



Internal Academic Review 2007-2008
Department of Electrical and Computer Engineering
Internal Academic Review Committee Report to Senate

The Internal Academic Review (IAR) of the Department of Electrical and Computer Engineering is now complete. The Internal Academic Review Committee (IARC) has taken into consideration all of the submissions related to the IAR of the Department of Electrical and Computer Engineering and respectfully submits the following report. The IARC Report to Senate is intended to supplement the findings of the attached Review Team Report and to provide a mechanism for the Head of the Department and the Dean of the Faculty of Applied Science to jointly report on the progress in addressing the Review Team recommendations (please see the “Outcomes” section of this report).

Summary of the Internal Academic Review of the Department of Electrical and Computer Engineering

The Department of Electrical and Computer Engineering (ECE) is to be congratulated for the commitment and enthusiasm of faculty members and the dedication of the departmental staff. The IARC applauds the Department’s recent and notable success in securing significant research funding.

The IARC agrees with the IAR report’s suggestion that the Department would benefit from a renewal of its vision and the development of a comprehensive strategic plan to streamline the curriculum, taking greater care to balance the undergraduate and graduate enrolment, and providing programming that is attractive to students and differentiates the Queen’s ECE Department from similar departments across Canada subject to accreditation requirements.

The IARC acknowledges the Department’s research strength and would encourage the Department to leverage this asset to shape future programming and remain competitive in student recruitment. The IARC also agrees with the IAR recommendations that a detailed plan for continuing research excellence be developed to encourage research in all areas including collaborative research within the department, across the university, and with industry.

As elsewhere, the Department faces challenges with enrolment and a complex curriculum. The IARC supports the IAR recommendation that the Department develop a student recruitment strategy, in conjunction with a newly developed strategic plan that articulates a clear academic direction and is applicable and interesting to students.

The IARC encourages the Department of ECE to leverage the enthusiasm and commitment of the faculty and staff in the unit, working in collaboration with the Faculty

of Applied Science, to address the recommendations of the IAR reports to maintain its competitive edge in a constantly changing field.

**Outcomes of the Internal Academic Review
for the Department of Electrical and Computer Engineering**

*submitted jointly by the
Dean of the Faculty of Applied Science
and the
Head of the Department of Electrical and Computer Engineering*

The Dean of the Faculty of Applied Science and the Head of the Department of Electrical and Computer Engineering welcome the careful review of the department's activities by the IARC. We are pleased to provide the following response to the specific recommendations of the committee.

1. Strategic Planning:

The Faculty of Applied Science undertook the development of a strategic plan in 2007/08 at the same time as the internal academic review of the department was being conducted. Our plan, which was approved by the Applied Science Faculty Board in January 2009, will guide the development of the Faculty in the coming years and serve as an overarching roadmap within which departments can align their distinctive program requirements. Strategic planning in the Department of Electrical and Computer Engineering will begin this fall. This process will be broad in scope taking into consideration aspects of the curriculum and its relation to other similar programs across Canada. Input from others outside of the Department will be sought, including that of the Faculty of Applied Sciences with respect to admissions and recruitment practises. The strategic plan will also include provision for encouraging research within the department, across the University and with industry.

2. Undergraduate Programs:

The Department of Electrical and Computer Engineering recently streamlined the undergraduate program to increase its attractiveness and distinctiveness and remove much of the complexity from the current curriculum structure. The formal options within each of the two programs have been replaced with streams of suggested course concentrations. In this new program, the emphasis is on simplicity, flexibility and student choice. Both programs now share many electives, and students need not select a stream within a program, nor even select between the Computer Engineering and Electrical Engineering programs, until third year. A number of attractive elective courses from other departments have been added to provide students with more opportunities for interdisciplinary study. Further evolution of the streams into current areas such as biomedical engineering, mechatronics and nano-electronics, is also under consideration. A continued effort is underway to promote the new curriculum to students, and especially

the relationship of the various streams to future career opportunities. A major review of curriculum, led by the Associate Dean (Academic), is taking place for all programs in the Faculty of Applied Science.

3. Research Promotion:

The Department appreciates the committee's acknowledgement of its research strength. This strong research profile figures prominently in the department's strategy for student recruitment. This profile was further enhanced in May 2009 with provisional approval for the Queen's Centre for Energy and Power Electronics Research (ePOWER). The development of a Centre for Research in Communications Systems is underway, led by the Department of Electrical and Computer Engineering with collaboration from the Department of Mathematics and Statistics and the School of Computing. Building on these successes, promotion of other research areas of strategic importance within Electrical and Computer Engineering will also be implemented.

