

Memorial University of Newfoundland

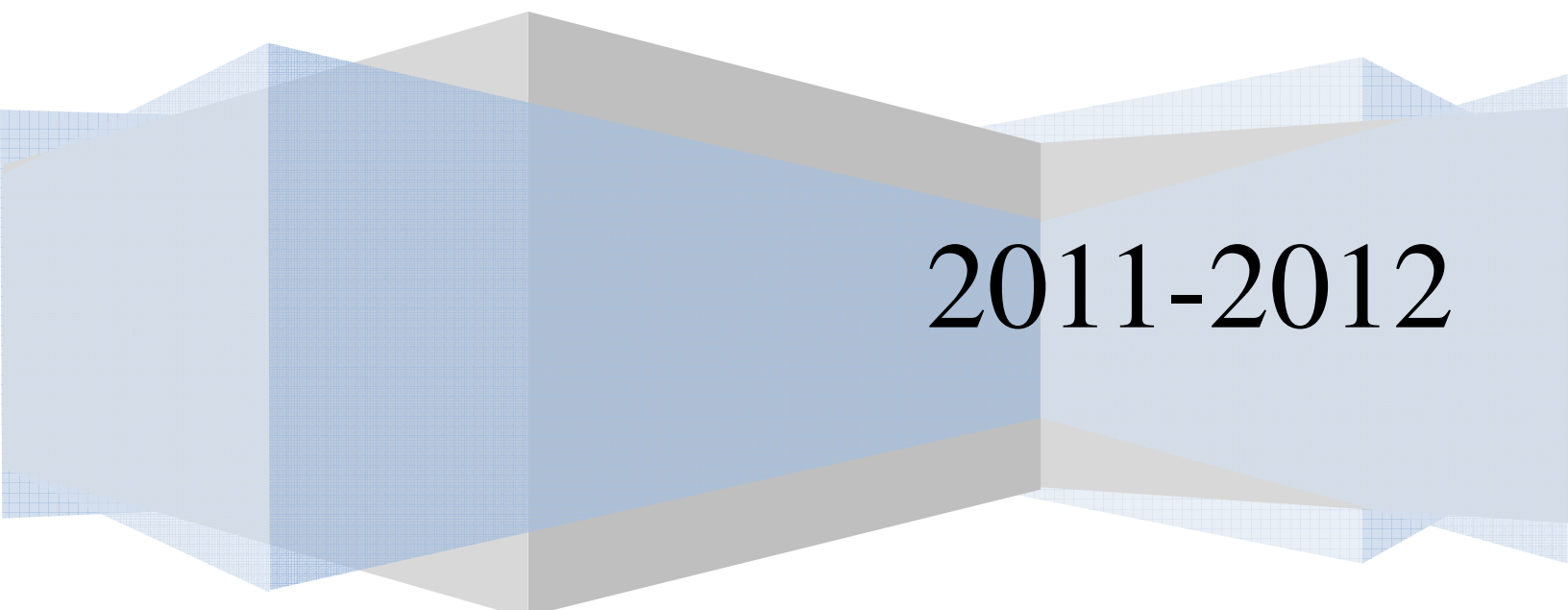


MEMORIAL
UNIVERSITY

Academic Program Review

Self-Study Report

Department of Computer Science



2011-2012

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1 Introduction

We live in a world of computers and the Internet. From smart phones to medical imaging, from secure financial transactions to online cloud services, computing is ubiquitous. Computing is also rife with examples of rapid growth and success: from Amazon to Compusult, from Microsoft to ZedIT, innovative computing companies are driving economic growth. Many innovations start in the academic community. Innovation in modern science, arts and humanities relies on computing concepts and tools. Computational simulations and models, digital images and sound, interactive tools and communications: these applications pervade all disciplines both as a means and as a subject of study and research.

Computer Science is critical to multiple aspects of the economic and educational development of our community and province. It is a central concern at the heart of the University's academics. It marks the difference between producing students with the insight to penetrate the technology saturating their world versus producing students who merely know how to use Google and Facebook; it is the difference between technology-related programs that apply algorithms, theory and software design techniques to create innovative solutions versus graduating students who can merely install, use and maintain someone else's information technology; it is the difference between a faculty resource with a broad knowledge of approaches and expertise in computing versus isolated pockets of narrow computing knowledge for specific problems in specific disciplines. This review will help direct our efforts to better support the academic computing knowledge and skills required by our community.

A rapidly-evolving field like Computer Science continues to face challenges. This document will outline where we as a Department have come from, where we are, and where we are going. It describes the challenges we face, our vision for our future, and the contribution we will make to the Faculty of Science, the University, and the larger community.

2 History of the Department

2.1 *Origins and Program Development*

The first course in Computer Science at Memorial University was offered from within the Department of Mathematics in the 1968-1969 academic year. There was an immediate interest among the student body, and demand for additional courses led to the appointment of additional faculty with specific duties to teach and promote the discipline of Computer Science over the next several years. This formed the basis of the Computer Science Group within the Department of Mathematics. Ten years later, in 1978, the Department of Computer Science was created within the Faculty of Science. The Department was initially formed around a nucleus of the Computer Science Group, consisting of seven faculty members, and two support staff. Some of these individuals are still serving within the Computer Science department today.

A general degree in Computer Science in either Arts (BA) or Science (BSc) was available by 1974. An Undergraduate Honours program was added in 1976, a Master's (MSc) degree program and an Undergraduate Minor program in 1977. Over the years, a number of joint general and joint honours degree programs have been created with other disciplines, accommodating a small number of students with cross-disciplinary interests.

The PhD program was introduced in 1993. An Honours Specialization in Software Engineering was introduced in 1997. Also in 1997, a work placement program titled the Computer Industry Internship Option (CIIO) was introduced.

In Fall of 2011, after a number of years of inception, a course-based cooperative Master's program in Computer Science was introduced, which includes a work term placement component. The initial class for the program is estimated to be 14 by the end of the first year.

2.2 Administrative Structure

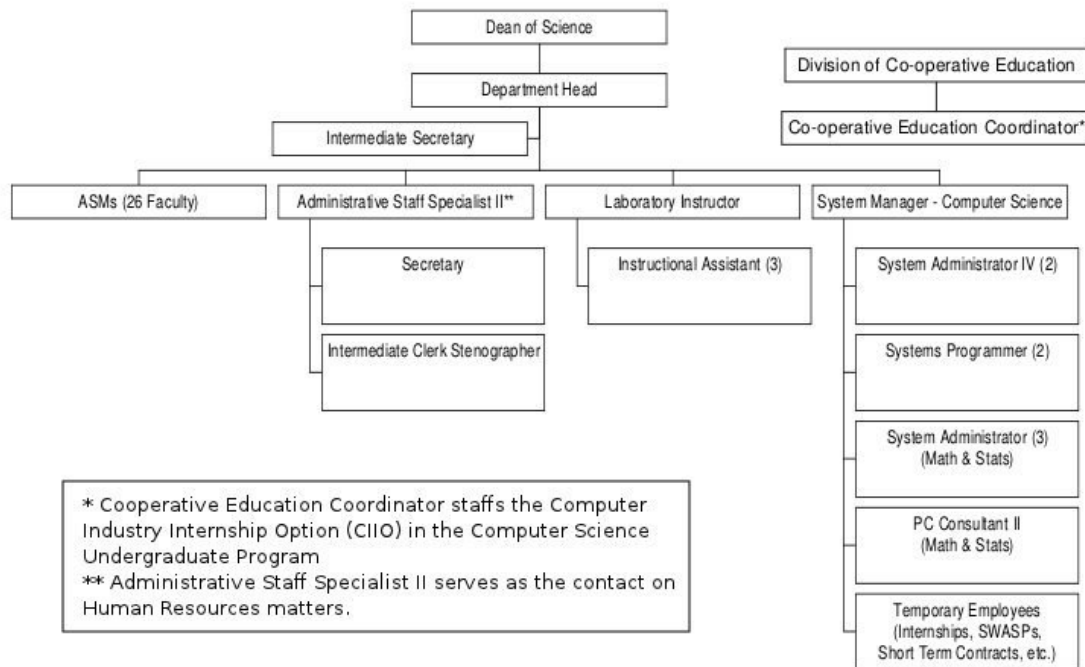


Figure 1: Computer Science Department Administrative Structure.

Computer Science is a department of the Faculty of Science. Departmental committees report to the Head or the Department as a whole, depending on the matter. The Promotion and Tenure Committee, and the Search Committee are established and governed by processes outlined in the collective agreement between the University and the Faculty Association; other committees are established by the Department or the Head, and report to the Department in regular meetings.

The Department also has a Deputy Head, Graduate Studies position with primary responsibility for administration of the graduate programs and an Undergraduate Advisor, who handles undergraduate inquiries and advises students on program and course selection. These positions are filled by faculty members.

In the following tables, the heads of the Department since its inception as well as the development of number of faculty complement are summarized.

Year	Department Head
1978 – 1990	Jane Foltz
September to December 1990	Paul Gillard (Acting Head)
January to August 1991	K. Vidyasankar (Acting Head)
1991 – 1994	Paul Gillard
1994 – 1997	Miklos Bartha
1997 – 2001	Paul Gillard
August to November 2001	Dean. R. Lucas (Acting Head)
November 2001 to August 2003	Jane Foltz, Interim Head
2003 – 2009	Wolfgang Banzhaf
2009 – 2012	Ed Brown

Figure 2: Heads of Department of Computer Science Since Inception.

Academic Year	Tenure-Track Faculty	Academic Year	Tenure-Track Faculty	Academic Year	Tenure Track Faculty
1978–1979	7	1989–1990	14	2000–2001	19
1979–1980	6	1990–1991	16	2001–2002	17
1980–1981	7	1991–1992	17	2002–2003	17
1981–1982	7	1992–1993	16	2003–2004	18
1982–1983	8	1993–1994	15	2004–2005	16
1983–1984	10	1994–1995	19	2005–2006	20
1984–1985	9	1995–1996	17	2006–2007	23
1985–1986	10	1996–1997	18	2007–2008	23
1986–1987	10	1997–1998	18	2008–2009	23
1987–1988	10	1998–1999	19	2009–2010	24
1988–1989	13	1999–2000	20	2010–2011	24
				2011–2012	24

Figure 3: Development of Tenure-track Positions in the Department.

2.3 Previous Academic Program Review

The Department's previous Academic Program Review was held in 2002. The 2002 Program Review presented 43 recommendations (see Appendix A), and resulted in an Action Plan dated July 2003, listing 36 specific action items. Many of the items from the 2002 review have been successfully addressed in the intervening period, including:

- A review of the undergraduate program occurred, and revisions were made;
- Application-oriented content in the undergraduate program increased;
- An undergraduate advisor was appointed;
- A successful undergraduate help centre was created and fostered;

- Graduate program enrolment was increased substantially;
- Graduate program offerings were decoupled from undergraduate offerings for some period of time;
- Cross and joint appointments with other units were supported;
- Departmental retreats were held at least once every year;
- Regular visits by outside visitors were made possible through support from the Dean's office;
- A distinguished speakers series was introduced with very good success;
- The Departmental website was completely revamped, and is in the third renewal process now, aligned with the Faculty of Science webpage redesign project;
- Technical staff salaries were improved;
- Social meetings with undergraduate students were organized every Fall and Winter term.

Some recommended actions were not undertaken, including:

- We did not seek accreditation of our program through relevant bodies like CIPS, since we felt that doing so would reduce the flexibility of our programs with little benefit to our graduates.
- Feedback on curricular activities from undergraduate students was sought only a limited number of times during the program revisions. The Head at that time kept an open-door policy to listen to students' feedback on program offerings. Since the Fall of 2010, the Head has held regular meetings with undergraduate student representatives.

Some of the actions following the last APR have not progressed very successfully, including:

- Action item 3-6 led to a new course, COMP-1600 (Basic Computing and Information Technology), in 2003 aimed at skills development for students from other departments. This course was not well subscribed, and subsequently was phased out. In Fall 2010, COMP-1600 was revived and retooled with advice from members of the Information Systems group in the Business Faculty, and is currently being deployed as a distance course offering.
- Action item 6-2 led to the removal of lab instruction duties from contractual and permanent faculty. This decision was reversed when the current Head came into office in 2009, and faculty have been reassigned lab duties as of the 2010-2011 academic year for courses with lab components.

Other developments not foreseen at the time of the last APR:

- Faculty complement has increased. A third of faculty are new hires since the last APR, bringing in new fields of expertise and having a beneficial effect on the Department's productivity.

- A new undergraduate course offering for Science students outside of Computer Science, COMP-1510 (Introduction to Programming for Scientific Computing) has been well subscribed and continues to show year-over-year increases in enrolment. This course was developed on request of the Departments of Mathematics and Statistics, and Physics and Physical Oceanography and in close cooperation with those units.
- COMP- 2500 (Data Analysis with Scripting Languages) was introduced in Fall 2007, for researchers and students from other departments. The Python language has been used in all of COMP- 2500 offerings due to its popularity in data analysis applications.
- COMP- 2000 (Collaborative and Emergent Behaviour) developed for the Communication Studies program in the Faculty of Arts is being offered for the first time in Winter 2012.
- The LabNet environment developed by the technical support staff of our Department continues to grow in functionality and adoption across the entire University. This allows the remote servicing of computer labs across campus in a secure manner.
- A new route to the degree of MSc in Computer Science has been introduced recently, the MSc (co-op) offering students the possibility to be placed in industry for two semesters.

