Cyclical Review of the Physics & Computer Science undergraduate programs Final Assessment Report

Programs:
Honours BSc Computer Science
Honours BSc Computing & Computer Electronics
Honours BA Computer Science (in Combination)
Honours BSc Photonics
Honours BSc Physics

Submitted by: Paul Jessop, Dean, Faculty of Science in consultation with Deb MacLatchy, VP: Academic and Pat Rogers, AVP: Teaching and Learning

Date: April 20, 2014

Part 1: Synthesis of Review Documents

a. Summary of Self-Study

The origins of the Department date back to 1963 when R. Koenig, the first physics faculty member was hired. Since that time there has been steady growth, with the introduction of computing courses in the 1970s and eventually the renaming of the Department to Physics and Computer Science in 2003. Currently the Department has 14 full time faculty members and offers 15 programs in Computer Science and 7 programs in Physics/Photonics.

Computer Science
The department was interested to receive input from the reviewers on a number of specific curriculum issues. Having a required thesis course is not viable because of the pressure it would place on faculty workload. Currently, students are exposed to group projects in CP317 Software Engineering and various 400 level courses but they have no experience with large group projects. In light of the current program structure, a capstone course would add value if it included a large group project. Is there an alternate way to introduce large group work into an existing course?

There is always tension between delivering courses in traditional computer science areas and introducing content from new emerging areas. As a small department, we need to offer a carefully selected set of required and elective courses that meets the needs of the discipline while being attractive to the modern student. Our incoming first year students, both computer science majors and non-majors, have a wide variety of programming backgrounds. Approximately 50% of the almost 400 students in CP104 Introduction to Programming have little or no programming experience and for 75% of the students, the course is a requirement. The department believes in a programming-first teaching approach and we are currently using Python for year one programming courses, CP104 and CP114.

If we were to offer two introductory courses based on students' previous programming experience, it is unclear how we would get students to the same level of expertise by the end of the term or the end of year one. Another issue is how to stream the students into the correct course. (In physics, some students who qualify for the calculus-based physics take the algebra-based physics course because it is perceived to be easier.) We are interested to know of alternate approaches that have been successful in handling the mixed backgrounds of incoming students.

The use of Python as the first programming language is controversial within the department. Although a non-traditional language for computer science programs, the switch from C to Python has had a significant impact on students. Students' questions are now about concepts and algorithms instead of syntax issues and there is now an exceptionally different teaching environment and significantly improved student attitude.

The controversy regarding the use of Python is intertwined with the positioning of CP114 Data Structures as a year 1 course. Comments from the reviewers regarding the year 1 course sequence would be appreciated.

Physics and Photonics
As the physics and photonics programs are very new, the department was interested in receiving input from the reviewers on some of the specific curriculum changes under consideration, in particular:
• the addition of PC3XX Mathematical Physics
• the use of PC450 Instrumentation to address lab experience
• the addition of PC4XX Seminar in ... Physics series to address both the issue of electives and the issue of meeting higher-order learning outcomes in the physics program.

When the photonics program was initially developed, telecommunications was a booming industry, especially in Canada. As the program has now graduated a number of student cohorts, there has been a noticeable lack of students entering the telecommunications or related industries. Students obtaining the best entry-level positions immediately after graduation had a background in Computing & Computer Electronics. The department has considered shifting emphasis from communication to electro-optics and geometrical (imaging) optics, a shift that could work well with the Computing & Computer Electronics program. If we were to shift our application emphasis, what other areas should we consider (acknowledging the small size of the department)?

Currently, we offer two honours physics programs and provide a significant amount of service teaching with five physics faculty and the assistance of some computer science faculty. With one physics faculty member leaving and replacement uncertain, there is concern with the structure of the current Physics program (insufficient electives) and our ability to execute the proposed curriculum changes without damaging the existing Photonics program.

b. Summary of External Reviewer's Report and Recommendations

The review team consisted of Dr. Robert Thompson from the University of Calgary, Dr. Eric Neufeld from the University of Saskatchewan, and Dr. Donna Kotsopolous from Wilfrid Laurier University. The executive summary provided by the reviewers, along with their list of recommendations, is included below.