4. Student Recruitment:

The Department is not alone in witnessing declining enrolment in its programs in electrical and computer engineering in recent years. This trend extends across North America as well as Western Europe. It is more pronounced at those institutions, like Queen's, that admit students from a common first year engineering program rather than directly from high school.

The Department has undertaken a number of specific remedies to increase enrolment, including: direct targeting of high schools, increased teaching to, and engagement of, first year students and recruitment of admitted students. It is recognized that an increased effort is warranted. Graduate student recruitment remains strong. The department plans to capitalize on its success in graduate recruitment by extending the lessons learned therein to its recruitment efforts with undergraduate students. Promotion of the Department's research strength is seen to be an effective strategy for increasing undergraduate enrolment as well as graduate enrolment.

Attachment:

Review Team Report

Internal Academic Review

**Department of Electrical and Computer Engineering
Queen's University**

Report of Internal Review Team

November 27, 2008

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1. Introduction

This report describes the findings and recommendations of the Queen's reviewers for the Internal Academic Review of the Department of Electrical and Computer Engineering (ECE) that began in 2007. This report is being submitted much later than the committee had initially intended because the report from the external consultants was not received by the University until September 2008, eight months after its due date. The committee would like to acknowledge the contributions made by students Craig Baker and Paul Yang, both from the Department of Mechanical Engineering, during the early stages of the review process. Unfortunately, these students have left the campus and were not able to participate in the analysis of the report from the external consultants, nor in the writing of this report.

Our committee agrees with most of the comments by the external reviewers, and many of their recommendations are echoed in Section 7 of this report. However, there are some points of disagreement, which are described at various locations throughout this document. This report addresses the overall operation and contributions of the ECE Department, as required by the Queen's Senate Policies on Internal Academic Reviews. We begin with a discussion of the undergraduate and graduate curriculum, which is followed by an assessment of scholarship and research within the Department. Teaching and learning methods are also analyzed, as is the Department's connections with industry and its service to the University and to the profession. Recommendations are provided at the end of the report.

