Moreover, it would be far more efficient and effective for the department to be involved in all teaching of statistics on campus. As it is now, multiple departments teach their own flavor of statistics to their own students, both at the graduate and undergraduate level. Instructors of such courses, which also exist to varying degrees at some other institutions, are often not aware of the latest statistical methods, fail to understand the underpinnings of the methodologies, and tend to teach only the methods that they were taught when they were students. The same could be said for instruction in areas of interest to statisticians. Statistics students could benefit from courses in computer science – e.g., high-dimensional computing—which are best taught by content experts in those areas.

4. The MSc Program in Actuarial Science

The MSc program is the only co-op graduate program in actuarial science in Canada. It has been very successful. There do not seem to be any major issues of concern. All the students we met are very satisfied with the training they received and the internship opportunities the program provided. We heard that all the students in the program have had at least one work term. Given that most insurance companies are headquartered in Eastern Canada, this is remarkable. With the reputation the program has established and the demand from students, the department should consider gradual expansion of the MSc program when there are adequate teaching resources to support such an expansion.

5. Actuarial Research/PhD Program

The actuarial faculty are dedicated and committed educators devoting most of their time to teaching, academic advising and students supervision, which leaves little time for research. As a result, it is challenging for the actuarial faculty, especially the junior faculty members, to develop a strong research program. Lack of PhD students in actuarial science further hampers their research productivity. The department has, for the first time, admitted a PhD student in actuarial science and the student will be co-supervised by a statistician. The department plans to develop a PhD program in actuarial science in the near future, and we support this goal. Having a PhD program in actuarial science would not only raise the profile of the department in the actuarial academic community, but would also attract a great amount of interest from strong students domestically and internationally. Since there is a global shortage of actuarial faculty, the demand for graduates from this program would be high. Furthermore, the modeling group and risk management group of all major insurance companies are hiring PhDs in actuarial science. However, given the current faculty resources, the department does not appear to be well-positioned to launch and support such a program.

6. Initiative on Joint Program with the Business School

The department is considering a joint graduate program with the business school in Actuarial Science and Financial Engineering. Undoubtedly, the existing faculty have the expertise and qualifications to successfully develop and run the program, but it is unclear whether sufficient resources from outside the department can be allocated for this program. The resources currently within the department could not be used to develop and sustain this program without further sacrificing the access to courses and quality of the current programs.

7. Additional Recommendations for Actuarial Science

It is clear from our meetings with the faculty and from the self-study that the faculty resources in actuarial science are barely adequate for the current undergraduate and MSc programs. Unless a 5th faculty member is hired in actuarial science, the department does not have the resources to carry out the various initiatives it proposes, i.e., the PhD program in actuarial science, the joint graduate program with the business school and the post-degree diploma program. As discussed, several of these proposed initiatives are meritorious, and a strong case can be made for hiring at least one additional faculty member in the area. However, in a time of budget challenges, this need should be weighed against other needs. (See the later discussion in this report.) If a 5th person is hired in actuarial science, we recommend that this be an established senior researcher in the area of financial insurance. In addition to improving teaching resources, the senior person would be able to provide leadership in

research and in developing the PhD program. Financial insurance is one of the most important research areas in actuarial science and an area that attracts a large number of PhD students. A hire in this area would help a successful launch of the PhD program. It would also help with developing the finance courses if no agreement can be reached with the business school.

The department needs to develop a strategic plan and set priorities for enhancing existing programs and developing new ones. For actuarial science, the faculty are already overburdened by teaching and administration, and their research has suffered as a result. Even with an additional faculty member, implementing all the aforementioned initiatives over a short period of time would be difficult. Among these initiatives in actuarial science, it seems to us that, if one or more persons are hired to increase teaching capacity, then priority should be given to development of the PhD program.

D. Additional Areas for Future Program Development

With a changing world, it is not surprising that an energetic and talented faculty would be thinking about new opportunities and future program development, as well as how to help students obtain a graduate degree more quickly. Several opportunities proposed by the faculty in actuarial science have been discussed in the previous sections. Proposed key areas for future development outside the area of actuarial science are:

1. Development of an MSc degree in Biostatistics.
2. A non-research-oriented, course-based MSc degree as an alternative to the MSc thesis degree.
3. Partnership with Computer Science for a degree focusing on abilities to deal with "Big Data" issues and research opportunities.
4. A "4+1" or "3+2" combined degree" program in which the student would earn both a bachelor and master level degree.

These are discussed separately below.

1. Program in Biostatistics

A student with a BSc, MSc or PhD degree in Biostatistics has many opportunities in today's world, such as in areas of medical or public-health research, drug development, medical device development, health care assessment and regulation, and academics. However, new areas have developed which also demand the data modeling, model assessment, and prediction expertise of a biostatistician such as statistical genetics (discovery of genome associations or causal relationships with human diseases and traits) and analysis of "big data" (generated through administrative records on the use of health care services, medications, preventive health care, etc.) . The demand for students trained in Biostatistics is strong and increasing internationally – especially in China, where they recently announced the formation of 50 new academic programs in their Universities to build capacity in this area. The opportunities for BSc degrees in Biostatistics are more limited than either MSc or PhD degrees, as those with a BSc will be in a position to implement the methodology under the direction of someone more senior, but generally would not have sufficient training to be making independent bio/statistical decisions.

The core coursework for degrees in biostatistics is often very similar to that in statistics, and from that perspective, much is in place to move in this direction. There would be some differences in focus/topics, such as formal training in design of clinical trials, comparative effectiveness, and survival analysis, but generally the topics covered now for the graduate degrees in statistics would be applicable to biostatistics as well. There is one introductory course, *Introduction to Biostatistical Methods for Health Sciences* (STAT 305), which is suitable for basic understanding at the undergraduate level or at the graduate level when biostatistics is not the student's primary discipline (service course) but would be inadequate at an MSc in Biostatistics level. The department has six tenured or tenure-track faculty with interests and qualifications in biostatistics (Rachel Altman (Assoc. Prof) , Jinguo Cao (Asst. Prof), Jinko Graham (Assoc. Prof.), Joan Hu (Prof.), Brad McNeney (Assoc. Prof), and Michelle Zhou (Asst. Prof)), including statistical genetics and bioinformatics. In addition, there are two adjunct faculty members with ties to health-focused agencies (Robert Balshaw, BC Centre for Disease Control, and John Spinelli, BC Cancer Agency).

Another opportunity in this area would be possible partnerships and synergisms with the Faculty of Health Sciences. Their MPH degree requires one biostatistics course (HSCI 801-4: *Biostatistics for Public Health Practice*), but with more involvement from the Statistics department, a concentration area in biostatistics and epidemiology could be developed.

While there are many opportunities, there are also challenges. Typical academic training in Biostatistics includes a component of participation in medical or public-health research, usually involving a multidisciplinary team of researchers. The involvement with real data, challenges of trying to understand as much as possible of the underlying science driving the research, writing reports, and presenting analyses are common training experiences. A Biostatistics faculty member is usually also part of that team, and will oversee/direct the activities of the student and provide mentoring as needed. This type of training may, in part, be structured into a course (e.g., consulting course or practicum), but typically would be a primary source of funding for a graduate research assistant while enrolled in the graduate program.