2.4 Current Departmental Initiatives

In 2009, Departmental retreats were re-organized as workshops for multi-year planning. Initial concerns identified in the December 2009 and April 2010 workshops led to working groups struck in Fall of 2010 and finally adoption of a set of specific initiatives, which have served as a touchstone for departmental efforts in the last 18 months. Among the initiatives:

- Exploration of common program offerings and program promotion with other units, starting with the Information Systems group in the Faculty of Business Administration. With the recent closure of the joint e-Commerce program between Computer Science and Business, there is now a programming need in the Information Systems area.
- As first steps in constructing a comprehensive outreach program, we have introduced a visitation schedule to promote Computer Science in High Schools, and have organized and promoted open house activities.
- In the area of instructional and curriculum improvement, a course outcomes analysis to determine expected and actual course outcomes (academic knowledge and practical skills outcomes were in fact identified as separate projects, but are combined in this list).
- To encourage collaboration among colleagues and connections with other academic units, an informal “brown bag” lunch seminar series was initiated in Fall 2011.
- In the area of alternative programming for the undergraduate curriculum, development of distance education offerings. Materials developed may also be used for self-study programming for accelerated progress of Computer Science majors; and also for advanced placement courses for high school students.

- Increase in resources for student programming competitions was agreed to, but has yet to be implemented.

These initiatives are in various states of progress; they fed into the APR planning activities and contribute to the corpus of the Department's future plans.

2.5 Current APR Process

The University initiated the current APR process for the Computer Science department in January 2011. As a first step, departmental group discussions relating to the review were held in March, extending the work of our existing workshop groups, with additional representation from staff and students. A departmental workshop in April comprised open discussion of group reports and presentations.

In a second step, submissions by the groups and departmental sources was compiled by the Head into the first draft of this self-study document and presented to the Department for feedback in November of 2011.

A committee of three faculty members (Drs. Banzhaf, Bungay, and Fiech) was struck to respond to feedback with appropriate revisions and complete the document. A revision of the self-study was discussed at a departmental meeting in December 2011. Approval of the final version of this document was reached on February 23, 2012.

3 Departmental Mission, Vision and Strategic Objectives

3.1 Goals and Mission

The departmental goals established on formation of the Department in 1978 were re-affirmed in the last departmental review in 2002 as:

- 1 To promote excellence in teaching and to provide students with an education that will help them to:
 - enjoy the traditional benefits of a broad university education;
 - pursue useful careers in computing;
 - assume a high position of leadership in society in general and in the profession in particular;
 - carry on their education through subsequent degree programs;
 - develop a code of professional ethics compatible with the best interests of society;
 - understand the need for constant effort in maintaining their education.
- 2 To provide and advance graduate programs in Computer Science.
- 3 To create, disseminate, and advance knowledge of all aspects of the discipline of Computer Science through development of research and professional activities.
- 4 To provide educational opportunities, leadership, and expertise in the broad area of computing and information technologies to the University community, to government, to local industry, and to the community at large.

Broadly stated objectives are more properly formulated as a mission statement, which we would update as follows:

The Department of Computer Science is dedicated to collaboration, innovation and excellence in the promotion, application and advancement of Computer Science knowledge through teaching, research and scholarship. In this role, the Department fosters a respectful and inclusive environment in which all its members (faculty, post-doctoral researchers, graduate and undergraduate students, and staff) work together to achieve the highest standards of Computer Science Research and Education within the University and in the national and international arena. We are committed to the dissemination of knowledge and collaboration with local industries and institutes.

3.2 Vision

A complementary vision statement for the Department is: *The Computer Science Department will be the place that people approach for knowledge and expertise in computing.* This statement captures the core objectives of pursuing excellence and engagement with the community.

3.3 Strategic Objectives

The following departmental strategic objectives are not specific performance targets, but are more focussed than the mission and vision statements. The general theme is the pursuit of excellence. Commensurate with our vision, our ambition is that the Computer Science department strives to create, within the next ten years, a reputation for excellence on the local, regional, national, and international levels.

The strategic objectives are:

1. Communicate the strategic importance of the Computer Science department to the Memorial University community
 - Every discipline relies on computing expertise to some degree for teaching, research and development. This has produced duplicate efforts to develop expertise in multiple units. We need to communicate to other units on campus the computing know-how available in our Department and continue efforts to exploit our expertise via collaborative research projects and appropriate computing curriculum development and delivery. We must also promote our campus-wide contribution through the LabNet computing service framework, and leverage this infrastructure as part of innovative cloud solutions for academic use in teaching and research at Memorial.
2. Develop partnerships with local industry
 - As the only Computer Science research unit in the province we seek to share our expertise with industrial partners. More joint projects, consultancy work, and student-led start-ups will be advantageous to the growth of IT and other hi-tech industries in our community.
3. Establish an international reputation in strategic research areas
 - We must build on individual research accomplishments to create internationally recognized research groups. Strategic areas defined by our research groups have to play an increasing role in our hiring decisions, student recruitment and scholarship awards. We need to actively promote faculty members for leadership positions on provincial, national and international levels.
4. Become a top ten destination in Canada for graduate students
 - We can become a top graduate student destination in Computer Science. Innovative research projects and increased commitment towards quality supervision will bring us closer to this goal. We can increase competitiveness of scholarships and explore non-traditional funding sources. We will continue to make a welcoming home for students in our Department.

5. Attract the brightest high-school students from Newfoundland and Labrador, and Atlantic Canada
 - We need to appeal to the brightest young minds in our province as a competitive (or even preferred) educational choice. In order to be successful, our outreach initiatives must improve the communication of the unique opportunities in our field.
6. Offer a modern and innovative curriculum
 - The Computer Science field is constantly advancing. We must continue to modify/adapt our course offerings and instruction in response to rapid research and industrial developments. In addition to our immediate instructional initiatives, we must aim for a complete review of our programs every three to four years. We will adopt the best practices in Computer Science education while seeking novel and innovative instruction and delivery methods. Excellence in teaching must be recognized and promoted.
7. Engage alumni as our brand ambassadors
 - We must foster a sense of belonging among our domestic and international alumni. Alumni fundraising efforts for scholarships and professional networking would benefit Computer Science students. We can begin with a more structured approach to “staying in touch”. A Computer Science alumni database and periodic alumni get-togethers would be effective. Great relations with our alumni begin when they are still students.

3.4 Fit with Faculty of Science Strategic Plan

Our mission statement and strategic objectives aligns with the Faculty of Science's research mandate of providing basic science knowledge to serve as the foundation upon which more applied disciplines are based.

Many of our challenges as identified in this self study echo those of the Faculty of Science (see Appendix B): as competition for tri-council funding increases, we must exploit alternative funding sources; our physical infrastructure must improve; we need to engage alumni. Our initiatives and strategic objectives are intended to address these challenges.

Computing is exploited in some form in nearly all research disciplines. The Computer Science department is well positioned to facilitate interdisciplinary research and to establish research collaborations within and outside the University. Out of five currently identified research strengths of the Faculty of Science, the Department's current research activity contributes to Marine Sciences, Biomedical Sciences and Health, and Mathematical and Computational Sciences. Our communication, partnership development and reputation oriented objectives (strategic objectives 1 through 4) correspond to the quality, engagement and promotion of research points among Faculty of Science's research goals. Activities concerning industry

partnerships, research collaboration and fostering excellence are ongoing. This document will ultimately suggest further action incorporating recruitment objectives, infrastructure and research focus.

The Faculty of Science teaching goals pursue themes of instructional quality, appropriate and modern infrastructure, research experience, and teaching excellence. Our current initiatives in instructional improvement and alternative programming, and current revision of the graduate curriculum are relevant to these goals. Infrastructure support, teaching excellence, curriculum innovation, and recognition of teaching excellence are all part of our strategic objectives (those numbered 1, 4 and 6 respectively). We aim for a significant increase in Computer Science enrolment, above the expectations of Science as a whole.

Engagement goals of the Faculty of Science relate to outreach, alumni relations, creating a unique profile, media and technology use, and student competitions. Our outreach and student competition initiatives are being developed, and strategic objectives 2, 3, 5 and 7 address industry contacts, national and international reputation, student outreach, and alumni relations. We also have concern for our relations with the Memorial community, reflected in strategic objective 1. The Department is committed to improving connections, and anticipate that this review process will contribute appropriate guidance.

3.5 Fit with Memorial's Strategic Plan

Our mission statement and strategic objectives are aligned with the University's Strategic Plan. The institution's core values of quality, excellence, accessibility and flexibility are reflected in the elements centered on innovation in the undergraduate program, strengthening the Graduate programs, and increased outreach and collaboration in teaching and research. They demonstrate an interest in accountability through establishing measurable targets, and responding to the University Plan's action areas: students, creative activity, scholarship, provincial needs, conditions for success, and institutional responsibility.

Innovation in the undergraduate program speaks to the institutional goals of an improved teaching and learning environment, program innovation, increased enrolment, and improved recruitment, accessibility, and advancement.

Strengthening the graduate programs' visibility, quality and funding speaks to the institutional goals of an improved teaching environment, enhanced financial support, and research engagement and productivity.

Defining the Department's institutional role speaks to the institutional goals of provincial linkages, lifelong learning, importance of people, infrastructure, information resources, international participation, and improved administrative practices.

Improved characterization of our research agenda should allow focus on the institutional goals related to high-need areas, research collaboration, external funding and productivity.

4 Research/Faculty Contributions

Currently, Computer Science has 9 Full Professors, 11 Associate Professors, 2 Assistant Professors, 2 Lecturers, 2 Joint Appointments with 50% responsibility in Computer Science, and 6 Cross Appointments that participate academically in the Computer Science department.

Name	Position	Research Interests	Hired
Banzhaf, Wolfgang	University Research Professor	Bio-inspired computing, computational intelligence, evolutionary computation	2003
Bartha, Miklos	Professor	Programming language semantics, algebra and category theory, automata theory, graph theory	1990
Batten, Donna	Lecturer	Information systems, programming languages, computer-aided instruction	1981
Brown, Edward	Associate	Human-computer interaction, intellectual property, data privacy and security	1987
Bungay, Sharene	Associate	Genetic algorithms, mathematical modelling, numerical methods, optimization techniques, computational chemistry, dynamical systems	2005
Byrne, Rod	Associate	Software architecture for embedded systems	1994
Chen, Yuanzhu	Associate	Computer networking, distributed computing, combinatorial optimization, graph theory	2005
Deb, Ashoke	Associate	Parallel processing, functional languages, logic programming, dataflow architectures, graph reduction machines, vector machines,	1975
Fiech, Adrian	Associate	Web Service Repositories, Software as a Service (SaaS), Service Oriented Architecture (SOA) and Software Specification	1994
Gillard, Paul	Professor	Computer architecture, VLSI design, computer graphics	1978
Gong, Minglun	Associate	Computer graphics, computer vision, image processing, pattern recognition	2007
Gupta, Radha	Lecturer	E-learning, microcomputer based information systems, database systems, computer science education	1985
Hoeber, Orland	Assistant	Information visualization, Web search, human-computer interaction, information retrieval, geo-visual analytics	2007

Name	Position	Research Interests	Hired
Kolokolova, Antonina	Assistant	Theoretical computer science, complexity theory, mathematical logic,	2007
Lu, Siwei	Professor	Computer vision, artificial intelligence, pattern recognition, image processing, neural networks	1988
Mata-Montero, Manrique	Associate	Theoretical computer science, serial and parallel computational complexity	1990
Miminis, George	Professor	Scientific computing, numerical methods in control engineering, numerical methods for vector and parallel architectures	1984
Shieh, John	Associate	Artificial intelligence, computer vision, knowledge-based systems, pattern recognition, robotics	1988
Tang, Jian	Professor	Database systems, distributed computing, fault-tolerant computing, design and analysis of algorithms, data mining	1988
Vidyasankar, K.	Professor	Distributed computing, database systems, graph theory	1977
Wang, Cao An	Professor	Design and analysis of algorithms, computational geometry, image processing, robotics, computational biology	1988
Wareham, Todd	Associate	Complexity theory, algorithms, combinatorial optimization, approximation algorithms and heuristics, cognitive science, computational biology	1999
Yu, Gwoing Tina	Associate	Intelligent computing, interactive computing, reservoir modelling and simulation, genetic programming	2005
Zuberek, Wlodek	Professor	Modelling and evaluation of systems, distributed computing, discrete-event simulation, programming languages	1984
Joint Appointments			
Peña-Castillo, Lourdes	Assistant (50% Biology)	Bioinformatics, genomics, machine learning, artificial intelligence.	2010
Vardy, Andrew	Associate (50% Engineering)	Autonomous robotics, spatial representation in robots and animals, autonomous underwater vehicles	2005
Cross Appointments			
Evermann, Joerg	Associate (Business)	Information systems, databases	2009

Name	Position	Research Interests	Hired
Norvell, Theo	Associate (Engineering)	Programming methodology, software engineering, hardware description language design, software in education	2004
Meruvia-Pastor, Oscar	Assistant (Science)	Interactive 3D graphics, non-photorealistic rendering, multimedia application development, biomedical visualization	2011
Parsons, Jeffrey	Professor (Business)	Information systems, operations management and management science	1999
Peters, Dennis	Associate (Engineering)	Documentation for computer system requirements and design	2004
Pike, David	Professor (Math)	Computational problems in combinatorics and graph theory	2006

4.1 Research Productivity

Faculty CVs are provided in Appendix D. A study of the research performance of faculty was undertaken by one of the APR study groups. As a measure of faculty productivity, the total numbers of publications for the Department were compared for each year from 2003 to 2010. This data is shown in Figure 4 in both weighted and unweighted form.