2. Undergraduate and Graduate Curriculum

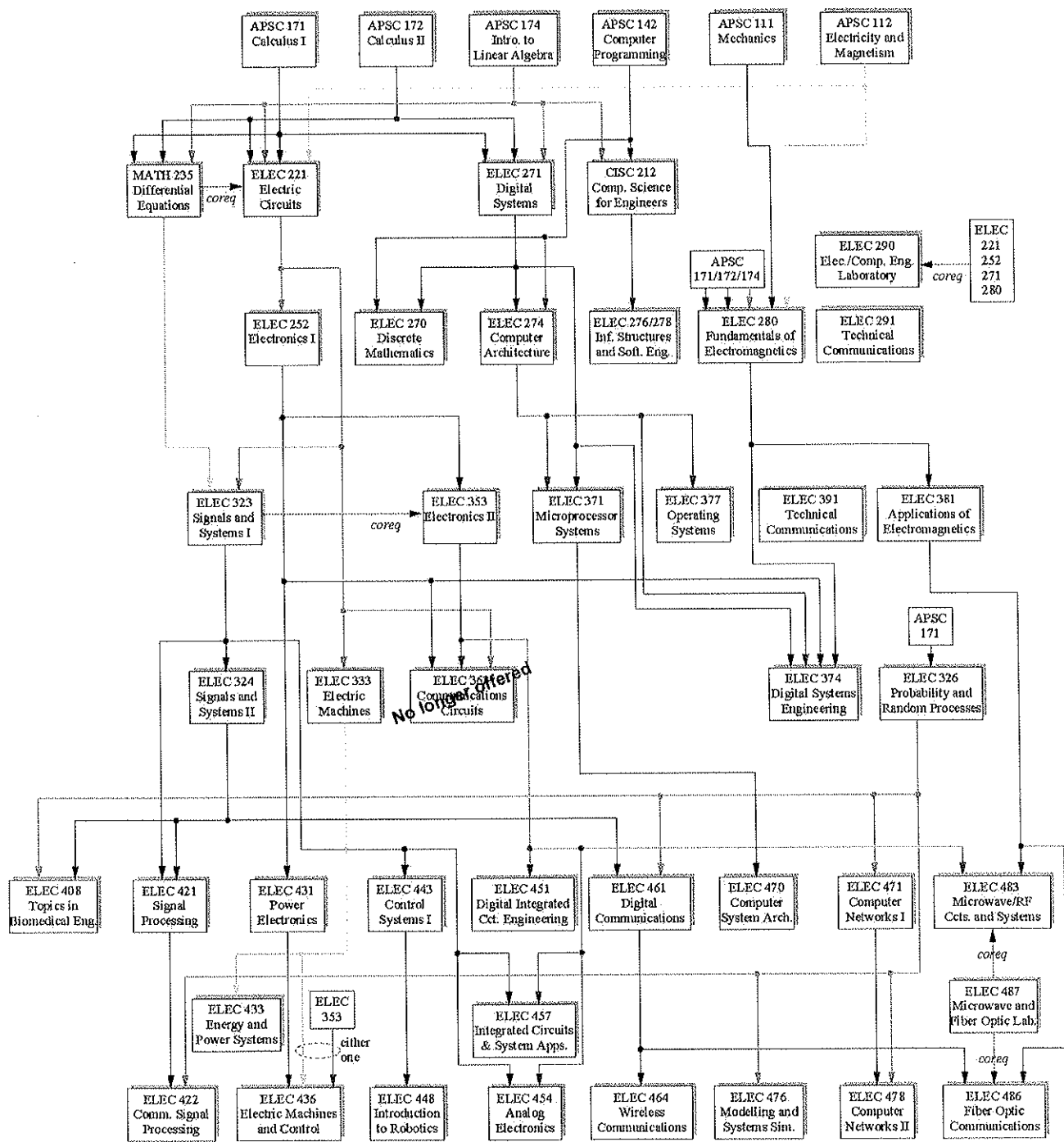
2.1 Undergraduate Programs

The ECE department currently offers two undergraduate degrees: a bachelor's degree in Electrical Engineering (BAsC ELEC) and a bachelor's degree in Computer Engineering (BAsC CMPE). The curricula within these two programs are organized such that, at the second year level, they differ by only one math course in the Winter term. In this way, transfer from one program to the other is easy until the third year, where the core and elective courses diverge significantly.

The BAsC ELEC and BAsC CMPE programs are subdivided into nine streams of specialization: Biomedical and Signal Processing; Communications and Signal Processing; Communications Systems and Networks; Electronics and Photonics; Power Electronics and Systems; Robotics and Control; Computer Hardware; Computer Systems; and Software Engineering. These streams were recently introduced as an alternative to the more restrictive "options". Students are strongly encouraged to select a stream but they are ultimately free to choose their courses, consistent with CEAB accreditation requirements and the Electives Lists A and B, as outlined for their program. The nine streams differ in the recommended third and fourth year courses.

The ECE department offers a large number of courses in support of their programs: At the second year level, nine courses are offered; 10 courses are offered in third year; and in fourth year, 24 courses are offered. The interdependencies between such a large number of courses is necessarily complex, and the department provides a flowchart (Figure 1) on their web site to assist students with navigation through the course hierarchy.

Figure 1. Queen's ECE Prerequisites and Corequisites
 ([http://www.ece.queensu.ca/undergraduate/coursesummaries/Queens ECE prerequisite graph 2007.pdf](http://www.ece.queensu.ca/undergraduate/coursesummaries/Queens_ECE_prerequisite_graph_2007.pdf))



The Department contributes to service teaching in a number of ways. ECE provides instruction in First Year Applied Science, including APSC 100, APSC 141, APSC 142 and APSC 190. ELEC 210 is a resource-intensive, pure service course taken by one option in the Mathematics in Engineering program, all Mechanical Engineering undergraduates, and all Mining Engineering undergraduates. Other second and third year courses, offered primarily for the ELEC and CMPE programs, are also core or electives for several engineering programs. Even at the fourth-year level, students enrolled in three of the four Mathematics in Engineering options select 4th year ELEC courses. In the 2006/2007 academic year, for example, 31 Mathematics and Engineering students were counted among students registered for fourth year ELEC courses (see Section 7.4 of the ECE self-study). On the other hand, ECE students complete two MATH courses at the second year level, one 2nd year PHYS course and a COMM course. As well, the Department maintains a collaborative relationship with the School of Computing. For example, both ECE and the School of Computing contribute to teaching the six fourth year SOFT-designated courses.