The proximity of Fraser Health to the Surrey campus, as well as connections to the BC Cancer Agency and the BC Centre for Disease Control, would most likely provide many opportunities for this synergism of education and health research. However, we see two major challenges to moving strongly and quickly in this direction. First, the current funding structure for faculty and their research does not lend itself to the typical biostatistical funding model, in which faculty are paid, along with their graduate research assistants, to participate in such team research. The traditional external research funding in the Statistics department comes through NSERC, and primarily supports graduate students to participate in the research. It cannot be used for faculty time, nor is it able to fund biomedical and public health research. Our understanding is that the Canadian Institutes of Health Research (CIHR) does fund such research, and according to their website, both Simon Fraser University and Fraser Health are eligible institutions. However, we do not know the details of this funding mechanism and thus whether or not it is a viable option to allow/encourage such collaborative partnerships or if it could be used to support methodological research in biostatistics.

The second challenge is that the development of a strong graduate degree(s) in Biostatistics will require an investment of time from one or more faculty champions to build the relationships with the Faculty of Health Science and other researchers in the biomedical/public health arenas within the University, as well as with Fraser Health or other institutions. The current set of expectations and rewards for faculty would not permit such a large investment of time and effort unless the administration would be willing to support and fund it. Such an extensive commitment to this development could easily be detrimental to achieving the academic record necessary for promotion (or promotion and tenure), before the rewards of the investment could be realized. Currently, there is only one person in this interest group at the Full Professor level, and given the tight demands already in place for her time (as well as for other interested faculty), it is unlikely that these investment efforts/demands could be met without financial support and recognition at all levels of the importance of such developmental work.

We note that the graduate degree programs in the Faculty of Health Sciences include a Master of Public health, a Master of Science, and an interdisciplinary doctoral program. According to their website, the Faculty of Health Sciences can offer an MSc with an emphasis in epidemiology and biostatistics combined, but they are less well positioned, in terms of faculty breadth and depth, to offer an MSc in Biostatistics. It would be important to find a way to train professional biostatisticians that is a win-win for both Faculties.

Recommendations:

- Work with upper level administration to discuss models and avenues for support of faculty time and graduate research assistants; determine feasibility of additional hires (including at least one at an experienced senior level) for this initiative.
- Initiate conversations with targeted individuals (e.g., respective Deans, department heads) on the feasibility and funding models for greater collaboration between the Statistics Department and departments in the Faculty of Health Sciences.
- Design an MSc degree in Biostatistics to determine what new courses (and faculty to teach them) would be needed and what the impact would be on timing of applicable courses currently offered.
- Work with the Faculty of Health Sciences to either involve them in the teaching of this program or to provide feedback on how well the course content will meet the needs of the students' future employers.

2. Course-based MSc Program

The current MSc degree program is focused on a combination of didactic coursework and one-on-one mentored opportunities to participate in a faculty member's research program. The funding for the graduate research assistantships comes primarily through NSERC grants obtained by the faculty, who have enjoyed a high level of success in obtaining this type of funding. These students graduate with a budding methodological career of their own and are very excited to have had this opportunity. However, the demand for training in statistics has grown greatly over the past decade, and without further increases in faculty size, this model seriously limits the ability of the faculty to admit more

qualified students. Furthermore, much of the growth, and therefore the demand, is not focused on the development of statistical methodology, but rather on solving real world problems through the investigation of existing data or designed experiments. Typically, employers are looking for employees with a solid background in statistical methodology and the skills needed to make judgments, analyze and interpret data. They are unlikely to be asking (or expecting) MSc level graduates to develop new methodology.

The current program does not address this need, but a course-based MSc curriculum would attract students interested in this type of analytic work and would not require the heavy time demands on faculty generated by the research-oriented MSc thesis degree. Since the NSERC funding mechanism for graduate research assistants would not be available for these students, and the funding available for teaching assistants is limited, the expectation is that they would fund this graduate education themselves. It may also be possible that they would be funded as research assistants by collaborative research in the health sciences, should that funding avenue be developed.

The faculty envision a one-year MSc program to meet this goal. One year is reasonable if the students come from a closely aligned undergraduate degree (e.g., BSc in Statistics at SFU) and do not need outside employment to support their study. It might be a little short if the program were to admit bright and mathematically-gifted students who have very minimal or no real experience with statistics as a discipline. Often these shorter MSc degree programs are carefully aligned with a directed undergraduate program to achieve the needed levels of expertise in a shorter time frame, as discussed below in the joint "3+2" and "4+1" degrees.

Recommendations:

- Determine if there is a faculty champion for this initiative and where it sits in the department's priority list.
- Determine what impact admitting more students into such a course-based degree would have on the timing of course offerings.
- Carefully consider the type of students the faculty want to attract. Students in the undergraduate program at SFU might benefit from a combined "3+2" or "4+1" program, while external students may require a few more courses than would be possible in one year to get up to speed.
- Pursue this if possible. There are great unmet demands for these types of students!

3. Joint Partnership with Computer Science on a MS Degree Focused on "Big Data"

In today's world, there is tremendous discussion about the challenges of effectively eliciting useful information from readily-obtainable, massive amounts of data. For example, Computer/Information scientists are researching algorithms to quickly extract desired information and data characteristics, geneticists are looking for associations of diseases with elements of the genome, and statisticians are researching ways to develop better measures of uncertainty in those findings.

Several faculty expressed interest in this developing and challenging new direction, and in partnering with Computer Science to teach statistical approaches and issues related to analyzing such data. This

was described as a professional program, but it could also be an academic program. To be successful in this endeavor, it would be important for statistics to be “at the table” when development discussions are being held. It was not clear to us that Computer Science, who is taking the lead in this direction, is actively seeking such partnership. Before investing too much time on this, it would be important to determine what Computer Science envisions the role of statistics to be in this effort (e.g., partnership in research?; teach course content only?; undergraduate or graduate level courses?) and to determine what level of activity would be desirable and beneficial from the perspective of the Statistics Department in view of its limited resources and other initiatives.

4. Combined BSc and MSc Degree Programs

Another desire of the department is to develop a combined accelerated BSc and MSc in statistics, with the latter being course-based and requiring only one additional calendar year. This is commonly known as a “4+1” program. Such a program might attract strong undergraduate students, for whom the accelerated pace would be feasible and attractive. In view of this, an alternative model to consider might be a 3+2 program, in which the BSc course work is accelerated and completed in 3 years. The additional two years are at the graduate level. This would allow time for a more complete exposure at the graduate level, and might require fewer changes in course offerings than a 4+1 program. The latter would require offering additional graduate level courses in order to assure timely access to the courses. It is possible that a combined degree like this could be incorporated into one of the other initiatives, such as developing a Biostatistics stream. It would also be worthwhile to discuss plans in this direction with the Dean of Graduate studies, who notes that SFU facilitates development of combined-degree programs.