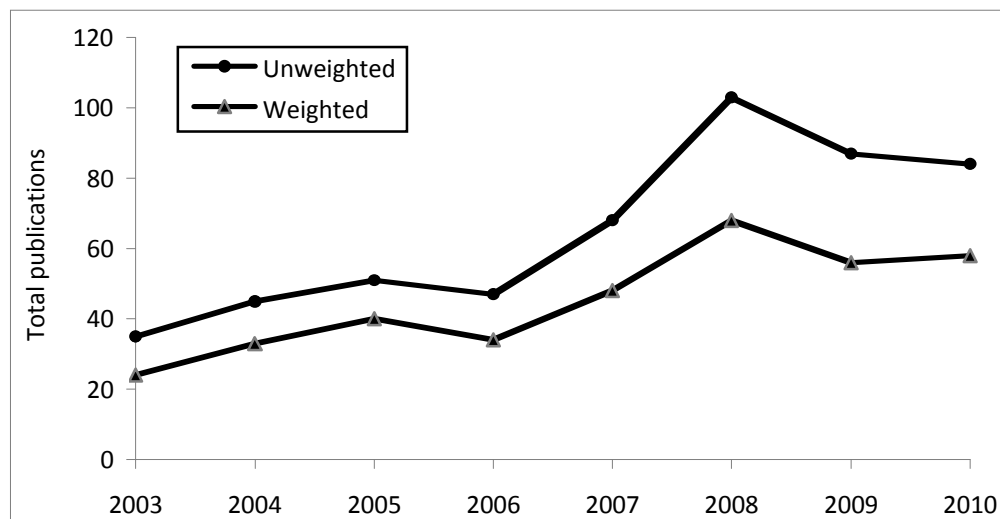


Figure 4: Total Publication Activity of Faculty Over Recent Years (Unweighted and Weighted).

The weighting used was:

- journal paper – weight 1.0
- book chapter – weight 1.0
- conference paper – weight 0.5
- conference abstract – weight 0.25

There is a clear increase in the total number of publications per year, with the sharp increase coinciding with the arrival of new faculty. There is also an increase in the average number of publications per faculty member (Figure 5).

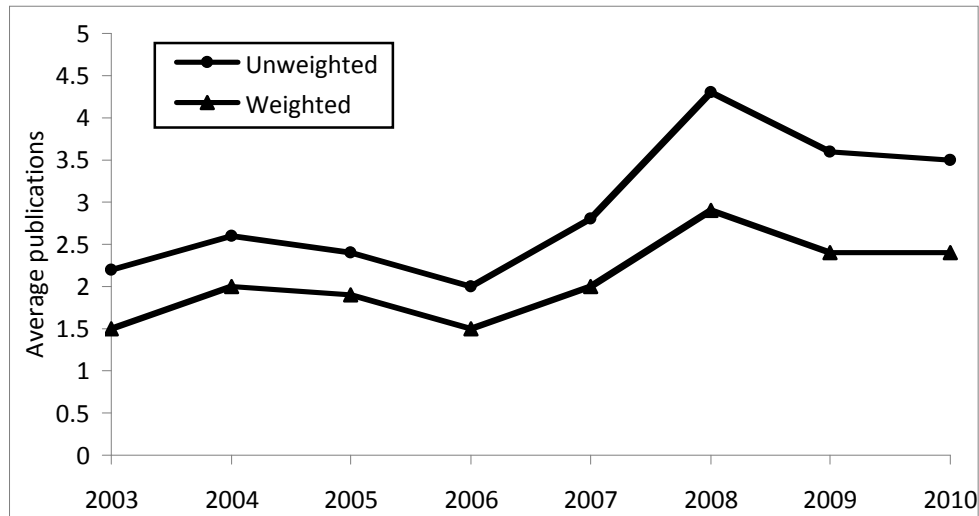


Figure 5: Average Number of Publications per Faculty Member Over Recent Years (Unweighted and Weighted).

This average number is about 2.0 equivalent publications per year per faculty member (i.e., publications other than journal papers were rescaled to journal-type publication with weighting as indicated above).

If only faculty who are actively engaged in research are included then the average number of publications per faculty member has been quite constant over the years and is equal to about 3.0 equivalent publications per year per faculty member.

For the evaluation of the quality and impact of scholarly contributions, several citation indices were consulted and h-index values were retrieved for most faculty members (h-index is a metric which takes into account both the number of publications and the number of citations for individual publications; its value is small when the number of publications is small or when the number of citations is small).

The plotted h-index values (Figure 6) show three groups of values, one group with an h-index of 10 or more (8 faculty members), the second with an h-index between 5 and 10 (five faculty members), and a third group with an h-index of 5 or less.

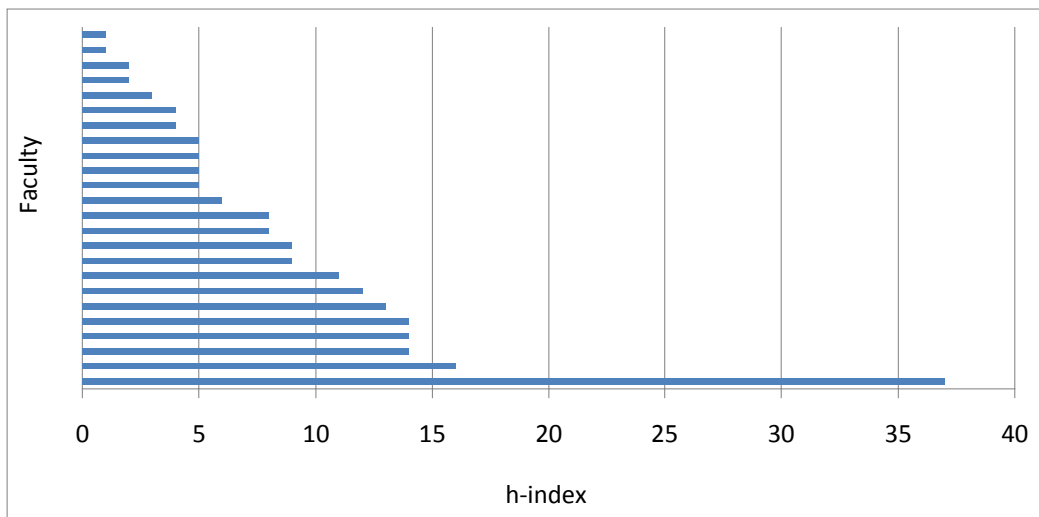


Figure 6: h-indices of Faculty as Measured in January 2011.

Taking into account that the recommended value of the h-index for granting tenure at research universities is about ten, we need to improve the impact of departmental publications. This can be achieved in part by selecting higher “visibility” journals and conferences for publication of research results and by increasing research productivity of faculty members.

The Department trails the Faculty of Science in research output. The study group found that the publication rate of faculty members needs to increase overall, but there are a number of “inactive members” of the faculty who need encouragement to engage more fully in research activity. Between 10 and 15 faculty members have measurably reasonable output based on h-index, citation and publication rates.

Some efforts to improve research productivity are under way: the graduate program is being streamlined, and the new course-based graduate program includes a research component; some progress has been made in identifying research groups as a way to encourage more faculty involvement; formal and informal seminar activity has been increased. We are creating a positive environment for improved research performance.

4.2 Grants and Funding

External research grants and awards administered by the Computer Science department are shown in Figure 7 and Figure 8:

Year	NSERC		Others (\$)	Total (\$)	Administered elsewhere ⁽²⁾
	Number	Amount (\$)			
2011-2012	10 with 1 deferral	191,500	152,721	344,220	766,458
2010-2011	10 with 1 deferral	290,200	90,897	381,097	758,243
2009-2010	11 with 1 deferral	371,650	64,033	435,683	174,285
2008-2009	14 with 1 deferral	351,100	154,088	505,188	190,235
2007-2008	14	258,220	107,750	365,970	103,878
2006-2007	13	254,170	124,801	378,971	100,597

Year	NSERC		Others (\$)	Total (\$)	Administered elsewhere ⁽²⁾
	Number	Amount (\$)			
2005-2006	9	181,170	157,843	339,013	
2004-2005	8 with 1 deferral	167,170	46,880	214,050	
2003-2004	7 with 1 deferral	127,170	0	127,170	
2002-2003	8	168,230	0	168,230	

Notes:

- (1) Does not include in-kind contributions.
- (2) Grants where the principal investigator has financial reporting responsibility within another unit.
- (3) Includes DG and other NSERC programs.

Figure 7: Research Funding Administered in Computer Science.

Faculty members occasionally delay the pay-out of NSERC funds. With maternity leaves and sabbaticals taken at regular rates, this is not a concern. The numbers also include NSERC strategic grants in 2008-2011.

Applicant success rate of our Department has fluctuated; but in recent years, Discovery Grant rejection rate has increased (here as well as at other universities). Faculty members closer to retirement age appear to be less successful, also a discouraging trend. Additional discussion of NSERC Discovery Grant success is provided in Section 9.1.

Figure 8 summarizes funding (including University-internal) to members of the Department for hiring students as researchers and assistants not included in the above table. Some of these small grants can be used for faculty to re-initiate research activity.

Academic Year	MUCEP (\$)	SCP (\$)	SWASP (\$)	USRA (\$)
2010-2011	8,303	-	2,400	4,500
2009-2010	4,311	-	4,700	-
2008-2009	2,832	-	-	13,500
2007-2008	5,616	-	-	-
2006-2007	5,436	-	2,730	-
2005-2006	9,181	879	1,800	-
2004-2005	10,279	814	-	1,125
2003-2004	6,492	780	1,950	1,125
2002-2003	3,745	2,340	1,950	-

Figure 8: Other Funding.¹

¹ MUCEP (Memorial University Career Experience Program) is an internally-funded program for hiring undergraduate students to work on career related projects. SCP and SWASP are summer placement programs funded through HRSD Canada and the provincial department of Labour, respectively. USRA is the Undergraduate Student Research Awards competitively funded through NSERC.

We have no practice of tracking funds administered by other units that are not accounted by Computer Science, so only partial data could be gathered, depicted in the last column of Figure 7. This column also reflects recent success in a number of larger applications for which our faculty are either principal or co-investigators. Since these are multi-year grants, this dramatic increase is not a one-year anomaly.

The Computer Science department also maintains licensing agreements for software through University co-operation agreements, with a commercial value in excess of \$300,000 annually.

4.3 Supervision

The current distribution of graduate student supervision is not entirely equal—25% of faculty members supervise 75% of our graduate students. The numbers are shown in Figure 9 (co-supervision is counted as 0.5).

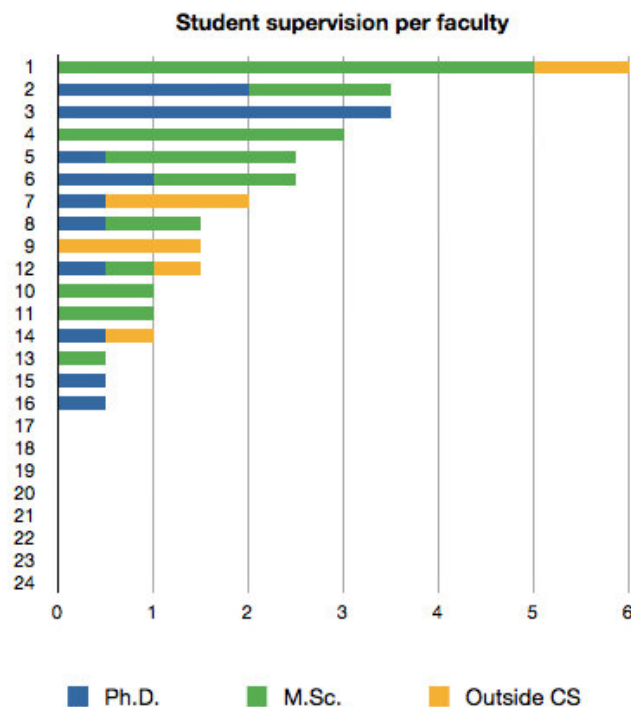


Figure 9: Number of Thesis-program Students Supervised per Faculty Member.

One third of our faculty currently does no graduate thesis-based supervision. Merely six faculty members supervise two or more students (or equivalent co-supervision). More positively, we are getting a clear contribution from our cross-appointed colleagues, who supervise the equivalent of five students (these numbers are not reflected in the above figure). A number of students in other units are supervised by Computer Science faculty. There are several reasons for low participation of faculty in graduate student supervision--limited financial resources being only

one of them. Faculty members who cannot support graduate students through their grants have difficulty attracting and maintaining students. At the same time some of our colleagues have expressed disappointment with prior supervisory experiences and have been very reluctant to commit to student supervision, despite available funding. Surprisingly, this is also reported by newer faculty members who are maintaining rather active research programs.

PhD students have supervisory committees of three faculty members, all of whom are involved in monitoring the student's progress and completing annual progress reports. The supervisor naturally takes the lead in these activities, and the exact contribution of each committee member varies depending on the individuals involved.

Other than graduate thesis-based supervision depicted in Figure 9, there are typically 2-5 undergraduate honours students supervised in a typical academic year. In some cases, honours work has developed into graduate research and successfully funded projects. A few faculty members have also been active in supervising students in the Engineering course-based program. Our own new course-based MSc program also requires supervision of a research project, which is increasing supervision activity in the Department and providing an opportunity for faculty without funding to supervise.