The following points provide a set of the most important recommendations of this external review committee. The details are found throughout this document, but these points distill out what we view as the keys to move this Department and its programs forward from a position where it is a unit of extremely hard working faculty members with a somewhat directionless set of programs to a unit where the faculty are rewarded by the success of

their efforts and the University is rewarded by the existence of a set of high quality, focussed and successful undergraduate programs.

1. **Increased levels of productive communication within the Department and between the Department and senior administration of the university are necessary.**

2. **Faculty should develop a strategic student recruitment plan that is connected to a well articulated "choose us" vision and mission. External facilitation is recommended.**

3. **Closer alignments between classes and tutorials are necessary, particularly for physics.**

4. **Curriculum and program offerings should be reviewed to consider depth and breadth rather than breadth alone. Given the current context, it may be that the Department may need to substantially focus their goals and objectives in such a way that allows them to be excellent in select areas. Being all things to all people is not possible for this Department given the obvious constraints of resources and enrolment numbers.**

5. **A bi-lateral double-degree committee should be established to ensure programmatic coherence and effective collaboration between the Department and the SBE. Students in the double-degree programs expressed significant concerns and disadvantages.**

6. **Syllabi should more fully articulate learning outcomes, program goals, university policies, and so forth. Formal guidance is necessary along with some professional development through TSS.**

7. **Increased success in mathematics is a priority for the program. The failure rate is alarming. Concern was expressed by faculty but also by students.**

8. **The level of programmatic ambition is low amongst Faculty and Senior Administration. The potential within the Department for necessary leadership to move the department forward is uncertain. The Department, along with Senior Administration, are encouraged to engage in focused and outcome driven strategic planning. An external facilitator may be useful.**

9. **The Computer Science faculty should explore new directions and opportunities for areas of focus in their program, which could aid in the establishment of a clear 'Choose Laurier' message for programs in Computer Science. e.g. The Web, Social Media, and mobile (not to mention interdisciplinary computing) are changing the job and consumer markets in profound ways, yet the underlying**

computing is much the same.

10. **Another change in Canada is the de-emphasis on individual research (Discovery Grants) and increased focus on industry-relevant research, which usually requires teams. This puts WLU faculty in a tough position to compete. Addressing these concerns going forward requires some organizational planning and strategic direction.**

11. **A careful review of hiring plans for the Faculty to examine the extent to which a teaching only position may support the predominant mission of this Department for service teaching.**

12. **We recommend that the University and Department IT services come to the table, with a facilitator if necessary, and clearly distinguish the unique computing needs required to deliver a computer science program from the routine computing needs of students, faculty and staff in the program, and identify genuine efficiencies that do not compromise the computing experience on either the academic side or the service side.**

13. **We repeat the recommendation of the previous External Review that the Computer Science program seek accreditation.**

c. Summary of Unit Response

In response to the External Reviewers' Report, the Department established two committees: the Vision Committee and the Publicity and Outreach Committee. In due course the following initiatives were advanced: collaboration with Niagara College (Photonics); starting work on creation of new courses; improving the operation of our 2+2 program with Chinese universities in Photonics and possible extension to Computer Science; establishing recruitment and outreach strategies (in collaboration with the Recruitment & Admissions Office), which should result in the strong marketing of our programs, especially Photonics; Creation of a Photonics Advisory Board which will include industrial partners.

Generally, the Department agrees with most of the recommendations contained in the External Reviewers' Report and is in the process of detailed implementation.

There is a lot of enthusiasm among members of the Department related to promoting our unique programs, establishing new collaborations, both within the Laurier community and outside, and developing new initiatives. The Reviewers' Report has generated positive momentum, which will result in an improved program.