Over the past decade, the ECE Department has received significant funding for equipment purchases for undergraduate labs. Specifically, via the Access to Opportunities Program, the Department received over \$600,000 between 1998 and 2003. In recent years, the Department has received lesser amounts (\$10 000-\$15 000) towards equipment purchases and upgrades. Recent involvement of the Office of Advancement has been productive, with an ECE alumnus donating funds towards equipment.

The ECE Department has demonstrated a commitment to curriculum renewal. First, retreats focusing on undergraduate curriculum were held in April of 2006 and May 2007. Second, the department introduced streams, along with several supporting courses. Finally, the capstone project courses were significantly restructured.

2.1.1. Feedback from External Consultants

The external consultants had many positive comments about the program and the faculty. Overall, they found “the faculty to be productive, enthusiastic and fully engaged in providing the best possible educational experience for undergraduate and graduate students”. The course offerings at the 2nd through 4th year levels were viewed very favorably, and Drs. Connor and Dubois noted that both programs “have an excellent mix of fundamental and elective disciplinary courses bolstered by professional development, project management, design, communications, etc. with electives chosen to specialize in one of seven well-designed areas. The overall curriculum is indeed very solid.” Focusing specifically on the Communications Group, they noted that “If one looks at the undergraduate curriculum in EE especially, one finds that essentially all core courses are part of the toolset required to be a successful Communications Engineer” and added the following guiding comments “There are research and teaching programs at other universities that are trying to address Comm. this broadly, but they have not yet achieved the kind of holistic approach that looks ... possible at Queen’s.”

In regards to enrolment, they noted that “Undergraduate enrolments in ECE have declined significantly over the past few years while faculty numbers have increased, leaving a significant imbalance. For example, the intake of new second-year students declined from a peak of 200 in 2001 to under 70 in 2007.” In response to this decline, they commented that “Either undergraduate and/or graduate enrolments in ECE must increase or the faculty size must decrease. ... [E]nrolment increase is clearly the preferred choice.”

Competition with Engineering Science programs, particularly the Eng. Phys. and Eng. Math (Control Communications, Computing & Communications, and Control & Robotics options), were viewed as detrimental to the ECE Department. The external consultants noted that “ECE programs compete directly for students and resources with programs offered in the Faculty of Arts and Science... [T]he impact on ECE programs appears to be negative” and they recommended that “the ECE related engineering programs offered in Arts and Sciences and their supporting resources should be moved to ECE.” The external consultants noted that the latter recommendation would first require a full assessment of the impact of such a move on the university, the students, and the ECE Department.

The external consultants provided many suggestions in regards to recruiting. Some of these impact the programs and courses. They said that “the strongest message received from the students was that their program was very hard. They were proud of their ability to succeed in such a hard program, but that message is not the first one that should be given to prospective students.” To place this in context, the consultants noted that “the second strong message received from ECE students was that information obtained from students already in the program had the biggest impact on their ultimate decision to pursue an ECE degree.” The consultants noted that “what is missing is some substantive experience for students in which they can develop a real appreciation for the career paths that are possible in each area. Students also did not report that they were able to acquire bits and pieces of this experience in their core ECE courses.” The consultants also said that “the students... indicated that there does not seem to be enough work in technical communications in their courses” although, in response to the question “Are the technical communications courses within your undergraduate programs working well?” in a faculty survey on Teaching and Learning, the department notes that “this aspect of the curriculum is generally working well.” Student feedback suggests otherwise. Finally, the consultants recommended that “procedures should be developed to have industrial colleagues be part of curriculum discussions in ECE, which can provide an exceptionally powerful ingredient for new course and program development if information from systems that students understand and use can be brought into the classroom.” Taken together, these comments suggest that there is room for improvement in the programs and the courses offered by the ECE Department.

2.1.2 *Number and type of courses offered*

The ECE Department offers a large variety of courses, particularly at the fourth year level. At first glance, such a diverse course list implies a healthy curriculum. Indeed, on page 9 of the self-study, the Department notes that “the EE and CE programs ... provide a rigorous education in fundamentals with curricula that match or exceed those offered by competing universities.” These competing universities include the University of Toronto and the University of Waterloo, both of which have over 70 ECE faculty. Unfortunately, *the delivery of a large number of courses does not guarantee a healthy curriculum*. Student feedback on surveys (see Fig. 6.6.2 on page 41 of the self-study, for example) indicates that the curriculum should be improved. The current curriculum is aimed at offering a breadth of courses, and this raises several practical issues such as content overlap between courses, continuity between courses, low student numbers per course, and the relevance of the material in individual courses. Other issues, such as average teaching loads, costs for TAs and laboratory supplies are also related to the number of courses delivered. At the fourth year level, courses appear to be heavily instructor-centered (courses are

closely aligned with faculty research interests) and we recommend a review to reduce their number while offering courses that are strategically student-centered and industrially relevant.