5. Concerns and Challenges

While the department shows great enthusiasm for all of the discussed “initiatives”, it is clear that it lacks the resources to implement all of them successfully. Furthermore, it is not reasonable to expect that the university can provide sufficient resources to support all of the proposed initiatives. Hence, it is critically important that discussions take place, both internally and with administrators at SFU, to prioritize the opportunities and needs. For each of the potential initiatives, faculty leadership would be needed to spearhead the discussion and, if selected for implementation, to lead the development. Discussions should also carefully consider how many additional resources would be needed for each initiative and how the initiatives fit with the department’s strategic plan and with the broader goals of SFU. It is not clear to us that all of this has been thought through carefully. There are too many enthusiasms! If a faculty member who is not yet a full professor is to provide leadership for one of these, his or her efforts should be broadly supported by the department and administration, with necessary adjustments in the expectations for evaluation and promotion.

IV. Research Activities

A. Overview

The department has developed a strong reputation for research in certain areas of statistics. This is especially true for areas of applied research, but there are also pockets of strength in theory. Areas of

strength include, but are not limited to, design of experiments (both physical experiments and computer experiments), biostatistics, bioinformatics and statistical genetics, and environmetrics. The first two of these areas, while still featuring multiple contributors, have unfortunately suffered from losing their leaders (Sitter and Dean).

As is the case for other statistics departments, the department can choose between hiring specialists in particular areas (targeted searches) or strong faculty who can make research contributions to multiple areas (opportunistic searches). Targeted searches can help in building or maintaining areas of emphasis in the department (e.g., design of experiments, biostatistics, actuarial science, environmetrics), but have the disadvantage that they discourage the application of strong candidates who do not fit the targeted pigeonhole. Especially in view of the initiatives discussed earlier, some targeted searches will be necessary, but we do not believe that it is in the best long-term interest of the department to have only targeted searches.

Faculty have been highly successful in obtaining NSERC research funding in the past. This funding has been critically important to support graduate students. Conversely, the thesis-based MSc degree has been very helpful in fueling the research enterprise, resulting in numerous publications and supervisory experience for all faculty, which has helped to compete for NSERC funding. With the changes at NSERC, both towards a model that funds fewer investigators and that has lumped Statistics back into a group with the Mathematical Sciences, the success rate can be expected to decline dramatically. As the self-study points out, "[the] result [of NSERC re-organization] has been disastrous for the discipline of Statistics ..." This would seem to argue that the thesis-based MSc degree becomes only more important, but also means that the department, in consultation with the university, must proactively consider strategies for other streams of research funding. This is in contrast to the advantages of a course-based MSc program discussed earlier in this report.

1. Other Funding Mechanisms for Research

While it is always important to consider alternative sources of revenue, with potential for reduced federal and provincial funding, and in view of existing academic opportunities for statistics and actuarial science, this is an especially critical time for the department to consider alternative sources of funding. There are many possibilities to consider. Since some of these would require considerable planning and preparation if pursued, discussions within the department and with the administration should take place as soon as possible.

Some of the suggestions that we encountered during our visit include:

- With the changes at NSERC, make adjustments that increase funding chances. For example, emphasize issues that tend to receive a high priority for funding decisions (such as training of highly qualified personnel) and consider other NSERC competitions (e.g. for partnerships with industry) besides the single-investigator competitions.
- Work towards conditions that would make it easier to compete for research funding from other federal funding agencies, such as CIHR.

- Encourage faculty to pursue funding opportunities through private foundations, industry, or other entities.
- Explore use of the VPR NSERC and CIHR bridging grants program.
- Explore options for Graduate Fellowships with the Dean of Graduate Studies.
- Pursue opportunities for external partnerships with other institutions or companies.
- Explore how statistics can be more involved with and benefit from PIMS.
- With the junior Canada Research Chair (CRC) coming to an end, present a compelling case to the Dean of Science for a Tier I CRC. Since several of the initiatives would greatly benefit from recruiting senior leadership, there are ample opportunities for building a strong case for a Tier I CRC, possibly even while continuing a Tier II CRC.
- Explore how additional income can be generated through engagement with external audiences, for example through webinars or short courses. Such funds could be used for bridge funding and/or special initiatives.

Success with alternative external funding sources, some of which already exists, would also place the department in a better position for making compelling requests for the limited university resources. If the department decides to move in the direction of obtaining research support from non-traditional sources, we would encourage the faculty to discuss how such activities would be viewed and rewarded in promotions and tenure, and viewed with respect to the goals of the department. Every funding agency has goals that the financial support is intended to pursue. Targeting research funding from non-traditional entities (such as Foundations) can impact the type of research to be done and the time it takes to complete it. It would be important for the department, School, and University to have a common understanding of the merits and/or disadvantages of going down that path for research and student funding.

2. Challenges

We realize that some of the suggestions in the previous section come with formidable challenges, many of which are not under the department's control. The re-organizations at NSERC will simply make it more challenging to attract Discovery Grants, but that is precisely why other competitions will also need to be considered. Developing collective as opposed to individual areas of strength, and partnerships with other units on or off campus (see also below), could increase competitiveness for such other competitions. Such collective areas of strength could also assist with faculty and student recruiting efforts. CIHR funding is, we are told, hard to obtain, but it may be possible to create conditions that improve the chances, such as developing a Biostatistics program, intensifying collaborations with the Health Sciences, or building partnerships with entities like Fraser Health.

As already noted in the section "Program in Biostatistics", a serious problem in exploring partnerships, internal or external, pursuing alternative funding opportunities, and building new programs is that SFU does not seem to provide adequate mechanisms for such activities. This pertains to issues such as money flow associated with partnerships and programs, but also with the time that a faculty member spearheading such efforts will have to invest. Building bridges to other units and exploring new

collaborative opportunities can be extremely time intensive, and this needs to be recognized and rewarded.

The department seems to feel that there are barriers at the VPR level to succeed with some of these efforts. But since success will benefit both the department and the university, we believe that discussions between the department and the office of the VPR can lead to a better understanding of the challenges and the possibilities, and quite possibly to improvements that facilitate the exploration of some of the opportunities.

The department has been involved in efforts involving joint appointments, in particular with Health Science. The success of such appointments depends heavily on the individual holding such a position and on the expectations that the different units have for this individual. Given that there seems to be no culture of such joint appointments, such appointments can be very demanding for a junior faculty member. However, given that such positions can also promote cross-disciplinary research, and given the need for senior leadership with some of the interdisciplinary initiatives (Biostatistics, Big Data), it might be worthwhile to consider hiring a senior faculty member into a joint appointment. For the right individual, such an appointment (for example with Health Science or Computer Science) might actually be more attractive than an appointment that is entirely in statistics.

It is not clear whether all the challenges can be overcome. However, if there is no effort to overcome them, then the outcome is clear.