Part 2: Executive Response

The External Reviewers' Report consists of 19 pages of commentary, observations and opinions followed by an executive summary that presented 13 specific recommendations. The Unit Response and the Implementation Plan below tend to focus on the recommendations. However, the recommendations understate the seriousness of issues that are discussed in the main body of the report. The reviewers had some rather harsh criticism and pointed out serious problems that need corrective action.

Three specific issues that came up repeatedly in the report were:

- The Department lacks a sense of direction or an identity that positions it within the landscape of all the other Computer Science and Physics programs with which it competes for students. The reviewers stressed the need for a serious strategic planning exercise, going so far as to say:

   If the Department does not make serious efforts to move forward a strategic planning exercise with respect to its goals, programs, and pedagogical approaches, it is at serious risk of moving into a period of stagnation………The Physics and Photonics programs are sufficiently small that they might not survive an extended period of stagnation.

   They suggested that, with respect to Computer Science, we might consider a stronger focus on "applied computing" as part of our identity.

- The Department (and the Faculty as a whole) needs to improve our student recruiting and articulate the "value proposition" for Laurier Science. The department "lacks any programmatic enrollment target" that would guide recruitment efforts.

- The small classes in some of the Department's courses present a great opportunity for the introduction of innovative pedagogies, but there is a noticeable lack of innovative approaches to teaching.

The report also had many complimentary things to say about the Department, but its overall message was a stern warning that the department must come to grips with defining a vision for the future and with low enrolments in Physics and Photonics.

a. Identification of Program Strengths

The reviewers quite correctly pointed out that perhaps the greatest strength of the program is the talent of its faculty, staff and students. The faculty are strong researchers who are able to secure research funding and publish at a good rate, even though they are working in a department without a graduate program. The laboratory staff are exceptionally dedicated to providing the best possible lab experience to their students. The students are hard

working and enthusiastic, and their strength is best indicated by the fact that virtually all graduates of the program find employment in relevant fields or proceed to graduate school.

The reviewers felt that the curricula for both the Computer Science programs and the Physics programs were strong and they especially praised the laboratories and upper year projects. Although they pointed out some of the practical problems associated with the Department's double degree programs and the 2+2 program with Jiangsu University, they saw these as areas of strength upon which the Department should build.

b. Opportunities for Program Improvement and Enhancement

Recruiting: The department should put more effort into recruiting more and better first year students. This is especially true for the Physics and Photonics programs where student numbers are dangerously low. We can't rely entirely on the university's central recruiting office for this, since they must focus on overall numbers and can't be expected to have detailed knowledge of what Physics and Photonics are all about and the career opportunities that are open to graduates. As stated by the external reviewers, the department needs to establish realistic enrolment targets and then work to meet them.

Strategic Planning: In order to attract more students, the department needs to articulate its programs' "value proposition" and be able to make it clear to prospective students why they should choose Laurier as the place they want to study Physics or Computer Science. This will require a serious strategic planning exercise aimed at establishing a greater sense of identity and more clearly defined areas of focus that will differentiate Laurier's Physics and Computer Science programs from their competitors at nearby universities. The reviewers suggest that the Computer Science focus should be on applied computing, and we would suggest that a greater focus on applications and industrial relevance would be appropriate for Physics and Photonics as well. The Department should develop its own vision for the future and not have it imposed on it by the external reviewers or the Dean. But it must be a vision that is practical and sustainable. The reviewers were of the opinion that the Department is currently delivering its courses "on the knife-edge of sustainability."