Ultimately, the number of courses and their content should reflect the knowledge and skill sets identified as critical for students in the two programs, or perhaps in a single program if enrolments continue to decline. The very large number of fourth year courses offered suggests that this rationalization process has not yet occurred. We suggest that the curriculum be reviewed in detail, keeping in mind the following guiding questions:

- 1) What knowledge set is required for the students in these degrees?
- 2) What skill set is required for the students in these degrees?
- 3) What courses are required to deliver the targeted knowledge and skill sets?
- 4) What innovative ideas can be implemented in the curriculum to attract students to the program? How can this program “stand out” relative to other Canadian ECE programs?
- 5) Can the courses be offered reliably and cost-effectively?
- 6) Are all accreditation requirements met?

Current undergraduates and industrial partners should be actively involved in this process. While economic factors, the common first year course structure, and other factors may influence enrolment in ECE programs, the Department must be more pro-active and innovative in meeting these challenges. One approach, discussed extensively by the external consultants is aggressive, sustained, and strategic recruiting. The other approach is to design programs that are outstanding: A department with 27 faculty cannot offer as many courses as one with 70+ faculty.

2.1.3 Number and type of programs offered

The two BAsC programs are subdivided into nine recommended streams. Given the size of the Department, the number of streams is too high. We suggest that the streams be reconsidered with the objective of reducing their number. Specifically, the Department should consider which streams are undersubscribed, which ones could realistically be merged, which are most industrially relevant and helpful for recruiting, which could be eliminated, and which are most viable in a limited-resource environment.

2.2 Overview of Graduate programs

The ECE Department offers three graduate programs: a non-thesis, self-funded MEng degree; a thesis-based MSc(Eng) degree; and a PhD degree. Promising MSc(Eng) students may be promoted to the PhD program without completion of a Master’s thesis. The Department recently underwent OCGS review and received a “good quality” rating for its graduate programs. In a recent letter (see Appendix A), the ECE Department Head, Dr. Blostein, notes that “there are 133 funding-eligible graduate students including 46 graduate students in year one. The total graduate enrolment ... currently stands at about 140. About half of the 140 are Ph.D. students.” This corresponds to 5-6 graduate students per faculty.

The Department plans to expand its graduate program. Item #3 in the Department’s Strategic Plan (page 17 of the self-study) states “Expand the graduate program to a total of 200 students over a period of several years in order to increase both research intensity and resources.” With this goal in mind, the Department has several financial incentives in place. First, the Department

pays the differential tuition fee for visa students. Second, top-ups are offered to holders of major scholarships. Third, guaranteed minimum stipends are offered to MSc(Eng) and PhD students. *While these incentives help to maintain a healthy applicant pool, research funding is the primary barrier to an increase in graduate enrolment.* Certainly, many qualified applicants are not offered positions (see Table on page 37) due to funding constraints.

Enrolment in the MEng program has historically been kept low but, with recent funding incentives, an increase in MEng students will bring revenue to the Department. Recent changes to the graduate program include the elimination of written examinations in the revised comprehensive format and the introduction of a Department-wide seminar requirement. In an effort to maintain program quality, graduate courses are not “double numbered” with undergraduate courses. However, with a total of 27 graduate courses offered, graduate teaching places considerable pressure on resources that might be better directed toward graduate recruiting or research. Although the current ECE graduate student complement stands at 133, only 14 hold major awards (NSERC, OGS, OGSST). This is a relatively small fraction of scholarship holders, even considering the number of visa students. The ECE Department does not currently have graduate supervisory committees for Ph.D. students. These committees, consisting of 2-3 faculty members per student, serve many purposes in other departments at Queen’s. First, they provide regular feedback to the student in regards to research progress and future directions. Second, the committee members can form the basis of examination committees for comprehensives and thesis defenses. Third, these committees can intervene in student-supervisor conflicts. Fourth, they provide a means to foster research collaborations among faculty. Finally, advice to relatively new supervisors often follows from more experienced supervisory-committee members. The ECE Department consists primarily of new faculty and a supervisory-committee format would be particularly beneficial.