V. Organization and Governance

While a committee structure with approximately 3 persons per committee exists, the culture is that one person on the committee often does most, if not all, of the work. The positions rotate, and it appears that it is not difficult to find someone willing to do the work. The faculty are happy with this structure, and have a high level of trust that their colleagues make decisions with which they agree or are at least able to support. Perhaps this is partly due to a core of the faculty having grown up together since the inception of the department. They also appreciate the fact that this model reduces the amount of committee work required of all. When questioned more about this structure, they noted that it works for them now, but may not do so well in the future, especially with personnel changes that have occurred or could occur in the next years. A downside is that it may not prepare the more junior faculty to become tomorrow's leaders of the department. However, it appears that the person doing the work on these committees often seeks input from other faculty informally, including junior faculty. Ad hoc committees are formed as needed for individual issues, and often involve more than one person contributing to final decisions.

Regarding admissions for graduate students, the graduate chair first screens applications to help smooth the process for others, and makes suggestions on potential matches for advisors of new students. However, the applications are available to all, and each faculty member takes responsibility for making the final decision on whom to support with their research money.

Because an incoming graduate student will work for (and be paid by) the same person who is their academic supervisor, it could, in some cases, create a difficult situation for a student who would like to resolve some issue they feel is present between them and the supervisor (e.g., not meeting often enough, not getting direction that is clear enough, wanting to switch supervisors to do work more closely related to their interests). The confounding of the employer/employee relationship with the student/supervisor relationship could be tricky for some, depending on styles and personalities. While our understanding is that this has rarely been the case, and the cases in which the students did not feel comfortable bringing up an issue to the supervisor were minor, we see it as a potential problem that is best prevented through clear communication on expectations and roles. For example, the department might include a component on expectations of supervisors (e.g., how often they would meet, how the student should request additional meetings), expectations of the student, and the path to take to resolve issues (e.g., if they can't work it out with the supervisor, to whom they should turn next.)

VI. Infrastructure

A. Space

Office and workspace are mostly adequate at the moment, although there are exceptions to this statement and any further growth will present formidable challenges. Increases in majors, minors and course enrollments have already resulted in some space issues that need attention.

Office space for faculty is adequate for now, but would become inadequate with additional hires. Space for visitors (including Surrey faculty) and sessional instructors, consisting essentially of one large office, is inadequate. Perhaps that the space recently vacated by the Dean of Science can help to solve this issue, but since doors to this space must be locked there are issues with accessibility to this space. In addition, this suite consists primarily of open space and contains only a couple of offices.

The space for support staff (Charlene Bradbury and Kelly Jay), while functional, is crowded and could use some renovation and re-organization.

With the increased enrollments in undergraduate service courses, the Statistics Workshop space on the Burnaby campus is at times inadequate. Moreover, part of this space, while exclusively used by Statistics, is technically shared with Mathematics. The space becomes especially overcrowded, causing potential safety concerns, on days before projects and assignments are due. It will only become worse if service course enrollments continue to increase. The department and university should work to eliminate the potential safety hazard.

Undergraduate statistics and actuarial science majors have no space to congregate, which would be highly desirable. They also do not have space or mailboxes to facilitate any undergraduate collective activities, such as a statistics club or other social activities. They currently use the Statistics Workshop space when it is not crowded with students taking those courses, but this is intended to serve only

those enrolled in the service courses and not as a consistent gathering place for majors throughout their degree program. This additional use of the workshop space contributes to the occasional overcrowding, although it is not the main cause.

Workspace for graduate students appears to be sufficient for the number of students enrolled, but the space is spread over several locations. This is clearly not ideal. The best space available for graduate students is the space that is rented in IRMACS, but with the new space obtained from relocation of the Dean of Science, paying for the rent in IRMACS may no longer be the best option. With other workspace needs in mind, as discussed in the previous paragraphs, and in view of the limitations of the new space (location and security), the department must decide how to best use the new space and assess whether this additional space can reasonably meet all of its needs. Without plans for the effective use of the new space (or a plan to try and trade it for different space) and a careful assessment of additional needs, it would be hard to make a compelling argument for a lack of space.

B. Computing

The nature of statistics and actuarial science is such that excellent computational facilities and strong computational support, both in hardware and software, are essential. Increasingly, there has been a need to balance IT support with the need for adequate security, resulting at many institutions in some form of centralized support.

Centralization of IT support has made some imprints at SFU, but computing support is rather heterogeneous for the department, in part perhaps because the department's workspace is not in one location. Most of the department's computing needs are now served through FASNET, and problems can be addressed via submission of an email. Most of these problems are assigned to individuals who also serve the mathematics department. More complicated problems are handled by support personnel with higher levels of expertise for those problems. While this means that the department no longer has an in-house IT specialist, the department seems generally satisfied with the support that is provided. There is ready-access to someone who can provide desktop support and the turnaround on email requests submitted for other problems is quick.

There is concern about the continuation of this support structure. Will the FASNET support structure continue in its current form? The review committee would like to emphasize the importance of a high quality computing infrastructure for the department, both for teaching and for research. This will only become more substantial in the future, especially if the department chooses to move in more computationally-intensive areas of research. If a quota system is implemented or if stringent data security measures are applied, then data storage and backup can also become increasingly a problem in this "big data" era, even though storage is extremely inexpensive these days.

VII. Program Assessment

In discussing the undergraduate programs in the self-study, the department notes its own shortcomings in tracking graduates after graduation. The self-study also notes:

"One of our goals is to improve this tracking so that we can better measure student success post-graduation and feed this information back into our regular program reviews."

We applaud this goal. Former graduates can provide important feedback on the successfulness of the program, and can also make useful suggestions for improvements. Benefits of staying in touch with these students while their careers evolve go also beyond program assessment. For example, it might be good to invite some of them back to meet with current students, both at the undergraduate and graduate levels. The perspective and information that these former students can provide for current students can be very valuable and can typically not be provided by faculty. Moreover, these former students may be able to help with securing meaningful internships or co-op experiences for current students, as well as permanent positions for graduating students.

We would however also like to emphasize that program assessment should not be limited to tracking graduates. It might, for example, be useful to collect non-grade based information from the instructors to assess the effectiveness of courses. Together with student teaching evaluations, which are collected as we understand, this could provide instantaneous feedback about positive and negative aspects of a course or instructor. Also worth considering are exit interviews, possibly in groups if individual interviews are infeasible due to the size of the number of graduating students. Our experience is that exit interviews can bring out positives and negatives of the program as perceived by students. Such interviews also provide an opportunity to emphasize the department's desire to stay in touch with the students. We also strongly recommend that peer teaching reviews are conducted for junior faculty. Training of faculty often focuses more on research than on teaching, and most new faculty will benefit from comments from experienced colleagues who have observed their teaching. Formal mentoring committees that provide junior faculty with professional advice, not just with respect to teaching, might also be a good idea. For example, in two of our departments, each junior faculty member is assigned either a 2- or 3-member mentoring committee. While some of these committees are more effective than others, they are intended to provide this junior faculty member with professional advice (teaching, grant writing, paper writing, research directions, how to respond to various requests for service, etc.). The committee prepares an annual report for the department Chair about the progress of the junior faculty member, which the Chair uses in his/her evaluation discussions with this person. If there are weaknesses in the performance of the junior faculty member, this process will hopefully bring these to the forefront at an early stage and lead to improvements. This will also help to improve the programs.