Curriculum Review: The reviewers commented on the Department's "plethora of program offerings" and the "somewhat directionless set of programs". They commented that "the sheer number of computer-related programs offered by the Department is confusing to the reviewers, let alone the students." A strategic planning exercise should take a careful look at the currently existing set of programs and consider whether some streamlining would reduce confusion. This would be timely as the Department proposes the introduction of yet another program – the BSc in Applied Scientific Analysis. There is also a need for review and revision at the level of individual courses. The reviewers remarked repeatedly that the Department should seize the opportunity for curricular innovation that is presented by the small size of many of its classes.

c. Prioritization of Recommendations Approved for Implementation

The three most important themes contained in the recommendations are student recruiting, strategic planning and curriculum/program review. Consequently the highest priority recommendations are number 2 (recruitment), number 8 (strategic planning) and number 4 (curriculum review).

Another group of recommendations deals with more specific issues that fall under one of the three main themes. Number 3 (alignment between classes and tutorials) and number 6 (contents of syllabi) fall under curriculum/program review. Number 10 (organizational planning and strategic direction for research) and number 11 (hiring plans and possible teaching only position) fall under strategic planning. Number 9 (directions and opportunities for the Computer Science program) relates to both strategic planning and recruiting. These are important recommendations, but we will group them with numbers 2, 8 and 4 for purposes of the implementation plan.

Recommendation 13 (pursuit of CSAC accreditation) is perhaps not as crucial as those listed above, but we intend to implement it.

Four of the Recommendations are not included in the implementation plan:

Recommendation 1: We believe that the communication between the Department and the senior administration has improved considerably since the external reviewers visit. This is partly because the reviewers' report itself has forced the Department and the Dean to work together to address important issues. It is also because of the efforts of the new Department Chair, who is working hard to promote the interests of the Department, and the University's current Integrated Planning and Resource Management (IPRM) process, which requires a review of all academic programs.

Recommendation 5: The main issue raised by the double degree students, the lack of business courses prior to their first co-op work term, has already been addressed by a reordering of the course sequence. Ongoing communication between the department and SBE can be improved either by reactivating the double-degree committee or through the involvement of the Associate Deans of the two Faculties. Our experience is that the latter is more efficient and more effective and will be promoted.

Recommendation 12: Since receiving the reviewers' report, the role of ITS in providing for the specific computing needs of the Computer Science program has been clarified and there is now a much improved working relationship between the Department and ITS.

Recommendation 7: The difficulty that many students face with mathematics is a problem across the entire Faculty of Science and also in the School of Business and Economics. It is a major concern of the Mathematics Department and senior administration and was the focus of a Success in Math committee that included the Vice President:

Academic, the AVP Teaching and Learning as well as members from the Math Department and the Physics and Computer Science Department. It is an ongoing concern but a parallel effort within P&CS would not be a useful addition to what is currently in place.

d. Personnel Issues (confidential and if applicable)

With a faculty resignation in June 2013, that faculty position was filled through a limited term appointment. In the current climate of budget cuts, the Dean has to consider the option of eliminating that position, but that would severely weaken the Physics and Photonics programs. The long term disposition of this particular faculty position will be informed by the Strategic Plan that the department develops, and possibly by the outcome of the IPRM process.

Part 3: Implementation Plan

Recommendation to be Implemented	Responsibility for Implementation	Completion Date	Additional Notes
1. Student Recruitment Planning (#2 incorporating parts of #9)	Department Chair, P&CS Vision Cmte, Associate Dean: Priorities and Planning	March 17 2014 for formation of Recruitment Committee and articulation of plan for 2014 admissions. Ongoing execution of recruiting strategy	Liaison with the central Recruiting and Admissions office is essential
2. Strategic Planning (#8:incorporating #10, #11 and parts of #9)	Department Chair, All P&CS faculty, Dean, Associate Dean: Priorities & Planning	Presentation of a written Strategic Plan to Divisional Council in Fall 2014	
3. Curriculum Review (#4 incorporating #3 and #6)	Department Chair, P&CS faculty FoS Curriculum Cmte	Rewrite course syllabi for 2014/15 courses. Comprehensive review of all programs by Fall 2014	Strategic Planning and Curriculum Review are closely linked and could be treated as a single exercise.
4. CSAC Accreditation (#13)	Department Chair	Fall 2014	