2.2.1 Feedback from External Consultants

The external consultants provided few remarks on the graduate curriculum and programs. They did comment, however, that “Masters and Doctoral Programs are relatively standard, but solidly based on excellent courses, examination, etc. The number of new courses developed in recent years shows the vitality of the program.” Members of the Queen’s internal review committee have serious concerns about the large number of graduate courses being offered, many with small enrolments. Several recommendations related to graduate programs are provided in Section 7 of this report.

3. Scholarship and Research

ECE faculty members are relatively young with more than half of the Departmental complement having been hired in the last 10 years, particularly between 1999 and 2003. Hence, during this IAR period, many junior faculty members have been in the process of establishing research programs through: graduate student recruitment, applications for funding and establishing research facilities. Junior faculty members have also been developing teaching and service dossiers to meet Renewal Tenure and Promotion criteria.

The ECE Department is notable for the accomplishments of two of its senior members: P. Jain who holds a Tier I Canada Research Chair and J. Cartledge who holds a Queen’s Research Chair. Five of the Department’s junior faculty members have received Early Researcher Awards from the Province of Ontario.

Currently, ECE has five designated research groups:

- Biomedical, Robotics and Control Engineering
- Communications
- Computer Architecture and Software Engineering (merged in 2008)
- Microwaves and Photonics
- Power Electronics

We agree with the external consultants that, in general, the research groups appear to be loosely organized and there does not appear to be a common strategic goal or vision within each of these research groups. While it is recognized that there are some common areas in which excellent faculty work on similar topics and, thus, interesting and important work is produced, the activities of most groups “do not have great national and international impact”. This could be due to a lack of meaningful collective activity within ECE, which has limited the overall research growth. More shared goal-setting, vision and leadership within the research groups would help research productivity within the Department. Researchers involved in more collaborative activities, particularly junior faculty members, would benefit from shared funding and resources in the building of their research programs.

Our committee recognizes and applauds the recent reorganization into a smaller number of research groups, as well as the successes in recent funding competitions that are noted by the Department Head in his letter in Appendix A. Continued and future success of ECE will depend on the Department’s ability and desire to sustain newly established collaborative activities and to develop research with meaningful national and international impacts, which will attract top students and further funding in strategic research areas.

More should be done to establish connections within the broader research community at Queen’s, at other research institutions, and with industry. This is an element that ECE should collectively address in the near future through strategic planning activities. The external consultants indicated that ECE needs to “develop collaborations with other departments at Queen’s and other universities to fill in critical gaps, which it does most effectively with the School of Computing and the Royal Military College. Strategies should be developed to look for other such opportunities, especially with the departments involved in Nanotech, Biotech, and Energy.”

The Queen’s IAR Committee strongly supports two recommendations outlined in the External Reviewer Report:

- The purpose and identity of the research groups must be clearly defined. All groups should be involved in research activities across departments, faculties, and institutions as well as lead activities in research networks and with industry.
- A detailed strategic plan for increasing research excellence, national and international visibility, leading to higher per-faculty funding in ECE must be developed.

4. Teaching and Learning Methods

Four sources have been used to obtain information about teaching and learning in the Department of Electrical and Computer Engineering. They are of different types, but all offer worthwhile insights and point in the direction of possible areas for improvement. The first of these is the standard Queen's University USAT evaluations. Data from this source were available to the Committee, in summary form, for the period 2002 (Winter term) to 2006 (Fall term). In general these results indicate that, in most years, the level of satisfaction of the Department's students is slightly above the average for the Faculty of Applied Science as a whole. This Faculty rating, in turn, is consistently somewhat lower than the corresponding level for the overall University student body. Of the ten terms reported on, there are two (2002 Fall and 2005 Winter) when the ratings on questions such as, "Overall, this is an excellent course", and, "Overall, this instructor is an effective teacher", are significantly lower than the Faculty as a whole and very much lower than the average University level. The return rate of evaluations in this Department is lower than for other Departments in the Faculty of Applied Science and in the University as a whole.

A second source of information is the exit poll data collected from graduating students over the period 1999 - 2006. In general these data are very consistent with the perspectives noted above from the USAT assessments. What is quite significant, however, is the direction of change with respect to student satisfaction with teaching and learning in the Department from the 1994 - 1999 exit polls. Percentage change of improvement in all fourteen categories was universally positive, and for ten of the fourteen categories, the change was at least 33%.