4.4 Faculty Achievements and Activity

Our faculty members maintain memberships in academic societies related to their research interests, including the ACM and IEEE, the two best recognized academic bodies in computing internationally.

There are a number of affiliated societies and special interest groups for specific topics in both of these organizations, and faculty participate in approximately ten of the special interest groups associated with their research interests. One of our faculty members has recently been elected chair of an ACM Special Interest Group.

On average, every three years, a student/professor team of our Department has received a best-paper award at a larger conference in Computer Science world-wide. While this is a small percentage of activities, we nevertheless try to use the occasions to encourage more high-quality contributions to conferences.

Faculty CVs reveal appropriate proportionate participation as conference referees and organizers (over 20 conference program and organization committees in the most recent reporting year, and six editorships in the most recent reported year; several hundred reported overall). In the summer of 2011, the Canadian Artificial Intelligence, Graphics Interface, and Computer and Robot Vision were held as joint conferences on campus at Memorial. These are the premier Canadian conferences in their respective areas, and this represented a significant achievement by members of the Computer Science faculty.

A few faculty members have received other outside awards, which we would like to see increase in frequency. In 2010, a University Research Professorship (URP) was awarded to a member of our Department. Only two such awards are made per year. As the highest award Memorial bestows on faculty, this is a significant recognition providing additional time for research.

4.5 *Collaboration and Community Connections*

Faculty members have ongoing research collaboration projects with many other units on campus, including Biology, Business, Chemistry, Earth Sciences, Education, Mathematics, Physics, Engineering, Geography, Linguistics, and Medicine. A prominent recent example of group collaboration is the Wireless and Mobile Computing Centre, located in the Engineering building with contributions from four members of Computer Science.

External research collaboration over the last few years include projects with colleagues from the National Research Centers, University of New Brunswick, University of Waterloo, Simon Fraser University, University of California (Berkeley), Motorola USA, University of York (UK), University of Nijmegen, Albert-Ludwigs University Freiburg, University of Muenster and Technical University of Eindhoven, University of Strasbourg, University of Evry, University Paris XI, Warsaw University of Technology and Hong Kong University. Faculty have also been engaged in research collaboration with a number of local software companies, including Consilient, Verafin, and Camouflage.

Over the last several years, the Department maintained a vibrant departmental seminar series and a distinguished lecture series. In spite of the challenge of our location, we were able to enjoy many talks by external speakers (about 30 speakers over the last three years alone). Most of the external speakers are visitors from universities and research institutions outside of Newfoundland, but we also have had several talks by speakers from outside of academia, both from local industries and government organizations (such as Verafin and RCMP) and from international companies (Nokia and Google), as well as researchers from other units within MUN (Mathematics, Linguistics, Faculty of Medicine, Faculty of Arts). In addition to talks by external speakers, we had most of the faculty in our Department give at least one talk over the last two years.

With so many talks (we have a seminar almost every week during Fall and Winter semesters, especially counting graduate and undergraduate honours student presentations), and separate seminars and group meetings ran by various groups in our department, attendance is a challenge. In particular, we are working on ways to improve graduate student attendance.

We also have a distinguished lecture series to host a prominent figure in Computer Science every few years. Our most recent speakers were Dr. Stephen Cook, a Turing award winner and father of NP completeness; Dr. John Holland, a winner of the MacArthur Prize and inventor of genetic algorithms; Dr. Lotfi Zadeh, winner of the Benjamin Franklin Medal and creator of fuzzy logic. The events included a public lecture, drawing up to 200 people; a research talk in our Department; and meetings with graduate and undergraduate students. The visits were rounded out with private events that extended traditional Newfoundland hospitality.

Community involvement by individual faculty members include high school student mentorship, judging in science fairs, and participating in the offering of short courses to junior high students through a Department of Education sponsored “enrichment” program. Department initiatives included several open house events in recent years, sometimes in conjunction with University-wide events. Technical expertise is offered to local community in development and software projects: most recently, software was developed for the Newfoundland and Labrador Craft Development Association, as well as a mobile application for the Cupids 400 celebration (with

the Newfoundland Government Department of Tourism). Technical staff has also supported the expansion of the LabNet network management suite to schools in the province. The Department maintains connections with local industry on an individual basis, and through membership in NATI (Newfoundland and Labrador Association of Technology Industries).

4.6 Faculty Renewal

The faculty complement is top-heavy in terms of age. Figure 10 depicts age brackets for current faculty. Notably, there is a gap in the age bracket of 41-45, reflecting a hiring hiatus in the 1990s. With recent legislative changes, the choice among faculty has been to continue working past what would have been mandatory retirement age. To date, four faculty have chosen to continue past the age of 65. Planning for renewal and possible replacement of retiring faculty has become a more challenging undertaking.

6										
5			x					x		
4							x		X	
3		x			x	x				
2										
1										
0										
	25-30	31-35	36-40	41-45	46-50	51-55	56-60	60-65	66-70	71-75

Figure 10: Faculty Complement by Age Bracket.

There has been no faculty renewal in the past two years; in fact, the Department has lost two contractual positions. The lost positions were generally used to provide introductory skills courses and broaden the enrolment base of the Department, a role which is increasingly filled by senior faculty.

New faculty hires prior to the last two years have proven very successful, including nine hires since academic year 2002-2003, counting appointments in Computer Science and joint appointments shared with Computer Science.

One serious problem we frequently encountered was the failure of spousal hires. In a remote location like Newfoundland, spousal hires are key to retaining faculty members. A tenure-track faculty member has recently chosen to accept a position at another University following a failed attempt at a spousal hire. While there is an official spousal hiring policy at Memorial, it is not backed up by specific budgetary allocation, and can flounder in budget negotiations between departments or faculties. Spousal hires for five out of six new faculty members were not possible.

5 Graduate Programs

5.1 Program Offerings

The Department of Computer Science offers MSc and PhD programs (see Appendix E for program regulations). The Masters program has two options—a research-oriented thesis option and a new applied course/co-op option. Although in the past the majority of our graduate students were enrolled in the thesis based MSc program, we anticipate a major shift in the future. Our Department intends to significantly strengthen and expand our PhD program.

5.2 Graduate Courses

See Appendix E for a complete list of Computer Science graduate courses.

Outlines for courses offered in the last three years are provided in Appendix H.

The calendar course listings are currently being revised by the departmental Graduate Studies Committee. A number of special topics courses have become regular offerings, while several regular courses have not been offered for quite some time. We are in the process of identifying a core of about 16 graduate courses to be offered at least once every two years. These courses will be supplemented each year with about four additional offerings which will reflect ongoing research projects and current interests. The initial core list has a rather scant resemblance to the calendar list. Updated courses have been incorporated into this graduate curriculum. The result not only will benefit course planning, but also will define the graduate program for recruiting purposes.

5.3 Graduate Student Enrolment

The number of graduate students in our programs has more than tripled since the last APR, but is still below what we might consider appropriate for our faculty complement. In 2011-2002, there were eight graduate students (four MSc and four PhD). As of December 2011, there are 40 graduate students (20 MSc (thesis), 8 MSc (course/work term) and 12 PhD). There has also been a substantial increase in the variety of 6000-level courses being offered. We went from six courses offered in 2002-2003 to 17 courses in 2010-2011. Figure 11, Figure 12, and Figure 13 reflect the development over the past nine years.

The need to offer a full complement of courses for the existing students is also reflected in the course/enrolment numbers shown in Figure 13. These figures include both regular graduate course offerings and directed readings courses. Directed readings offerings are provided for students needing to focus on a specialized area of study, with a selective and low enrolment.

Academic Year	MSc			PhD		
	Full-time	Part-time	On-leave	Full-time	Part-time	On-leave
2010-2011	24	7	2	11	1	1
2009-2010	22	3	2	10	3	0
2008-2009	19	3	1	9	0	1
2007-2008	18	5	1	8	0	1
2006-2007	23	5	0	7	0	1
2005-2006	22	5	2	5	1	1
2004-2005	20	5	2	5	0	0
2003-2004	17	2	1	3	1	1
2002-2003	6	1	0	3	1	1

Figure 11: Graduate Student Enrolment.

Academic Year	Number Convocating	MSc	PhD
2010-2011	6	5	1
2009-2010	5	3	2
2008-2009	5	5	0
2007-2008	8	7	1
2006-2007	8	7	1
2005-2006	4	3	1
2004-2005	1	0	1
2003-2004	1	1	0
2002-2003	3	2	1

Figure 12: Graduate Degrees Awarded.

Numbered Registered in COMP-9000 Maintaining Program	Number of 6000-Level Courses Offered		6000-Level Course Enrolment
	MSc	PhD	
Fall 2010	29	10	29
Winter 2011	25	12	23
Spring 2011	-	-	5
Fall 2009	22	9	41
Winter 2010	22	12	27
Spring 2010	23	11	-
Fall 2008	22	6	19
Winter 2009	20	8	21
Spring 2009	17	9	-
Fall 2007	21	7	28
Winter 2008	19	6	18
Spring 2008	19	6	2
Fall 2006	29	6	16
Winter 2007	23	7	20
Spring 2007	22	7	3

	Numbered Registered in COMP-9000 Maintaining Program		Number of 6000-Level Courses Offered	6000-Level Course Enrolment
Fall 2005	27	6	6	23
Winter 2006	27	6	6	45
Spring 2006	27	6	2	13
Fall 2004	22	5	4	28
Winter 2005	23	5	5	11
Spring 2005	24	5	3	19
Fall 2003	15	4	8	30
Winter 2004	20	3	6	29
Spring 2004	18	4	3	8
Fall 2002	4	4	2	2
Winter 2003	6	3	3	2
Spring 2003	6	3	1	4
120 graduate course sections with total enrolment of 466 over nine years				

Figure 13: Graduate Course Offerings by Semester.

In our graduate programs, we have students from Asia, North- and South-America, Europe, Africa, and the Middle East (see Figure 14).

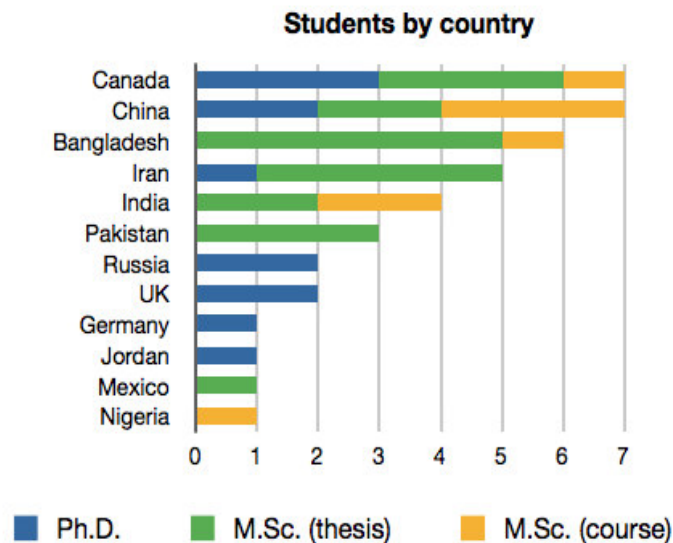


Figure 14: Countries of Origin of Our Graduate Students.

The distribution is somewhat biased, with the majority of our students coming from Asia. In the next few years, recruitment efforts will also be directed at European and North/South American universities in order to achieve a more balanced cohort of graduate students. Some faculty members believe that we need to increase our domestic student numbers significantly, and that we are overly reliant on foreign students; this reflects concerns regarding the strength of the

applicant pool. There is also a very strong gender bias in our program (similar to other Computer Science departments in North America), as shown in Figure 15.

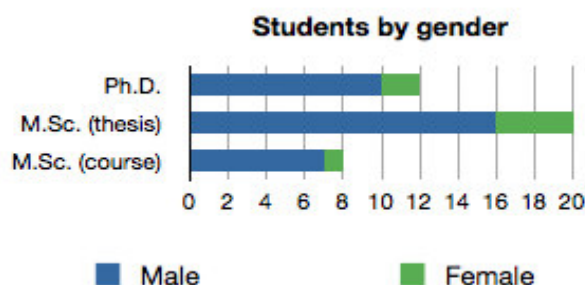


Figure 15: Gender Distribution of Our Graduate Students.

There have been a number of suggestions to create more participation in other course-based programs, including comparisons with existing programs in other units that recruit foreign students to specially-designed programs that are financially self-supporting, and apply a high differential tuition fee. The consensus in Computer Science is that we want all students, even those in the course-based program, to have a strong connection to the research activity in the Department. In the current course-based program, this is represented in part by the required project course. Fostered appropriately, there will be collaboration between course-based and thesis students, rather than segregation of the two student categories. This approach is intended to promote strong academic activity in the Department.

5.4 Student Outcomes

5.4.1 Graduate Completion Time

There are some concerns with the completion time and rate. In the past four years, PhD completion time averages 4.7 years in a nominal four-year program; and 3.5 years in a nominal two-year MSc program. However, it should be noted that this number includes part-time students, and that the average MSc time drops to 2.8 if two outliers are excluded. In the past two years, new practices have been implemented to reduce completion time which are already having an effect. Programs of Study now include only courses that are indeed offered during the first year of a student's program. We improved monitoring of student progress (a new tracking database ensures compliance with School of Graduate Studies and departmental policies) and are less lenient with program deficiencies. Students have responded favourably to the new measures.