Program assessment is a topic that has been embraced at many institutions, and there may be professionals at SFU who can advise the department on developing appropriate measures and procedures. While we do not recommend that the department blindly follow all of the general recommendations that are typically made by program assessment advocates, we do believe that the department can benefit from making improvements in assessing the quality of its programs.

VIII. Service Activities

A. Service Teaching

While we have addressed the issue of service teaching extensively in the section on “Teaching”, we would like to emphasize that statistics is used in many disciplines, and a basic understanding of data collection, exploration and analysis is of critical importance for many areas of research. The depth of knowledge that is typically desired differs from one area to the other, so that a single introductory statistics course suffices for some disciplines, but not for others. Virtually every statistics department is involved in service teaching at both the undergraduate and graduate level. This is also true at SFU, although the emphasis is on the undergraduate level because there is no adequate mechanism to provide the department with the necessary resources in return for more service teaching at the graduate level. As explained earlier, we believe that more service teaching at the graduate level could provide a tremendous jump for more interdisciplinary collaborations, which would greatly benefit the department and the university. Finding a solution for providing resources to offer more graduate level service teaching should be a high priority, we believe.

We also strongly discourage teaching of statistics without involvement of the Statistics department. There are a significant number of departments who teach their own flavor of statistics at SFU. While it may be hard to discontinue these courses without a mutual agreement, it should not be as difficult to prevent new courses like this from being developed without involvement of the department.

B. Consulting Service

The importance of an effective Statistical Consulting Center for the department and the university cannot be overstated. The effectiveness typically depends on the ability and enthusiasm of those who are in charge of the daily operations, as well as on resources available for operating the center. We believe that the center at SFU has a positive impact in multiple ways, but we also believe that it could benefit from further growth and development.

Consulting activities take place at both the Burnaby campus and, increasingly, the Surrey campus. Activities on the Burnaby campus are directed by staff member Ian Bercovitz, while faculty member Tom Loughin is in charge on the Surrey campus. Staff member Marie Loughin provides consulting support on both campuses. The center serves both on-campus and commercial off-campus clients, and charges a 30-40% surcharge for external clients. Total income from consulting is given in the self-study as approximately \$15,000/year. For comparison, the statistical consulting center at the University of Georgia generates approximately \$80,000/year from consulting. Other income at SFU’s center comes from teaching by Bercovitz, including one or two sections in SFU’s NOW (Nights or Weekends) program and the consulting courses STAT 811 and 812. As we understand it, the NOW sections are primarily taught to raise more revenues. While teaching STAT 811 and 812 is closely related to one of the missions of the Consulting Center, it would appear that it could benefit the university if Bercovitz’s time would be spent on consulting with SFU researchers and graduate students rather than on teaching the NOW courses. It would not require a large amount of support from, for example, the office of the VPR to make this happen. Again as a comparison, at the University of Georgia, both the Office of the VPR

and the College of Arts and Sciences provide \$30,000/year towards the salary of an Associate Director of the Consulting Center (with other contributions for support of student consultants being provided separately). This is seen as a win-win situation: A modest investment by the VPR with significant returns for the university, and an investment that is critically important for allowing the Consulting Center to focus on consulting and on training students to become better consultants/collaborators.

The potential value of an effective statistical Consulting Center can be multifaceted. First, it can be of value for the department in providing statistics students with valuable consulting experience, which is an important asset for practicing statisticians and can only be taught through actual consulting experience with clients. The consulting courses STAT 811 and 812 are mandatory for MSc students, with the second courses providing students with client interactions and training for report writing and oral interactions with clients. We believe that these courses are a very valuable part of the MSc program in statistics.

Consulting centers can also be very valuable for improving research quality across campus, and for being the catalyst for interdisciplinary research collaborations. Regrettably, as indicated in the previous paragraphs, it does not appear that the Consulting Center at SFU fully realizes its potential with respect to these issues. In addition, the self-study refers to reluctance among researchers to spend money from their grants on statistical advice for their own research or the research of their students. We do not fully understand the reason for this. Do researchers find free statistical advice outside of the center? Does the typical research-funding model prohibit expenditures for consultants? Have researchers been discouraged by the quality or timeliness of advice that they have received from the center? Has the center failed to reach out to researchers and make a case for the added value that it can provide? We do not know what the answer is, but must encourage the department and administration to find ways to improve this situation. As it is, the center does not seem to reach its potential in terms of contributing to the research mission of the university.

IX. Hiring Strategy

Opportunities to recruit have been limited during the most recent years. After two hires in 2007 (Dave Campbell for the Surrey campus and Jiguo Cao), the last 5 years have seen only 2 additional hires: Barbara Sanders for the Actuarial Science program (2010) and Michelle Zhou (2012). In contrast, during this same period, the department lost Larry Weldon (2007, retired), Randy Sitter (2007, drowned), Leilei Zeng (2011, resigned), and Charmaine Dean (2012, resigned). Jiguo Cao, who was on leave, is fortunately returning to the department, along with his wife. This means that the size of the department is virtually unchanged since 2007, and that hiring has for the most part occurred in response to urgent needs.

As discussed earlier in this report, the department has identified many areas of need. During the visit we did not get the impression, perhaps incorrectly, that hiring priorities had been discussed carefully by the entire faculty. There is however a priority list in the 5-year plan for 2013-2018 (Appendix B of the self-study). It provides the following order:

Hiring Priority I:	Replace Charmaine Dean.
Hiring Priority II:	Replace Jiguo Cao, should he resign his position.
Hiring Priority III:	Replace Larry Weldon with an Actuary.
Hiring Priority IV:	Hire a statistician in Surrey.
Hiring Priority V:	Replace Leilei Zeng.

While this list was prepared not too long ago, it would already seem to be out of date. Priority II is no longer an issue since Jiguo Cao will return. We heard little discussion about Priority IV, and Priority V, which is based on the loss of a joint position with Health Sciences, may depend on the interest of Health Sciences to partner with Statistics. Priority V could however also be moved up, combined with Priority I, if the department and university can solve the challenges associated with developing a Biostatistics program and chose to make that a top priority. This returns to the question of what is viewed as most important among possible developments: Biostatistics, an Actuarial Science PhD program, become a player in the “Big Data” arena? The department will need to decide on their plan for the future to determine the types of strengths needed in suitable candidates for the current needs and priority initiatives. As indicated previously, this will also require a careful evaluation of the challenges associated with each of these. Depending on which initiative(s) are pursued, multiple hires may be necessary.

There was some concern expressed that highly targeted hiring for very specific skill sets tends to result in a small pool of acceptable candidates – at the expense of more generally strong candidates who might not fit the target quite as well. There is no uniformly good solution to this problem. In some cases (e.g., hiring a senior person with very specific goals to build a program or someone with a much needed computational background to work in “Big Data”) the targeted hires are very appropriate and the only way to be successful. In other cases, it might be better to cast a wider net and focus more on overall strength and potential. For example, a strong junior hire will be able to move across boundaries over time and will not be constrained to working in the same area that he or she worked on for a dissertation.