A third source of information about teaching came from the observations made by students who attended the undergraduate and graduate sessions with the external consultants during their visit to Campus. Although the number of participants was much smaller than for course evaluations and exit polls, the format of the gathering permitted more extended discussion of viewpoints. In the opinion of the participating students, the range of teaching expertise in the Department runs from excellent to less than satisfactory. A high level of effort is required for students to succeed in the program. The range of teaching methodologies is narrower than is desirable (some students spoke of seeing "too many backs") particularly in light of the potential made available by new teaching spaces and other resources. Teaching assistants were seen as being particularly in need of support, both with respect to content knowledge and teaching methods. Some students felt that there was a need to provide more opportunities for developing skills in technical communication than is presently the case.

A fourth relevant document was the "Engineering Curriculum Renewal" Report for Applied Science submitted to the Associate Dean and the Undergraduate Chairs in September of 2008, particularly an Appendix containing the ECE response to survey questions. Most of the general recommendations of this Report, with respect to teaching would seem to be appropriate for the Department of Electrical and Computer Engineering. Take, for example, the section on the Improvement of Faculty and TA Development and Hiring and Assessment Practices. The Departmental self-reflection part of this document shows that the Department is aware of some of the directions where change is desirable.

The following recommendations are made with respect to teaching and learning in the Department:

- Continuing efforts need to be made to extend and broaden Faculty and Teaching Assistant expertise in teaching methodologies.
- One dimension of such an initiative might be to increase the role of project work within the curriculum. Effectively implemented, such an emphasis could become an effective part of addressing related concerns about recruitment, technical communication and outreach.
- Maximal utilization of powerful resources such as the ILC needs to be given a high priority.

5. Service and Connections

5.1 Strengths

The ECE Department is commended for organizing the Biennial Symposium on Communications, which is always held in Kingston. This meeting results in strong engagement with government, industry and other academics from Canada and abroad. It is Canada's premier conference in the communications field, with 92 technical papers presented at the 2006 Symposium and several sources of financial support (Communications and Information Technology Ontario, the Communications Research Centre, the Kingston IEEE branch). The external consultants stated that the Symposium is "probably the most visible manifestation of the reputation of the Queen's ECE Communications Group and also is the most significant example of service to the profession by ECE faculty."

We also commend the ECE Department for establishing an Advisory Council of alumni from industry (formed as of Summer 2008 and described in the letter in Appendix A). This Council is a potential strength, providing advice and an industry perspective to the Department and the Dean. The advisors can help with important issues in the Department (e.g., recruiting students into the program, providing sites and contacts for student projects and faculty research, providing sources of student employment in summer and upon graduation). To assist the ECE Department in this endeavour, we provide information in Appendix B about the activities of the Queen's School of Business Advisory Board, which has been very helpful to the School of Business.

The Department's research collaborations with Royal Military College, with other universities and with Canadian Microelectronics Corporation are commendable and help shore up a relatively small department with outside colleagues. We recommend that the Department should increase its collaborative activities.

5.2 Weaknesses

There is little evidence that the ECE Department spends time and effort thinking about what it is known for and what it wants to be known for. It will be difficult for the Department to grow and to attract more students and more research dollars if does not market itself well and if it stays in the shadow of larger and better-known Ontario university ECE departments (e.g., Waterloo, Toronto). Queen's ECE does not appear to have established a message about one or two key areas of expertise. Communications could be one of these areas, based on the assessment provided by the external consultants in their report.

The ECE Department does not appear to leverage connections with industry to help with student recruitment and employment. Research ties with industry appear strong for some ECE researchers, but there does not appear to be a deliberate effort to leverage those connections for the express purpose of creating excitement about ECE, which would help with recruiting of students and placing graduates. Such efforts could help to address the enrolment issue. If first year students see that ECE graduates are being hired for challenging, rewarding jobs, more will be interested in ECE.