5.4.2 Graduate Student Awards

Our students have been participating in national and local academic award programs. In recent years, several students have been awarded the designation "Fellow of the School of Graduate Studies" for maintaining superior grades in their required courses. One Alexander Graham Bell

NSERC scholarship was awarded in 2009, along with a Dean's award for excellence and the Governor-General's gold medal for excellence in a thesis based Master's program in 2010. In the Fall 2011 competition, three PhD students in our Department received the Dean's Doctoral Award (valued at \$20,000 over 4 years). Only 14 such awards have been granted across the Memorial campus.

5.4.3 Post-graduate Activities of Students

In the last three years, 13 MSc and 3 PhD students have graduated. Employment opportunities in our field are so extensive there is no doubt that any of the students can find relevant industry positions. Four M.Sc. students have gone on to doctoral studies, and seven of the graduates are employed in industry research positions. A few examples:

John Mercer (2002): Did an MSc under the supervision of Dr. Mata-Montero and went on to do a PhD at McGill University. He now works in the finance industry.

Ulf Schünemann (2005): Originally hailing from Germany, he did a PhD under the supervision of Dr. Fiech. He returned to Germany and now works as a developer for 3S-Smart Software Solutions GmbH in Kempten, Germany.

Ting Hu (2010): Originally coming from China, she did a PhD under the supervision of Dr. Banzhaf. She is currently a postdoctoral fellow in the Computational Genetics Lab at Dartmouth Medical School, NH, USA.

David Churchill (2009): He did his undergraduate studies at Memorial, added an MSc under the supervision of Dr. Vardy, and is currently a PhD student at the University of Alberta.

Debmalya Biswas (2005): Originally from India, he did an MSc under the supervision of Dr. Vidyasankar, and then went on to do a PhD at INRIA/University of Rennes in France. He now works as a Senior Researcher in the Pervasive Communications Lab of the Nokia Research Center in Lausanne, Switzerland.

Mark Stavely (2010): He did a PhD under the supervision of Dr. Bungay and now works as software development engineer for Microsoft in the Interactive Entertainment Business Division.

5.5 Self-study Feedback From Graduate Students

Feedback sought from graduate students during the self-study process can be found in Appendix F. Graduate students expressed satisfaction with the instruction and the courses being delivered by the Department. Some concerns arose about timely delivery of courses that are included on Programs of Study. This concern is being addressed by increased attention to the adequate selection of courses to be included on such programs (see previous section).

The most significant concern raised by graduate students deals with the financial support formula in the Department. Students deem the provided amounts as inadequate (\$12-14K per year). These funding levels lead many graduate students to seek part-time employment, with consequent impact on their progress. This is being addressed starting with the past year (see Section 5.6).

Graduate students have also been lobbying to have the number of courses in the Master's (thesis) program reduced, claiming that the course load is too high and that it leads to delays in completing the degree requirements. This position received little support from the departmental Graduate Studies Committee. Most faculty members believe that graduate students should be able to cope with the workload of up to three courses per semester. Course content can be examined to ensure that no unreasonable demands are put on our students, but this does not appear to be a problem for most of our courses.

The graduate students also advocate increased partnerships with other units on campus, including research group collaboration. They report a perceived need for specific instruction in programming skills and tools, suggesting that such courses or workshops would be well received by students in both our own and other programs. Graduate students expressed a willingness to be involved and promote such workshops.

5.6 Graduate Student Funding

Graduate funding in Computer Science is a combination of School of Graduate Studies Scholarships (\$4,500 for MSc students, \$7,000 for PhD students per annum), teaching assistantships (typically \$2,277 per annum), and supervisor's grant contribution. Until recently, departmental practice required faculty members supervising students to provide funding that together with the SGS and TA support would result in \$12,000 for MSc (thesis) and \$14,000 for PhD students. Typical funding for graduate students in Computer Science programs are closer to \$18K for Master's students and \$22K for PhD students (based on the CACS AIC review of 27 Canadian Computer Science departments), while graduate tuition at Memorial is as much as \$4-6K lower than at comparable institutions in Canada. Students often do not consider this impact on their total costs when they receive funding offers, and may not consider it in their choices.

A desirable funding target has now been established at \$16,000 for MSc (thesis) and \$21,000 for (PhD) students. Funding offers are moving closer to this target.

In order to address the existing funding shortfall, graduate students need to be encouraged and supported in seeking alternative funding sources. MITACS and Compute Canada programs are being considered, among others.

The new course-based MSc program will not be a burden, as students in this program have to be self-supporting. The new program also incorporates a work-term component which may help students defray the cost of their education.

6 Undergraduate Programs

6.1 Program Offerings

The objective of our undergraduate programs is to provide students with the appropriate skills and knowledge to be effective general problem solvers using computing techniques and technologies. This involves theoretical knowledge as well as practical skills, and prepares students for industrial careers as well as further education. It also distinguishes our program from polytechnical IT training with a focus on technology, and from professional programs such as Computer Engineering.

Programs offered by the Computer Science Department include:

- Major in Computer Science (BSc or BA)
- Honours in Computer Science (BSc or BA)
- Honours in Computer Science (Software Engineering, BSc only)
- Computer Industry Internship Option (CIIO) (BSc or BSc Honours)
- Minor in Computer Science
- Computer Science Joint Major (BSc only) with one of
 - Applied Mathematics
 - Pure Mathematics
 - Statistics
 - Physics
 - Economics
 - Geography
- Computer Science Joint Honours (BSc only) with one of
 - Pure Mathematics
 - Statistics
 - Physics
 - Geography

By far the majority of our students take a major in the BSc program. We have only a handful of students in the Honours, Joint and BA programs in any given year (See Appendix G). This is not viewed as a problem, however; there is little administrative overhead to these programs, as they primarily provide variations in course selections. The exception may be the Honours program, intended for students interested in pursuing higher academics.

The undergraduate Computer Industry Internship Option (CIIO) program is a very popular component of our program, with many students in their third year taking an 8 to 16 month work term. Students are formally assessed on their work term via progress reports and a final report, which includes an employer evaluation component. Although increasing the completion time in the program, the CIIO provides students with industrial experience, and promotes interaction of the Department with local and distant industries. Concerted and ongoing interaction with industry partners relies on staffing through the Co-Operative Education division. The following is a list of the employers that frequently hire Computer Science co-op students:

- CNS Systems (formerly ICAN Marine), Mount Pearl
- ClearRisk, St. John's
- IBM, Ontario
- Memorial University, Student Affairs
- Memorial University, Department of Computer Science
- RIM, Waterloo
- Compusult, Mount Pearl

Students who apply to the honours program must meet a performance standard (a 75% average), and complete a project with a written report under supervision of a faculty member. Honour projects come from a variety of approaches, including theory, applications, and applied problems from other disciplines, sometimes drawn from local industry. Students targeting a graduate degree will often choose to complete an honours program. The Software Engineering honours specialization is one option within the honours program.

At Memorial, 120 credit hours (40 “regular” courses) are required for a typical Bachelor’s degree. Forty-five credit hours (15 “regular” courses) are required for a Computer Science major, including twelve mandatory courses. An additional six or seven mathematics courses are incorporated as pre-requisites or requirements for our Computer Science major program. Students in the Computer Science honours program take an additional 18 credit hours in Computer Science, comprising five courses and the honours dissertation course. The pre-requisite structure for required courses (sometime referred to as the “core” program) is illustrated in the following pre-requisite charts:

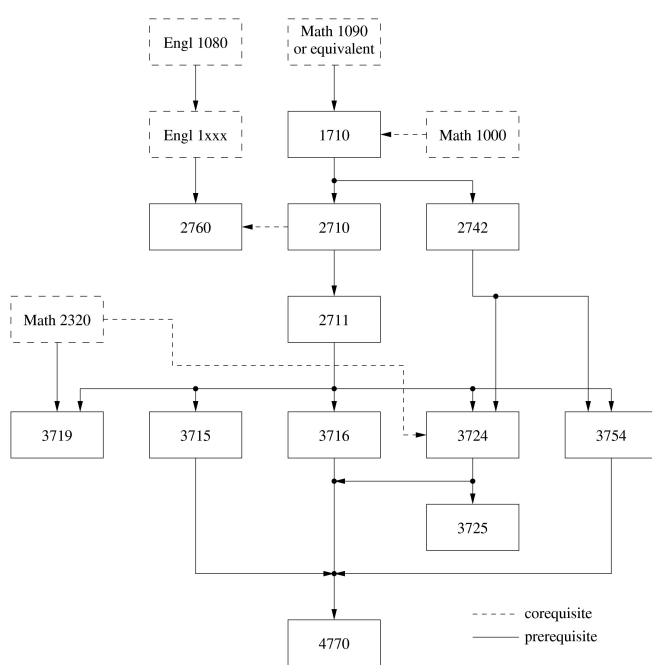


Figure 17: CS Course Sequence.

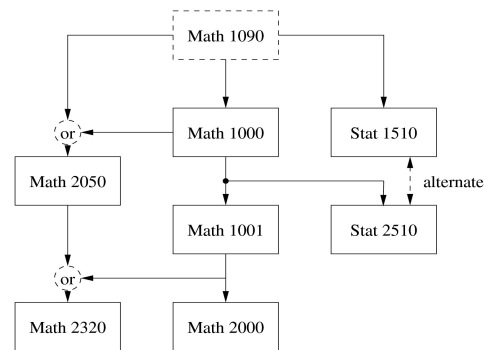


Figure 16: Math Courses Required for CS Majors.

As of February 2012, math pre-requisites have been moved from first year to second year of the program. COMP-1710 no longer has any prerequisites, making our major degree programs more accessible.

6.2 Program Description

Traditional course descriptions and outlines for the undergraduate courses are presented in our Undergraduate Handbook. In addition, recent course outlines have been requested from faculty members involved in course instruction and are included in Appendix H. A listing of the undergraduate courses offered through our unit follows below. **Core required program courses are listed in bold.** There are also a number of courses in first and second years primarily intended for *servicing students in other programs listed in italics.*

First -year courses:

COMP- 1700 - Introduction to Computer Science
COMP- 1710 - Object-Oriented Programming I
COMP -1510 - An Introduction to Programming for Scientific Computing
COMP-1550 - Introduction to Multimedia Application Development
COMP- 1600 - Basic Computing and Information Technology

COMP-1700 is an overview course that provides an introduction to Computer Science concepts. Students considering Computer Science or those who are looking for a broader introduction than strictly programming find value in this offering. COMP-1600 is intended primarily for Business-oriented students, and focuses on business applications, whereas COMP-1510 is intended for students in other science programs (principally Mathematics and Physics), who need exposure to numerical programming skills in their first course. COMP-1550 is a new course which has yet to be offered, but is designed to appeal to students who want to develop media (web, animation) relevant programming skills.

Second -year courses:

COMP- 2710 - Object-Oriented Programming II
COMP- 2711 - Introduction to Algorithms and Data Structures
COMP- 2742 - Logic for Computer Science
COMP- 2760 - Encountering the Computer: Society and the Individual
COMP- 2000 - Collaborative and Emergent Behaviour
COMP- 2500 - Data Analysis with Scripting Languages
COMP- 2650 - Problem Solving with Personal Computers

COMP-2650 has been a longstanding offering for students in other (non-Computer Science) programs covering programmatic problem solving in an applied context. Until this past year, Computer Science has also been offering COMP-2801 and COMP-2602 to similar audiences, but these offerings are being rationalized.

Third-year courses:

COMP- 3700 - Industrial Experience
COMP- 3715 - Network Computing with WEB Applications
COMP- 3716 - Software Methodology
COMP- 3719 - Theory of Computation and Algorithms
COMP- 3724 - Computer Organization
COMP- 3725 - Computer Architecture and Operating Systems
COMP- 3754 - Introduction to Information and Intelligent Systems
COMP- 3710 - Vocational Languages
COMP- 3714 - Programming Languages and their Processors
COMP- 3718 - Programming in the Small
COMP- 3731 - Introduction to Scientific Computing
COMP- 3753 - Computational Aspects of Linear Programming
COMP- 3550 - Introduction to Bioinformatics

Fourth-year courses:

COMP- 4770 - Team Project
COMP- 4780 - Honours Project
COMP- 4711 - Structure of Programming Languages
COMP- 4712 - Compiler Construction
COMP- 4718 – Survey of Software Engineering
COMP - 4721 - Advanced Operating Systems
COMP- 4723 - Introduction to Microprocessors
COMP- 4734 - Matrix Computations and Applications
COMP- 4740 - Design and Analysis of Algorithms
COMP- 4741 - Formal Languages and Computability
COMP- 4742 - Computational Complexity
COMP- 4743 - Graph Algorithms and Combinatorial Optimization
COMP- 4751 - Computer Graphics
COMP- 4752 - Introduction to Computational Intelligence
COMP- 4753 - Artificial Intelligence
COMP -4754 - Database Systems
COMP- 4756 - Image Processing
COMP- 4759 - Computer Networks
COMP- 4762 - Introduction to Computational Molecular Biology
COMP- 4766 - Introduction to Autonomous Robotics
COMP- 4767 - Information Visualization and Applications
COMP- 4768 - Software Development for Mobile Devices

Fourth-year courses appear extensive, but these are primarily electives for our own majors, many of which may be offered once in a two-year cycle, and others represent undergraduate versions of graduate courses. Students from the Engineering programs (particularly Computer Engineering) may also take them as elective courses. They are often updated to reflect current topics, giving students some variety in their course selection.