X. Summary and Recommendations

A. Summary

We would like to commend the department with the many excellent contributions that it makes to its mission and to that of the university. The department is very productive in terms of research and teaching, provides an excellent working environment for most of its members, and has built an excellent reputation in both the statistics and actuarial science communities. This success, which is even more impressive in view of how young the department is, has not happened by accident. It is in part due to active and ambitious faculty, who provided excellent and trusted leadership for the department over the years. While the faculty and leadership remain strong, the department also faces numerous challenges at this time caused by a convergence of multiple events. These include the loss of

some critical faculty; huge growth in majors and course enrollments, partially spurred by “big data” and a data-driven approach in many areas of modern research; numerous opportunities for new research collaborations; ambitions to expand course and degree offerings in areas of both statistics and actuarial science; a changed research funding model at NSERC; uncertainty about funding from other sources, including the province; and challenges at SFU for building new revenue streams for the department through teaching or research. How the department and university respond to these challenges will go a long way in determining whether the next decade is as successful for the department as the previous years have been.

B. Recommendations

We conclude this report by listing recommendations that we believe will help the department with continued growth and excellence. Some steps can be accomplished without additional costs, while others will require some investment of both time and money – perhaps space as well. Naturally, as with any report like this, there are uncertainties about funds available for such investments, and this can have a large impact on what is feasible and what is not. In today’s world, statistics is growing as a vibrant discipline with many opportunities for employment and impact. Investing in this area will pay strong dividends in the future to SFU.

1. Major Recommendations

- 1.1. A strategic plan. We believe that the department could benefit greatly from the development of a strategic plan that is based on extensive discussions within the department and with administrators outside of the department. While the 5-year plan shows that the future of the department has been given some thought, it is unclear that the choices presented in that plan are based on broad departmental discussions. Such discussions are needed to formulate common goals and to set priorities for enhancing existing programs and developing new ones. The self-study contains a plethora of ideas that the department wants to pursue. Indeed, opportunities for statistics and actuarial science are almost limitless these days, but resources are not. Therefore, what is called for is a careful evaluation of the opportunities, followed by judicious choices that are based on broad agreement within the department and that are commensurate with plans and needs at SFU.

- 1.2. Faculty recruiting. The department is stretched to its limits and is unable to meet SFU’s needs. This applies to both statistics and actuarial science. As noted in the self-study, the department does not believe that it teaches all of the statistics courses that it should be teaching, and we agree. The actuarial science faculty are clearly shorthanded, as pointed out earlier in this report. Add to this that some important senior faculty are no longer present (Sitter and Dean) and that others are approaching retirement, and it is abundantly clear that the department needs to recruit new faculty. The department should build a case for the importance of a Tier 1 Canada Research Chair in attracting a senior faculty member. We believe that a compelling case can be built for this based on one of the possible initiatives. Whether this should be in “Big Data”, in Biostatistics, in Actuarial Science, or in another area is something that the strategic plan should help to resolve. As noted elsewhere in this report, we believe that there are challenges that

need to be solved for all of these if such a search is to have a reasonable chance of success. We also strongly support the department's desire to hire a Lecturer in statistics. This position would help to reduce the reliance on sessional instructors in this area, improve the quality of teaching, and might enable the offering of a few additional courses. For actuarial science, we strongly recommend that the pool of potential sessional instructors be increased to alleviate the necessity for last minute changes in course offerings.

- 1.3. New collaborations and partnerships. In order to take advantage of some of the opportunities, there is a need to work with upper level administration to discuss models and avenues for support of faculty time, graduate research assistants, and other associated costs (e.g., computing environment support, travel, supplies). Establishing collaborations and partnerships, whether within SFU or with entities external to SFU (such as Fraser Health), requires vast amounts of time and effort. This must be reflected in faculty workloads and valued as a component of their expectations. One cannot just expect that faculty will do this on top of their teaching, research and service expectations. As it is, it appears that the department does not take full advantage of existing mechanisms, but also that existing mechanisms at SFU are insufficient to take full advantage of the opportunities for collaboration and partnerships. Constructive discussions with upper level administration are needed to bring some of the opportunities within the realm of possibility.
- 1.4. Alternative sources for research funding. Changes that have been made at NSERC do not benefit funding for statistics and actuarial science. As a result there is an urgent need for the department to look for alternative revenue streams to support research, and indeed, some faculty have tried. This could be through collaborations and partnerships, if developed successfully, through a focus on programs at NSERC that do not focus on single-investigator, through a focus on other federal funding agencies, or through any of the other alternatives mentioned earlier in the report. Focusing on such alternatives and whether it is possible to accept such funding within the SFU structures will take time and effort, and it is not too early to start this effort.
- 1.5. Program developments. The self-study contains a plethora of ideas for improving degree programs and service teaching. Most of these are worthwhile ideas, but the department simply doesn't have the resources to implement all of these, and should not expect to have sufficient resources anytime soon. Some of the proposed "plans" include the development of their own finance courses; discussing the possibility of a fast-track option for actuarial sciences with the Business School; developing a PhD program in actuarial science; developing a joint graduate program with the business school in Actuarial Science and Financial Engineering; offering a post-graduate diploma in actuarial science; offering more courses in statistics; offering a course-based MSc in statistics; offering a 4+1 or 3+2 combined BSc/MSc degree program, and offering a MSc in Biostatistics: We have discussed all of these options throughout this document, pointing out plusses and minuses, and have given recommendations that we won't

repeat here. It suffices to say that the department will need to make judicious choices based on discussions among all faculty.

- 1.6. Service teaching of statistics. At the undergraduate level, the department has made important changes in its service courses, and has seen large increases in enrollments. If at all possible, overcrowding in the Statistics Workshop should be addressed, and thought should be given for handling a possible retirement of Robin Insley in the near future. At the graduate level, the department proposes to offer modules that cover very specific topics of interest to targeted students within a short period of time. This is an interesting idea, with challenges that need to be worked. We have some reservations about the idea, but readily agree that it is worth a try if SFU cannot find a way to adequately support graduate service teaching with the necessary resources. That, we believe, would be preferable in terms of providing students in other disciplines with adequate basic knowledge of statistical ideas and methods. The current revenue model is quite unfortunate. For example, it encourages other departments to teach their own flavor of statistics (the department has a long list of such courses being taught at SFU, many also at the undergraduate level), which would not only seem to represent an inefficient use of resources, but is also unlikely to result in the best statistics training for students in these courses. While it may be difficult to eliminate existing courses of this nature, everything possible should be done to avoid the creation of additional statistics courses without involvement of the department.
- 1.7. Adequate funding for the Consulting Center. The Consulting Center is run by highly competent individuals, but we believe that the funding for the center is woefully inadequate. As a result, while the center seems to be successful in training statistics students, it does not nearly seem to be as successful in contributing to SFU's research mission. That is a pity; a small investment that would allow people in charge of consulting to focus their energies on consulting could pay tremendous dividends for the research quality across campus. There are many different funding models at other institutions. Some have invested large amounts of funds to set up large statistical consulting centers (e.g. U of Michigan and Michigan State U), others have been successful with significant, but more modest investments (e.g. Virginia Tech and UC Riverside), while still others have failed to make such investments (resulting in "centers" that are essentially run by graduate students without much supervision). At the University of Georgia we have during the last years moved from a system with very little support to one that has a Director, and Associate Director, 9 graduate student consultants supported through the center, and an income of about \$80,000 year from on-campus (primarily) and off-campus projects. Moreover, those who provide financial support (the office of the VPR, the Graduate School, and the College of Arts and Sciences) recognize the value of the return that they receive from their investments. At SFU, the department should have discussions with the administration to move in this direction.