6. Departmental Resources

On the surface, when compared with other Applied Science Departments, the ECE Department has more than enough space, support staff, and faculty to meet its academic mission and to ensure the future success of its undergraduate, graduate and research programs. We applaud the ECE Department for using their teaching resources to take on new teaching responsibilities in first-year Applied Science, and we encourage them to use this opportunity to showcase exciting ECE applications that will interest students in their discipline. However, several important problems need to be addressed. As noted by the external reviewers, the student to faculty ratio is exceptionally low. There are currently 26 tenured or tenure-track faculty members in the Department (the largest faculty complement in Applied Science, except Mechanical Engineering with 27), and there are significantly fewer students in the combined ELEC and CMPE undergraduate programs than in Mechanical, Chemical or Civil Engineering. Support-staff-to-student ratios are also higher in ECE than elsewhere in the Faculty. Undergraduate enrolments have declined from a peak level of 220 students in second year in 2001 to only 60 in 2008. We agree with the external reviewers that the Department should expand the scope of its recruiting activities, and we thank them for creative suggestions about how the Department can “develop the engaging narrative that will attract top students, faculty and industrial partners”. However, we disagree with their recommendation that the ECE Department should be permitted to continue to hire additional faculty in targeted areas. Instead, we recommend that the Department should further simplify and cull their undergraduate and graduate program offerings so that they can be supported by a smaller faculty and support-staff complement. Without an enormous increase in the combined undergraduate and graduate enrolment, we foresee that any faculty and staff who leave via attrition are unlikely to be replaced, because needs in other Applied Science departments are greater. The Department must be better-prepared to meet the challenge of operation with fewer resources than it has now. Reducing the breadth of undergraduate and graduate programs now, when the Department is over-staffed, can free up resources that can be better used for piloting new teaching methods, attracting research funding, developing external research collaborations, improving the Department’s connection with industry, and recruiting more and higher-quality students using the positive news that will arise from these other activities.

7. Recommendations

7.1 The ECE Department should develop a compelling vision and strategy for the Department that defines its role within Queen's Applied Science and differentiates it from other ECE departments in Canada. Included in the strategy should be a coordinated plan to better engage with industry and the community to help the Department address the issues of student

recruitment and research funding. Leveraging faculty members' relationships with other academics, alumni, the profession and industry could help achieve department-wide objectives. A vision and strategic plan will help with fundraising as well. Potential donors want to know what the department aspires to be in addition to what it needs.

7.2 ECE-related engineering options offered through MATH and PHYS should be reviewed along with the ELEC and CMPE undergraduate programs. There appear to be too many small programs and options competing for the same students.

7.3 The number of streams in ELEC and CMPE undergraduate programs should be reduced. Student feedback on the streams should be sought prior to, and during, this process.

7.4 The undergraduate curriculum should be revised to arrive at a reduced number of courses, particularly in fourth year, to make it more innovative, sustainable and cost-effective. The curriculum should be carefully rationalized to make it more student-centered and industrially-relevant so that the undergraduate programs will be more competitive with other departments within Queen's and with ECE programs at other universities. More emphasis should be placed on technical communications and project work.

7.5 Communication with and involvement of upper-year students during the program review and planning of recruiting activities is strongly recommended in view of their influence during recruiting. It is important for upper-year students to understand the relevance, experience and excitement of ECE, so that this knowledge can form the basis of informal conversations between existing and prospective students. Industry open-houses (as in Civil Engineering) or a seminar series aimed at undergraduates (e.g. ChemPals in Chemical Engineering) would provide networking opportunities for grad and undergrad students.

7.6 The ECE Department should continue to actively pursue funding options for lab equipment. It will be important to develop relationships with alumni and companies who are interested in supporting undergraduate programs because small enrolments may lead to lower levels of University-allocated funding in the future.

7.7 The number of graduate courses should be reduced. Specifically, historical enrolment data should be examined and courses with fewer than five students enrolled should be eliminated or offered as reading courses that do not count in teaching loads.

7.8 The MEng degree should be promoted with a view towards increasing graduate enrolment numbers.

7.9 A supervisory committee structure should be implemented for Ph.D. students, with regularly scheduled meetings between the student, the supervisor and the committee.

7.10 A graduate recruitment committee should be formed that seeks to recruit more students who are eligible for funding from the Provincial Government. This committee should make the recruitment of major scholarship holders its top priority. Connections with faculty members at other ECE departments should be leveraged to attract graduate students.

7.11 Continuing efforts need to be made to extend and broaden Faculty and Teaching Assistant

expertise in teaching methodologies. Better use of powerful resources such as the ILC needs to be given a high priority.

7.12 Connections should be established and enhanced within the broader research community at Queen's, at other research institutions, and with industry. The purpose and identity of the research groups must be clearly defined. All groups should be involved in research activities across departments, faculties, institutions, and in research networks with industry.

7.13 A detailed strategic plan should be developed for increasing research excellence, national and international visibility, and per-faculty funding.