6.3 Enrolment Numbers

Year of Major Declaration	2011-2012	2010-2011	2009-2010	2008-2009	2007-2008	2006-2007	2005-2006	2004-2005	2003-2004	2002-2003
Year 1	4	4	3	3	3	12	11	4	3	1
Year 2	25	23	16	16	22	14	19	17	22	24
Year 3	26	22	34	27	21	22	35	29	39	54
Year 4	38	37	25	18	24	40	33	30	54	58
Year 5	22	21	20	37	39	23	34	65	60	77
Total Declared Majors	115	107	98	101	109	111	132	145	178	214
Degrees Awarded (Male/Female)	*	14 (12/2)	16 (16/0)	22 (20/2)	24 (21/3)	18 (18/0)	33 (32/1)	40 (38/2)	34 (30/4)	60 (53/7)

Figure 18: Declared Majors and Degrees Awarded (*final numbers not available until May 2012).

Declared Computer Science majors and undergraduate degree production for the past several years are shown in Figure 18. Admission to the Computer Science program requires a formal declaration of major by the student. Computer Science has an “open door policy”, which means students may apply at any time during their program, and Computer Science majors do not tend to declare themselves until the second or third year of their program, which has an impact on the interpretation of the declared majors statistics. As long as they maintain eligibility to remain in the University, they can be registered as Computer Science majors.

There has been a drastic drop in participation in our programs from 2002 to 2006, and a steady attrition until the past two years, which show a recent upturn. This echoes national and North American trends, as shown Figure 19, which shows graduation rates trailing a general collapse of Computer Science and Computer Engineering program enrolments in the 2002-2004 time frame:

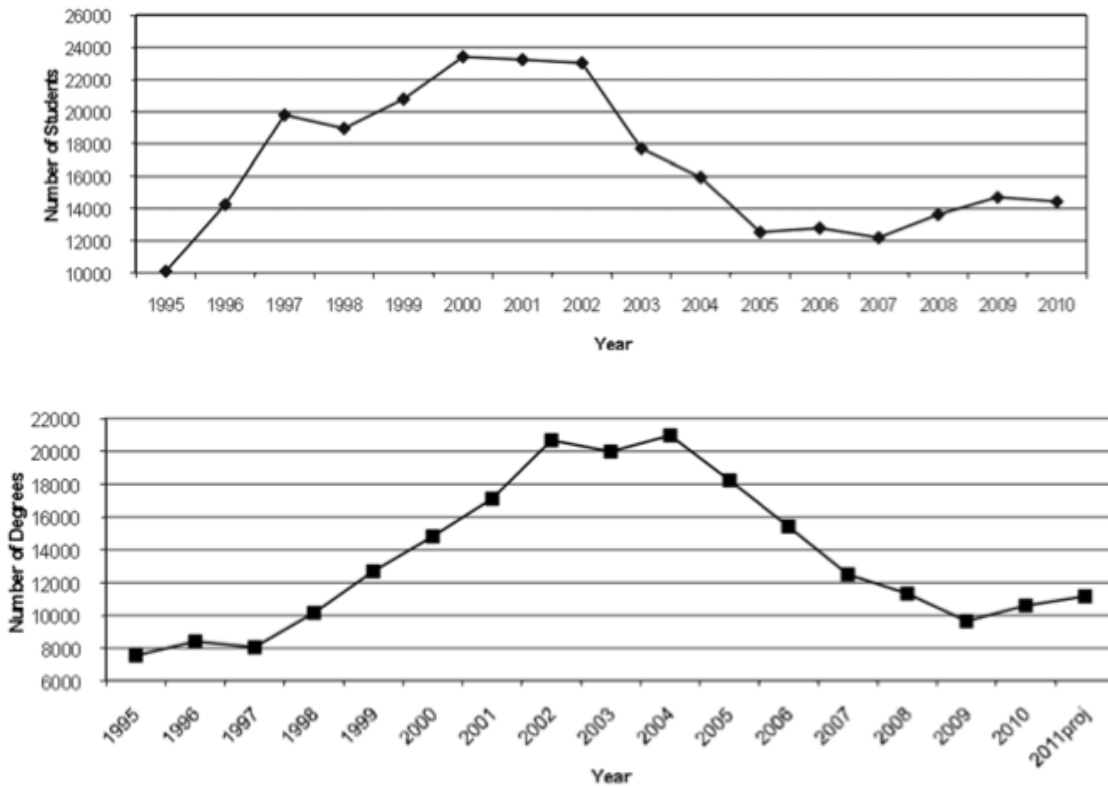


Figure 19: Survey of 150 US/Canadian Computer Science and Computer Engineering Programs (Taulbee Report, 2011).

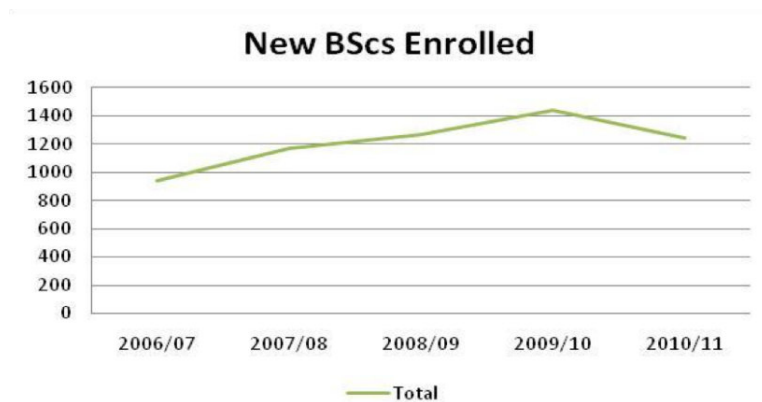


Figure 20: CACS/AIC survey of 27 Canadian Computer Science departments, June 2011.

In comparison to other Science departments, the number of majors is comparable to Memorial’s Physics/Chemistry departments, departments that also service a large number of non-majors with degree requirements in basic sciences. Based on the current job markets and demand for computing specialists, we aspire to a larger student body, more comparable to Biology or Psychology.

After a short period of job shortages in the early 2000's, demand for workers in the computing field has continued to climb dramatically.² Currently, computing careers are increasingly top-rated in terms of job availability and remuneration, belying the general perception of large market losses to the Far East. The American-based National Association of Colleges and Employers survey³, echoing the trade journals, shows that Computer Science is now the top discipline in terms of remuneration and number of starting offers. There is concern among those operating Computer Science programs that there is a general misperception of few or poor career opportunities in computer-related fields, when the opposite is in fact the case. This misperception is blamed for a corresponding negative impact on enrolment figures, followed by a strong expectation or an eventual rebound in Computer Science enrolments and stronger representation in school curricula.

With our current lab facilities, faculty complement and unfilled course capacity, we could support approximately four times the current enrolment figures, with a cohort of up to 100 students per year. In the late 1990's, the Department supported a student complement of approximately that size, and the capacity and demand for graduates exceed those numbers today. These enrolment numbers are achievable over time, but will require a sustained effort in outreach, recruiting, and collaboration with other units.

Academic Year	Semester	1000 Level	2000 Level	2000 level Discontinued Business Program	3000 Level	4000 Level	Semester Total	Annual Total
2011-2012	Fall	173	139	0	109	49	470	
	Winter	139	98	0	174	77	488	
2010 – 2011	Fall	156	264	147	35	32	487	1,000
	Winter	131	183	96	123	56	493	
	Spring	11	0		8	1	20	
2009 – 2010	Fall	123	369	190	88	45	625	1,110
	Winter	102	258	128	72	36	468	
	Spring	7	0		10	0	17	
2008 – 2009	Fall	133	385	201	80	45	643	1,180
	Winter	93	313	135	58	65	529	
	Spring	0	0		8	0	8	
2007 – 2008	Fall	121	384	193	107	42	654	1,203
	Winter	92	272	137	74	61	499	
	Spring	0	0		7	0	7	
2006 – 2007	Fall	149	394	198	86	44	673	1,203
	Winter	96	264	147	99	58	517	
	Spring	9	0		3	1	13	

² Sloan, Scully & McAllister, "Outlook on Enrolments in Computer Science for Canadian Universities", Information and Communications Technology Council, January 2008.

³ www.nace.org

Academic Year	Semester	1000 Level	2000 Level	2000 level Discontinued Business Program	3000 Level	4000 Level	Semester Total	Annual Total
2005 - 2006	Fall	101	405	180	114	59	679	1,219
	Winter	92	292	146	76	75	335	
	Spring	0	0		5	0	5	
2004 - 2005	Fall	182	345	149	136	96	759	1,443
	Winter	130	294	140	134	112	670	
	Spring	9	0		5	0	14	
2003 - 2004	Fall	116	374	139	148	118	756	1,510
	Winter	107	317	142	153	118	695	
	Spring	30	0		19	10	59	

Figure 21: Enrolment by course level.

Figure 21 shows the enrolment by course level. There have been recent dramatic losses in the second-year courses directly attributable to phasing out of Computer Science courses in other units' programs, which should amount to about 380 registrations per year. In fact, we anticipated a larger impact from these losses, and have found an increase in first year registrations for our introductory courses in Fall 2011 have helped soften the impact of these program losses. Whether these increased registrations will translate into increased enrolment in Computer Science degree programs will be determined over time. However, we are hopeful that this is a positive sign for improved enrolment and perhaps an indication that our outreach program is already having some effect.

Completion time in our program is measured by two criteria:

- A. Time between taking the first course in Computer Science to taking the last course in Computer Science to qualify for a degree; and
- B. Time taken to complete their degree after course COMP-2711 (normally in year two of their studies).

The latter criterion is necessary because many of our students do not declare Computer Science as their major until well into the program.

Based on data from the period 2002–2009, completion time under criterion A averaged 4.49 years, which reflects the fact that most students take courses in other fields, not related directly to their studies. Completion time under the somewhat more stringent criterion B averaged 2.76 years, plus the time prior to taking COMP-2711.

Our completion times are understandable considering that we operated without limiting enrolment or competitive entry requirements. However, we can do better. In terms of program suitability, one possibility is directing struggling students to other alternative program options, including a minor, or joint programs in Computer Science. We also see a small number of

students crossing between Engineering and Computer Science programs, for performance and other reasons of choice: there should be a standard transition route for these students. One option we want to consider is additional tutorials for students having difficulties with course materials, and building on the successful model of the Computer Science Help Centre.

6.4 Student Outcomes

Phone surveys of our graduates previously conducted with the help of the CIAP (Memorial's Centre for Institutional Analysis and Planning) were not available for this review, and a survey of our own graduates has only recently begun using information from Alumni Services. Currently the information we have is limited to personal contacts and knowledge of our own graduating students. The Department considers alumni development a weakness and will be addressing how to maintain adequate contact with alumni. At least 37 of our former graduates were contacted in the last two years, all but two of whom are fully employed in some aspect of the computing industry; however, statistics have not been gathered on employment relative to graduation dates. This available anecdotal information is inherently difficult to generalize: naturally, the students we maintain contact with tend to be those in the local software industry.

Based on personal knowledge, we estimate that about 10% of our students continued on to further academics, and the bulk of the remainder are employed in jobs drawing on computer-related skills. The last comprehensive alumnus survey by CIAP for Computer Science was ten years ago, showing over 90 percent of graduates are employed full-time. Given that there are more and better paid job openings than can be filled, and fewer graduates to fill them, well-paid employment is not difficult for our graduates to obtain.

CIAP supplied an analysis of responses of graduating students using exit survey data they collect on a yearly basis (see Appendix I). Although covering 2003-2010, the data collection appears highly skewed toward the earlier years (2003-2006), and is missing any data from 2008, so it is difficult to assess trends over time. In particular, we are interested in whether the changes implemented to respond to student concerns, such as updates in the curriculum, are reflected in student responses in later years. The increased emphasis on applied topics in our courses is particularly relevant to program satisfaction elements of the survey, for which CIAP reports Computer Science scores lower than the institutional norm, for example, on instructional quality items (questions 8 and 11) and choice of program (questions 9 and 10). The changes implemented to respond to these issues since 2002 would only be observed by more recent graduates; so it is unfortunate that the original data was not made available separately from the aggregate results.

6.5 Self-study Feedback on the Undergraduate Program

All constituencies of the unit (students, staff and faculty) express a consensus that we have solid traditional computer science content in the program, and a number of required and elective course revisions have increased the application-related content of the program. (e.g., required core course COMP-3715 on Web Applications, and elective course COMP-4768 on Mobile Devices).

Concerns arose around perceived relevance, continuity, and instruction rather than with the curriculum content. COMP-2711 creates a “bottleneck” in the core program for undergraduate student access to advanced courses. One unexpected comment from the undergraduate student representatives was that poor performance in COMP-1710/COMP-2710—our required introductory sequence for Computer Science majors—was not always a problem with student comprehension, but rather the opposite, that students with a pre-existing computing background found themselves disengaged from content progression that is too slow. Our accelerated program initiative and challenge for credit options can help address this concern. Instructors find that programming, algorithm design and algorithm analysis are challenging topics for most students. It was also noted that the technology appeal of the program, in content relevant to games development, networks, mobile devices, graphics, robotics and so on, is not generally visible to entering students and not accessible until well into the program, which means its potential value for student recruitment purposes is not well exploited.

Repetition of material between certain introductory courses, in particular the discrete math and logic courses, was noted. In some cases, undergraduate students felt unclear about what they are supposed to know from particular course offerings. Instructional support staff pointed out that consistency between different instructors’ course offerings is critical, and undergraduate students echoed this sentiment with reference to two specific courses. Faculty endorsed increased monitoring of curriculum delivery and providing more explicit guidance and tracking of students through the program.