2. Additional Recommendations

- 2.1. Completion times. The department is rightfully concerned about completion times for students in statistics, both at the MSc and PhD level. The problem is most glaring at the PhD level, though less information is provided about possible causes for this. It would seem to be the most serious issue though since students who take excessively long to obtain their degree can become a serious problem for a small PhD program. If not already known, the department should investigate what causes the problem, and attempt to alleviate it. At the MSc level, a course-based MSc degree and a combined BSc/MSc program could go a long way in resolving the problem.
- 2.2. Governance structure. There is much to like about how the department operates, and making major changes would probably be a mistake. But as pointed out earlier in the report, we believe that there is room for small improvements. For example, the department should provide explicit information on expectations about student-supervisor relationships, and offer formal and confidential ways for students to provide feedback on these relationships. A more formal mentoring system for junior faculty could also be beneficial in the long-run, especially with potential for multiple retirements in the near future.
- 2.3. Surrey campus. Clearly, we cannot predict how the Surrey campus will develop. We do believe that there is value in a presence of statistics in Surrey, both for teaching and consulting, and recommend not to make any changes for now. If other programs move to Surrey (Health Science?), then it would become necessary to expand the presence of statistics there as well.
- 2.4. Graduate student recruiting. We recommend a broader discussion in the department on what mix of graduate students should be admitted to the MSc in Statistics. Would the department like to see students with similar backgrounds, or is diversity in backgrounds seen as desirable? In the latter case, not all students may be well prepared to meet the challenges of the program, and remedial measures may be needed for some of the students. Both choices would be reasonable, and different statistics departments make different choices – it just appears that there has not been a broad discussion about this issue in the department.
- 2.5. Co-op experience for undergraduate statistics majors. It did not seem that co-op experiences for undergraduate statistics majors had, for the most part, been very successful. While we can imagine situations in which a co-op experience would be useful for statistics majors, given the wide array of statistical techniques for different types of data, it may be more beneficial for students who are seeking a BSc to take as many courses as is reasonable to acquire greater breadth in the discipline. This might also benefit time-to-completion for these students. We recommend that these students be discouraged from seeking co-op experiences.
- 2.6. Co-op experience for undergraduate actuarial science majors. For these students the co-op experience is critically important. However, based on conversations with co-op program representatives, opportunities for these students, many of whom are foreign born, are

negatively affected by their limited communication and language skills. This needs attention. The STAT 300W for actuarial sciences students does not suffice as a remedy. As this is undoubtedly a problem that plagues many disciplines, we encourage the university administration to consider how best to provide the needed support and training (e.g., writing labs, access to self-paced online instruction, etc.) for such students.

- 2.7. A 100-level "Breadth" course in actuarial science. The department started a successful 100-level "Breadth" course in statistics. We fully concur with the department that starting such a course in actuarial science to introduce basic topics in insurance is an excellent idea, provided that resources permit doing this.
- 2.8. Program assessment. The department should strengthen the assessment of its courses and programs. This is especially important in view of recent significant changes in course offerings and programs, and with other changes still in the pipeline. We have offered suggestions for improvement earlier in this report, but we strongly recommend that the department work with program assessment specialists at SFU.
- 2.9. IT support. Continuation of adequate IT support is absolutely critical for statistics. Computing is an integral part for statistics, both in support of teaching and research. The department is currently satisfied with the support that it receives, but if SFU follows trends at other institutions then it would not be surprising to see some changes occur in this support over the next years. We recommend that the department discuss IT support with the administration, so that the needs are abundantly clear when the time for changes comes around.
- 2.10. Staff support. The size of the support staff seems to be adequate at this time, although this could change quickly if the growth in majors, minors and service courses continues. The workload seems unequally divided though, placing some staff members in almost untenable positions. This needs to be addressed urgently.

We appreciate the opportunity to visit both the department and the University. We were very impressed with all the achievements and contributions the department makes to the University, and the responsiveness of the upper administration when conducting this review. If we can be of further help – perhaps to clarify or revisit an issue – we would be happy to do so.

EXTERNAL REVIEW – ACTION PLAN

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

Unit under review Statistics and Actuarial Science	Date of Review Site visit April 10-12, 2013	Responsible Unit person, Richard Lockhart, Chair	Faculty Dean Claire Cupples, Dean of Science
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Note: It is **not** expected that every recommendation made by the Review Team 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.

Should an additional response be warranted, it should be attached as a separate document.

1. PROGRAMMING

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

1.1.1 Undergraduate:

- a) The review committee urged us to do some course development in Actuarial Science. A package of revisions to our major and honours programs in Actuarial Science will be developed. In particular we will consult with the Beedie School of Business as we look for ways to secure reliable access to courses in finance suitable for undergraduate students in ACMA programs.
- b) The review committee recommended we cancel the undergraduate certificate program in Actuarial Science; we will do so.
- c) The review committee recommended we hire a lecturer in Statistics to increase our teaching capacity and lower our reliance on sessional instructors. We will seek to do so when resources permit.
- d) The review committee recommended that the university adopt policies to prevent the fragmentation of statistics instruction on campus. We whole-heartedly agree and will engage in discussions with our Dean and others around the university on ways to move forward; we acknowledge that service teaching in statistics calls for collaboration between our department and the departments being served and will explore ways to ensure this happens.
- e) The review committee recommended we develop a framework for course and program assessment. We will engage in consultations with TLC to do so.

1.1.2 Graduate:

- a) The external review committee called on us to consider a number of issues surrounding our graduate program: i) completion times in our MSc program and our PhD program; ii) total enrolments; iii) admissions criteria; iv) formal departmental guidelines for supervision; and, v) student-supervisor relationships. An ad hoc committee will review these issues and make

recommendations.

- b) The review committee suggested we pursue negotiations with other departments and faculties to develop modularized graduate service courses provided we get suitable resources in compensation for the corresponding loss of teaching capacity in our own programs. We will consult with a variety of other departments to see if such a plan can generate efficiencies and promote better educational outcomes.
- c) The committee supported our development of a PhD program in Actuarial Science. We will design such a program to be implemented when resources permit.
- d) The department put before the committee outlines of proposals for expansions of our graduate programming activities on a number of fronts. By and large the reviewers support all the suggestions but urge us to choose which of them we will push forward. We will seek, for each suggested program, a champion to take on the task of putting together a more complete picture of the suggested expansion which indicates clearly what work would need to be done and what resources might be required. We will then choose between those proposals that find such a champion after engaging in broad discussions of the sort sought by the review committee.

1.2 Resource implications (if any):

- The undergraduate program revisions in actuarial science will require 1 to 4 extra sections of actuarial science offerings per year. Our top current hiring priority is in actuarial science; this will provide some of the needed resources. In the case of finance courses we might need resources for two sessional instructors per year to mount our own finance for actuaries courses. Developing our own courses might, in the long run, be more efficient for the university. There might, indeed, be demand from some Business students for a more intense finance sequence and so our courses might add to capacity for Business students.
- The proposed lecturer position would obviously require resources.
- Consolidation of the teaching of service statistics courses would likely save the university resources overall.
- If we develop an extensive formal course and program evaluation process then we will require resources to implement the program. The need will become clear when the development is done.
- We cannot estimate resource implications for our various potential graduate program expansions until we develop detailed proposals. The availability of resources will inform our choices in this process.

1.3 Expected completion date/s:

Undergraduate

- Actuarial Science program revisions will be completed by the end of the 2013/2014 academic year.

- **Hiring a lecturer must wait for resources.**
- **Consolidation of undergraduate teaching in statistics is a long term goal requiring regular discussion and collaboration. We will begin now but no completion date can reasonably be set.**
- **We hope that program and course assessment procedures can be developed by the end of the 2014/2015 academic year.**

Graduate

- **The committee reviewing aspects of our graduate program will be struck in the 2013/2014 academic year with any needed changes to approved by the department during the next academic year.**
- **A program proposal for the PhD program in Actuarial Science will be developed by the end of the 2014/2105 academic year but implementation may have to wait until the next hire in Actuarial Science.**
- **Discussions concerning modularized course offerings are taking place in the 2013/2014 academic year and we hope to make proposals, if resources permit, during the next academic year.**
- **The program development activities we contemplate will be completed by the end of the 2014/2015 academic year; full development and implementation will require more time but we won't know how much until the development process is complete.**

2. RESEARCH

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

- a) The review committee recommended we seek a Tier I chair. We applaud the suggestion and argue that we must be the strongest candidates for any such chair when one becomes available.
- b) The committee recommends we look beyond NSERC for research funding. In general terms this is an action for individuals but we will engage in efforts to foster an expansion of our research support. Many of us have funding from a number of non-NSERC sources but an internal exchange of information, facilitated by a few group discussions seems useful.

2.2 Resource implications (if any):

- a Tier I CRC.

2.3 Expected completion date/s:

- Unknown – not under our control.

3. ADMINISTRATION

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

- a) The review committee recommended we increase the involvement of junior (recently tenured) faculty in departmental administration and increase the level of formality in our committee structures. We will reach out to those faculty and work to increase their role in order to develop future leadership. We will review and, if necessary, increase the level of formality of various committees.
- b) The review committee took the view that we need a strategic plan. The department will undertake broad discussions of the adequacy of our current strategic plans during the academic year 2013/14. A new strategic plan will be drafted if there is a consensus that our current five year plan, the plans articulated in our external review self study and our current hiring plan need modification.

3.2 Resource implications (if any):

- None

3.3 Expected completion date/s:

- **Committees will be restructured for the 2014/2015 academic year, co-incident with the appointment of a new chair and following broad departmental discussions of the extent to which such change is required.**

4. WORKING ENVIRONMENT

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

- a) The review committee considered that our space is not adequate. We agree. We will work to acquire office space for Visitors, Emeritus Faculty still active in research, Surrey faculty spending time at SFU, Sessional instructors, and postdoctoral fellows. In the next two years we expect to find ourselves unable to find enough offices to house all regular faculty.**
- b) The review committee called on us to provide space for an undergraduate student common area. We will seek resources to do so.**
- c) The review considered that our Statistics Workshop is overcrowded. We will seek to deal with this either by finding a larger room or by using two rooms with two lecturers. The latter possibility would permit the two workshops to specialize more in the courses served in an individual workshop.**

4.2 Resource implications (if any):

- **Space requires resources so this can only be done with the help of the faculty and the university. We have used the same workshop space for nearly 30 years and enrollments have grown very dramatically over that time; there is no way to fix this without resources. A second workshop likely is not a solution unless we hire the lecturer described above. A new, larger, room would be more efficient.**

4.3 Expected completion date/s:

- **Unknown.**

5. Other

5.1 Action/s:

- a) The review committee urges the university to find a more sustainable model for funding our statistical consulting service. We agree that the current model is not clear and that the service should play a bigger role within the university if resources permit. We will undertake discussions with the Dean and the Vice President Research on the subject.
- b) The committee expressed concern about the stability of our current arrangements for IT support. We agree that there are grounds for such concern and will engage in discussions with the Faculty of Applied Science and the Faculty of Science to ensure that we have secure, appropriate, and effective support.

5.2 Resource implications (if any):

- The consulting service fills a very important role in the university and needs a steady funding model but it is not clear how much extra funding is actually required. The main resource issue is: who will pay?

5.3 Expected completion date/s:

- Unknown.

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

<p>Unit Leader (signed)</p>  <p>Name: Richard Lockhart Title: Chair, Stat & Act Sci.</p>	<p>Date <i>November 23</i> <i>2013</i> <i>RLK</i> 23 September, 2013</p>
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Section 2 - Dean's comments and endorsement of the Action Plan :

I am very pleased with the quality and scope of the external review conducted on the Department of Statistics and Actuarial Science. The report is very balanced, pointing out the undoubted strengths of the department as well as the lacunae. The department's action plan is thoughtful and focused, addressing the major issues.

One of the strengths of this department is its collegiality, which includes informal mechanisms for making decisions and setting direction. As the report points out, and the department recognizes, changes in faculty demographics, faculty turnover and an upcoming change of Chair suggest that it is time to become more strategic and considered in planning future directions. The recent rapid growth in student numbers has put stress on resources, including personnel and space; this stress will be exacerbated if the department wishes to take on new initiatives – whether they be new undergraduate or graduate programs, enhanced service teaching or new research directions. This is an opportune time to seek additional resources from the Faculty of Science, including the proposed Lecturer in Statistics, but the department will have to be focused and proactive in presenting its case.

The Actuarial program is a gem but faculty members capable of delivering the program are spread thin. The department has requested a faculty hire in the area; I have given it a high priority in this year's hiring plan. In the meantime, I encourage the department to begin planning the PhD program in anticipation of the hire. My office has put effort into helping solve the problem of access by actuarial students to business courses, so far without measurable success. This problem is critical; I will fully support the department however they wish to proceed.

I recognize the need for space to support the statistical workshops and to accommodate faculty hires, and am working with the department to identify possible solutions. The statistical consulting service also needs support to ensure sustainability; I am happy to work with the department to come up with solutions.

Many of the review team's suggestions were just that – intended to be helpful rather than prescriptive. The department will benefit from the advice while being free to determine its own way forward. I look forward to working with them to that end.

Faculty Dean



Date

15 Nov. 2013.