Synchronization between lab and lecture material was also raised, and students talked about the popularity of applied courses, but cautioned the importance of maintaining up-to-date curricula and software tools. Sentiment was expressed that despite the existing increase in applications courses in the program, our introductory courses may be perceived to be too theoretical, and some practical components (real-time programming, device drivers, games development, broader exposure to programming languages) may be missed by graduating students, even though they are represented somewhere in the curriculum.

6.6 Undergraduate Curriculum Planning and Innovation

Our Department has traditionally designed its undergraduate programs according to the standardized curriculum published by the ACM (Association for Computing Machinery) and IEEE, whose next revision is due out in 2013. An interim curriculum report was issued in 2008, referenced as CS2008.

An internal department survey in Fall of 2009 concerned restructuring our undergraduate programs, with the suggestion that a well defined central theme for computer science would allow specific streams and specialties to be aligned around common knowledge essential to all sub-specialties. The proposed common theme was the topic of *algorithms*. Such a central theme would help interpretation and implementation of the more polyglot approach that appears in the CS2008 report. No specific direction was adopted, but it did serve to raise the level of discussion around curriculum revision in the Department. The issue of introducing program streams for specialization recurs frequently, and during the self-study activities, the following possibilities for streams were put forward:

1. Computer Games Development
2. Computer Security and Privacy
3. Mobile Computing, Networking and Cloud Computing
4. Intelligent and Adaptive Systems
5. Computer Graphics, Animation and Visualization

There is not yet a consensus on what streams are appropriate, but the faculty endorsed continued exploration of the concept by identifying a common core of courses and stream-specific electives.

An initial effort towards the streaming concept was the reduction of required courses in the minor program in 2010. With only three mandatory courses, and five choices, students with specific interests can tailor an undergraduate minor in Computer Science to their own major field or subject matter of interest. If promoted appropriately, this “flexible” minor may provide some insight into the local appetite for topic streams in a Computer Science discipline.

6.6.1 Teaching Technology and Online Capacity

Our courses generally exploit Web or Internet based tools for delivery of programs and instruction, several of which have been developed in-house. In some cases, it is possible to use the online tools provided through DELTS (Distance Education, Learning and Teaching Support), a specialized unit within the University, but often they do not support technology features required in Computing courses, and they deal with curriculum content and delivery technology as separate issues, in a manner that is not suited to Computer Science. Both staff and students had issues with inconsistent use of course support technology, including Web delivery and electronic submission. Partly, this is due to inconsistent use of the campus-wide delivery technology available through DELTS, which does not support the specific technologies relevant to a Computer Science education.

A current initiative explores the development of tools and materials for improved online delivery with the possibility of supporting additional distance education courses. This is particularly valuable for the introductory courses in our program that could be made available for Advanced Placement courses and recruitment efforts.

6.6.2 Exchange Students

We have a student exchange agreement with Mannheim University, which has been used infrequently for visiting students. The unit continues to be interested in developing international programs. We continue to investigate possibilities with the co-operation of appropriate units, such as the International Centre, and a number of 2+2 exchange programs have been put forward in recent years.

6.6.3 Programming Competitions

The Department has several programming competitions every year, each of which is attended by roughly 20 undergraduate students. The first of these (and the longest running) is typically held each September to select a team to represent the University at the Annual APICS (now Science Atlantic) Programming Competition held in October at a university in Atlantic Canada. The top three teams in this competition are in turn entered in the ACM International Collegiate Programming Competition (ICPC). Several times since the last APR (in 2002, 2003, 2007, 2008, and 2011), teams from our Department have made it to the next level in the ICPC, namely the Northeast North American Regional Contest. The remaining local competitions are scattered over the remainder of the academic year. Traditionally there have been two individual rather than team competitions (one in the Fall semester and one in the Winter semester), though in Winter 2011, we inaugurated a two-person team competition to help foster entrants for the Fall three-person team competitions.

Programming competitions are also becoming very popular as recruiting tools in our field. We intend to take a close look at how we might support student success in these venues.

6.7 Courses Offered to Other Units

Historically, Computer Science courses were in demand from other units, and the unit ran a comprehensive set of “service” courses that gave students in other units exposure to computing concepts and skills. These course requirements have been eliminated over the years, rapidly in the last few years, with significant enrolment consequences to the Department. In 2009, the Faculty of Business Administration (FBA) revised its curriculum and eliminated computing skills course requirements from its FBA Bachelor's programs, which entailed enrolment losses for the Computer Science department. In a surprise move, they also shut down a joint Computer Science/Faculty of Business Administration e-commerce program which, although undersubscribed, represented collaboration between the units. Some effort has continued since that time with the Information Systems group in FBA to develop new joint offerings that could fill a need for IT specialists with a Business background. In the following year, 2010, the Kinesiology program was revised, eliminating a computing skills requirement in their program. This was particularly disappointing since we had just completed a revision (with the advice of Kinesiology faculty members) of the course that was eliminated.

Perhaps most troubling is the rationale that accompanies these changes. Claims were made that students have sufficient computing background due to high school or social exposure. This is contraindicated both by student survey data which we collected and the increasing computer tools and data analysis skills exploited in these and other programs throughout the university. An informal survey of East Coast universities in the summer of 2010 revealed that a significant number of institutions require a computing course for all undergraduates. This leads us to speculate how a proposal for a required course in computing would be received at Memorial. Such a proposal would at least allow us to gauge whether the importance of computing has any traction or weight in the institution as a whole.

7 Connections with Other Academic Units

7.1 LabNet

Among significant University community support is the Computer Science system support group's development and maintenance of a suite of network administration software tools which has become known as LabNet. This originated in the late 1990's as a means of dealing with under-resourcing of computer lab support, developing remote imaging of computer systems that boots clean system images off remote servers. Incident to this technology are the advantages of having a virus-free system image loaded on each reboot that can be administered remotely, system updates through a centralized server without needing to service machines individually, and a reliable remote file and file management system with appropriate redundancy mechanisms. This proved to be so successful and popular that its use has grown well beyond the Department to over 950 general access computers, 85 servers, and 60 lab locations on campus. Additional on-campus services included in the LabNet infrastructure include secure remote backup, single sign-on authentication, a unified printing service (something that appears to be unique to Memorial University), and multiple operating systems support. Recently, the research data backup has been added to the services supported by Computer Science through LabNet. As other units adopt the LabNet suite and contribute to its development and expansion, a community of sharing cost, knowledge and development effort has grown up around this technology. In addition to distributing LabNet within Memorial, Computer Science Systems Staff has supported the expansion of the LabNet network management suite to schools in the province.

This is an opportunity to nurture and expand an original and successful technology. Commercial cloud and grid solutions are only now appearing which offer only some of the functionality that LabNet supports. While there are individual full-time employees in different units that are effectively doing LabNet support and development, there is no institutional mandate for continuing development of LabNet; its maintenance and development depend on individual units that recognize its value finding room in their resource allocation to participate. This situation is no longer viable for maintaining critical infrastructure, and institutional support is essential.

7.2 Internship Program (Co-op Education)

For the time period since our last APR, the work-term CIIO option within our undergraduate program has been managed by a Co-Op and Internship Co-ordinator from the Division of Co-operative Education. This is an academic staff position that comes under the MUNFA Collective Agreement.

On inception, Computer Science had a half-time contractual position for the development of the undergraduate internship option. Once established, responsibility for the program reverted to the Division of Co-operative Education, which has successfully placed and monitored students in provincial, national and international work placements. Given the scope of work and looming new challenges in the near future, we are concerned about the current allocation for the Co-ordinator position for growth and support of our programs. Under the existing staff allocation formulas, this single position is responsible for all Arts and Science faculties, with nine different co-op programs in existence and more in development. Both Computer Science undergraduate and graduate work-term placements (that is, the undergraduate CIIO program and the course-

based Master's program) are in this category. If a significant effort is to be undertaken to expand and promote our work-placement options, the staff resources must improve.

7.3 Joint/Cross Appointments

Our joint appointments (with budgetary burden sharing) and cross appointments (allowing supervision of students in the other unit) have been successful expressions of collaboration with other units in the University. There is potential for more shared appointments, for instance with Mathematics, Geography and other units. The table on page 16 shows the current appointments in these categories.

Supervision of students, cross-listed course offerings and faculty members in extra-departmental committees provide opportunities for co-operation and interaction.

7.4 Faculty of Science

Our involvement in the Faculty of Science includes the interdisciplinary MSc in Computational Science. The chair of this program was a Computer Science faculty member for nine years (2000-2009). Our faculty has regularly supervised students applying under the Computational Science program (5 out of 28 MSc students in Computational Science were supervised by Computer Science faculty), and supplied graduate course offerings to this program.

Of note is the joint search with the Department of Biology for a Bioinformatics position which ultimately was successful in 2009. A newly developed course in Bioinformatics (COMP-3550) is now cross-listed with Biology and we expect more synergies to flow from this collaboration.

A new Computational Chemistry program is in preparation in which Computer Science will contribute a number of courses. One faculty member collaborates with Chemistry faculty members, including co-supervising graduate students and postdoctoral fellows.

The Computer Science undergraduate program relies on introductory courses provided by the Mathematics and Statistics Department for its programs, and currently provides course offerings for students in the Mathematics and Statistics, and Physics and Physical Oceanography departments (COMP-1510), and electives oriented to Physics and Physical Oceanography students (COMP-2500). We also have a number of courses that provide numerical and scientific computing knowledge at the undergraduate level. There are several additional Computer Science courses suitable for students in other units (1600, 1700, 2650, and newly created 1550 and 2000). There is also at least one faculty member co-supervising undergraduate honours students and graduate students with a faculty member in the Mathematics and Statistics department.

7.5 Faculty of Engineering and Applied Science

We have a long-standing history of interaction with the Faculty of Engineering and Applied Science. However, our relationship with the Computer Engineering program has not always been smooth. There was an unsuccessful attempt at synchronizing the two undergraduate programs in 1994 when Computer Engineering was being introduced. When Computer Science

introduced an honours in Software Engineering shortly thereafter, the institution faced litigation from the professional engineering society over the naming of the specialty.

Individual faculty members continued to collaborate throughout this period, and troubles between the units are long past. Since the last APR, relations are typified by cross appointed and joint appointed faculty members and collaboration between the units in teaching and research.

Faculty members in the Department are involved in joint research projects with members of the Faculty of Engineering, including co-supervision of students. The Wireless Communications and Mobile Computing Research Centre (WCMCRC), established in April 2009 and housed in the Faculty of Engineering, was developed by faculty members from Engineering, Computer Science and Business Administration.

The Centre for Digital Hardware Applications Research (CDHAR) was established by faculty in Computer Science and Engineering, later involving faculty from Earth Sciences as well.

Faculty members from both Engineering and Computer Science are participating in the emSYSCAN project, coordinated by the Canadian Microelectronics Corporation (CMC), which will provide the University with over \$400,000 worth of systems hardware to aid in new and ongoing research in embedded systems. The particular hardware requirements are presently being formulated, and the equipment installation will begin within a few months.

For over 20 years, CMC has provided commercial quality hardware and software resources to the University, typically valued in the hundreds of thousands of dollars, primarily for the use of researchers and students in Computer Science and Engineering. Presently, most of this equipment and all the software reside in the Computer Science department, and the software is maintained by our systems staff.

Computer Science students and Engineering students frequently take courses as electives from the other unit. However, there are still senior Engineering courses in concurrent programming and hardware design which should be considered viable Computer Science credits, and at least one of our core program courses that could be re-examined for closer co-ordination. Improving interaction between our student populations would benefit both units, as well as help rationalize course instruction efforts. We look forward to increased collaborative efforts with the Engineering program.

7.6 Faculty of Business Administration

We collaborate with the Faculty of Business Administration in different ways. Two faculty members in Business are cross-appointed to our Department. There is at least one collaborative grant application that is currently under review.

COMP- 2801 was, until recently, a required course in the Faculty of Business Administration's Bachelor degree programs. Removal of this course requirement resulted in a significant drop in our second-year enrolment. COMP-1600 remains available for students interested in computing tools relevant to Business professionals. Some Computer Science graduate students have taken

courses within the Faculty of Business Administration. Likewise, some Business doctoral students have taken courses within Computer Science.

We hope that this collegial relationship between Business and our Department will continue to be mutually beneficial from both the research and teaching perspectives. We would like to engage the Faculty of Business in discussions on developing an appropriate program for students pursuing Information Systems careers.

7.7 Faculty of Medicine

With the current explosion in use of biomedical data and the increasing interest in electronic health/medical records, there is potential for increased collaboration between Computer Science and the Faculty of Medicine in both research and teaching. Recently a new faculty position in Health Informatics was created at the Faculty of Medicine. A research group in Health Informatics has existed for some time, and there is increased interest from several members (faculty and medical doctors) of the Faculty of Medicine to pursue interdisciplinary research in Health Informatics. Individual faculty members are participating in grant applications with members of the Faculty of Medicine, and have also co-supervised graduate students.

7.8 Faculty of Arts

We offer degrees through the Faculty of Arts (BA) and collaborate with individual faculty members in the Faculty through research projects (Dr. Yvan Rose, Linguistics, and Dr. Rodolphe Devillers, Geography). More could be done to introduce undergraduate Arts students to relevant knowledge in Computer Science which could also help with the gender imbalance in our student body.

Our most recent effort directed to Arts students is the introduction of COMP- 2000, which appears on the course selection list for the new interdisciplinary program in Communication Studies.

8 Departmental Infrastructure

8.1 Technical Support

Technical support for faculty research is provided primarily by departmental systems support staff, as many of the research support facilities are integrated with labs and teaching,

The technical staff complement for Computer Science is shown in Figure 22. There are seven system support staff, two of which exclusively service Mathematics and Statistics computing needs. As well as supporting the labs run by the Computer Science department and maintaining systems and labs within Computer Science and Mathematics, including teaching and research labs, this group also provides substantial support and development for cross-campus academic computing capacity, largely through the LabNet system. Staffing is currently inadequate for the demands created by the LabNet support activities.

Position	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
System Manager	1	1	1	1	1	1	1	1	1
System Administrator IV					2	2	2	2	2
System Administrator III	3	3	3	3	1	1	1	1	1
Systems Programmer-Computer Science	1	1	1	1	1	1	1	1	2
Systems Programmer	1	1	1	1	1	1	1	1	
PC-Consultant II		1	1	1	1	1	1	1	1
PC-Consultant I	1								
TOTAL	7	7	7	7	7	7	7	7	7

Figure 22: Technical Support Staff Complement.

8.2 Administrative Support

The administrative support staff comprises an Intermediate Secretary who provides support to the Head of the Department and serves as secretary to the Promotion & Tenure, and Search Committees; a Secretary and an Intermediate Clerk-Stenographer who provide clerical support for departmental files and faculty activity, and act as initial contact for student inquiries; and an Administrative Staff Specialist who deals with and advises all members of the unit on budget matters, University policy and procedures, and human resources issues.

Position	2001-2002	2002-2011
Administrative Staff Specialist II	1	1
Intermediate Secretary	1	1
Secretary	-	1
Intermediate Clerk-Stenographer	1.66	1
TOTAL	3.66	4

Figure 23: Administrative Staff Complement.

For the period from 2002 to the present time, the Department has had the same administrative support staff complement as depicted in Figure 23. This staffing is the minimum necessary to support the current academic programs and faculty complement. The staff support needed with the addition of a course-based Master's program is being absorbed by the current complement, although it is expected that substantial growth in this program will necessitate additional staffing.

8.3 Instructional Support

The instructional staff complement has been unchanged in the last ten years, with one Laboratory Instructor and three Instructional Assistants. These positions substantially support lab instruction for our courses, as well as the preparation and continual update of lab materials. This work includes production of lab manuals in the form of complex web pages used as learning apparatuses for students in laboratories, helping students complete exercises and experimentation with various applications, programming languages and computer architectures, and grading of lab reports and lab quizzes based on this work. This collaboration with faculty members ensures continuity of first and second year courses. Their role is analogous to laboratory assistants for other sciences; that is, support for practical skills, as well as theoretical concepts for undergraduate students.

Position	2001-2011
Laboratory Instructor	1
Instructional Assistants	3
TOTAL	4

Figure 24: Instructional Staff Complement...

In addition to their support for labs, instructional staff are involved with the on-campus student help centre, as well as online distance support. Many courses in Computer Science now utilize

the Desire to Learn (D2L) environment used by DELTS, with support from our instructional staff for customization of the D2L environment to meet some of our needs for lab-based and distance courses, as well as interaction with students via D2L discussion pages.

With the withdrawal of computer courses from external programs in Business and Kinesiology, we are experiencing a reduction in the number of lab offerings by two to three lab sections per semester (five per year). Despite this reduction in lab sections, the Department must maintain a strong instructional staff complement in order to accomplish its strategic goals. As the number of majors in our program increases, additional labs with requisite instructional staff presence will be needed. We are also building interest in other units and other disciplines in essential computing knowledge, and at least two new lab sections can be anticipated with these additional offerings. With new course offerings and increased enrolment, more support for the Student Help Centre will also be required.

New offerings will emphasize practical skills, and therefore instructional support will be critical. Furthermore, in a constantly evolving discipline like Computer Science, new courses will require support for new lab content, in addition to the continual update of lab manuals for existing courses. These will further increase our reliance upon our already busy instructional staff.

Since the lab environment has been identified by students as having a positive impact on comprehension of theoretical concepts, experienced instructional staff support is essential for the continued improvement of our first and second year programs.

8.4 Equipment and Computing Resources

The Department's central computer machine room maintains approximately 30 Linux-based servers providing system imaging, file and print service, standard web services and a range of computing applications to faculty as well as students. Server facilities are available to support faculty personal work stations, and a significant number of faculty use the facilities as image servers, file servers, unified printing support and as compute engines. Many faculty members' research computing needs can be supported within this service model. For faculty working on less compute-intensive research domains, modest machine configurations may be sufficient, in some cases housed in faculty offices, so there is not always a need to appeal to shared departmental resources. As needed, undergraduate and graduate teaching lab stations can also be configured as compute clusters when underutilized for teaching purposes. Such clustering has become less popular as the Department has gradually acquired a bank of 32 GPUs that support concurrent programming and high-performance computing, used for simulation and graphics problems. For intensive computing tasks, infrastructure is available on campus through Compute Canada and the ACEnet facilities.

Individual faculty acquisitions include several sets of autonomous robots, mobile computing development platforms, development boards and specialized servers for CAD and embedded application development, compute engines for genomics analysis, and a Mac-based compute cluster for simulation and evolutionary computing.

Specialized hardware development resources have been acquired through CMC (Canadian Microelectronics Corporation) contribution agreements, and minor purchases by the Department to provide hardware prototyping capability exploited for both teaching and research. These include prototyping systems for FPGAs, signal processing, embedded systems and ARM processors which are housed in an appropriate lab space.

There are three senior undergraduate and graduate teaching labs with 45 PC-based machines and 16 Mac computers in the Department. We support 60 machines for our principal undergraduate teaching in a lab outside our unit (Department of Computing and Communications) which our students may access at scheduled lab times.

Due to campus-wide system imaging using the LabNet infrastructure, most supported machines anywhere on campus can be configured to multi-boot different operating systems and run a comprehensive suite of software including programming languages, database systems, animation and video production tools, development environments and site-licensed development tools. Several hundred pieces of software are supported in this manner; we estimate at least 30 different software packages and/or applications have significant use for research and instructional purposes.

Some commercial software cannot be imaged across campus due to licensing restrictions. This includes circuit analysis, chip design, proprietary mathematical and statistical packages, and simulation tools. Much of this software is used by faculty both inside and outside the Department.

In 2010, a significant amount of equipment for undergraduate teaching was purchased through a direct grant from the provincial government to the Faculty of Science. This included mobile devices, GPU clusters, electronic classroom displays, robots, and lab hardware upgrades.

8.5 Budget

The Department's budget development for the past decade is shown in Appendix J. Budget requests are typically presented close to the beginning of the calendar year for the next fiscal year, but the budget allocation is often unknown to the Department until several months into the fiscal year, which can have a detrimental effect on planning.

The salary component of the budget can fluctuate depending on faculty complement and salary adjustments. The bulk of our operating costs go to student assistant salaries and materials and supplies. Materials are used to cover ongoing maintenance and upgrades to computing lab equipment, which are not considered capital expenditure. Computer work stations in our labs are nominally projected for a three to five year refresh cycle, but this cannot always be supported by our budget allocation.

It is often challenging to provide maintenance or upgrades to the existing infrastructure, as they are sometimes disallowed as inappropriate in an operating budget. Capital expenditures needed to maintain and reconfigure lab space, or upgrade equipment are often denied as "new initiatives" requiring a competition with other proposals, simply to maintain the academic mandate of the unit.

8.6 Space

The Computer Science department core space allocation consists of 59 rooms [15,521.87 sq. ft.] on two floors of the west wing of the S.J. Carew building.

The Computer Science department was originally located in the Chemistry-Physics building, moved in the late 70's to temporary buildings, and relocated in the 1995 (when those temporary buildings were demolished) to space outside the Faculty of Science in the Engineering Building (the S.J. Carew building). Growth of the Department needs and facilities meant finding alternatives which have not been available in the S.J. Carew building, leading to some of the faculty and students being housed in the Alexander Murray (Earth Sciences) building.

There are 23 rooms on the first level of the S.J. Carew Building assigned to Computer Science. These rooms comprise staff offices, graduate student offices, two faculty offices, computer server and storage rooms, one teaching lab, a graduate student lounge, and a research lab. Of 36 rooms available to us on the second level of the S.J. Carew Building, there are the majority of faculty offices (18), staff offices and the general office for the Department, storage, printing room, departmental lounge, seminar room, one extra meeting room, an open undergraduate student lab, and seven faculty research labs.

While nominally space allocation is the responsibility of senior administration, in practice Faculties, Schools and Units have tacit operating and planning authority over specific buildings they occupy. As a result, being housed in a building over which a different faculty asserts control has been problematic. Over the years, we have managed to gain significant input into the configuration of three classrooms near our core space in the Engineering building, and can effectively co-operate with the Faculty of Engineering on planning within these limited classroom spaces. The main teaching lab for introductory courses is across campus in a space in which Computer Science does not even have control of access but for which we have financed computing equipment and software upgrades. As a general computing lab which is managed through another unit (Computing and Communications), this is only available for structured labs at scheduled laboratory times.

It is difficult to obtain additional or flex space. As a result, six faculty members and eight to ten of our graduate students have been housed outside the main unit in space "borrowed" from the Earth Sciences unit in the Alexander Murray Building. As well, the undergraduate students have no club/study room and for many years have been guests in the Earth Sciences student club room, controlled by the Earth Sciences students. In short, a large segment of our faculty, graduate students and the undergraduate student body are physically distanced or disenfranchised from the bulk of the Department's core space. This has a poor effect on the quality and amount of interaction and synergy among members of our unit.

In addition, six laboratories in our main space have been largely given over to seating of graduate students. While some research programs in Computer Science are well served by personal work stations for graduate students, there are others that require specific laboratory space and specialized equipment that have not been well served by cannibalizing laboratory space for graduate student seating. Outstanding requests exist for robotics and games development

laboratories, for example, which have not yet been resolved. Others have been forced to double or triple-up and share lab space, with obvious impact on their research presence and capabilities.

Over the years, a number of proposals for resolution to a “permanent home” for the Computer Science department have been put forward, and some time ago this was among the top ten priorities in the University’s planning documents. However, there has been no specific endorsement of this project as an institutional priority for several years, and the latest express proposal was in 2008.

Computer Science is a dynamic discipline with a rapid innovation cycle. Housing such a discipline in temporary space for 35 years is unexplainable; it has a negative impact not only on how students view the Department but also on our self-image.

9 Efficiency Analysis

9.1 Efficiency Snapshot

The following chart is based on most recently released CIAP data for the year 2009-2010 which summarizes the challenges facing our Department:

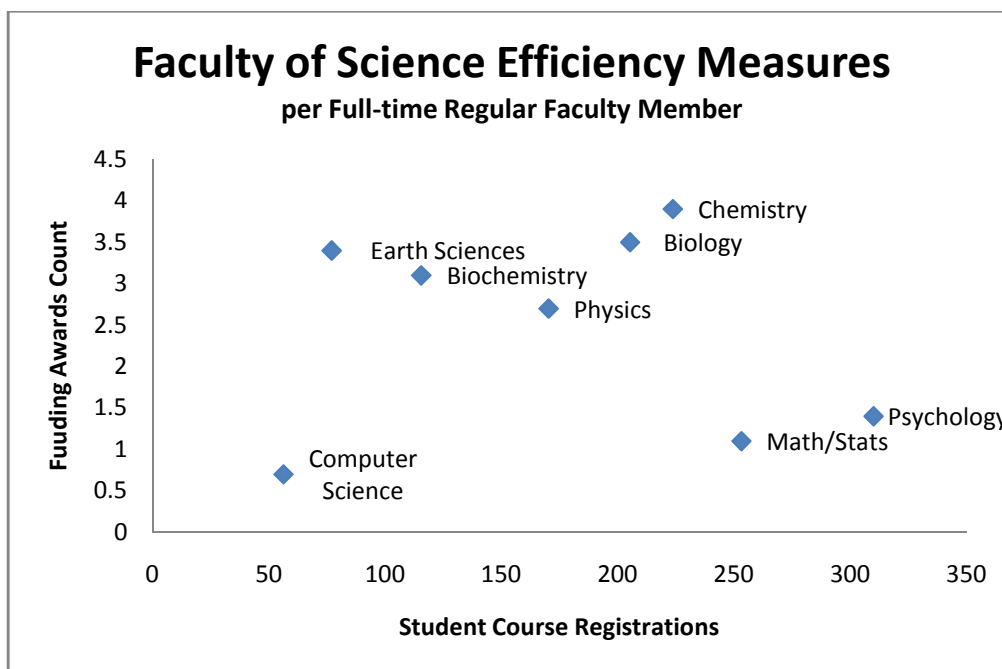


Figure 25: Comparison of Grants and Student Registration per Full-time Regular Faculty Member.

This 2009-2010 Faculty of Science snapshot compares efficiency measures of Computer Science faculty to that of other units within the Faculty of Science.

The number of students per faculty is the lowest in the Faculty of Science. Our teaching capacity utilization has been affected by other units dropping computing courses from their program requirements, providing an opportunity to recruit additional students and develop new programming which we need to exploit.

The other dimension of this graph shows grants won per faculty member. This also shows us in the lowest position of the Faculty of Science. The challenge here is to invest effort in grant and funding opportunities. We need to change a profile in which too few of our faculty in the Department bring in the majority of grants.

The trajectory of the Department since the last APR is depicted in Figure 26 and Figure 27, showing the trends from 2001 to 2011. Incorporating departmental data sources, these figures also include progress since the 2009-2010 snapshot.

9.2 Funding Development

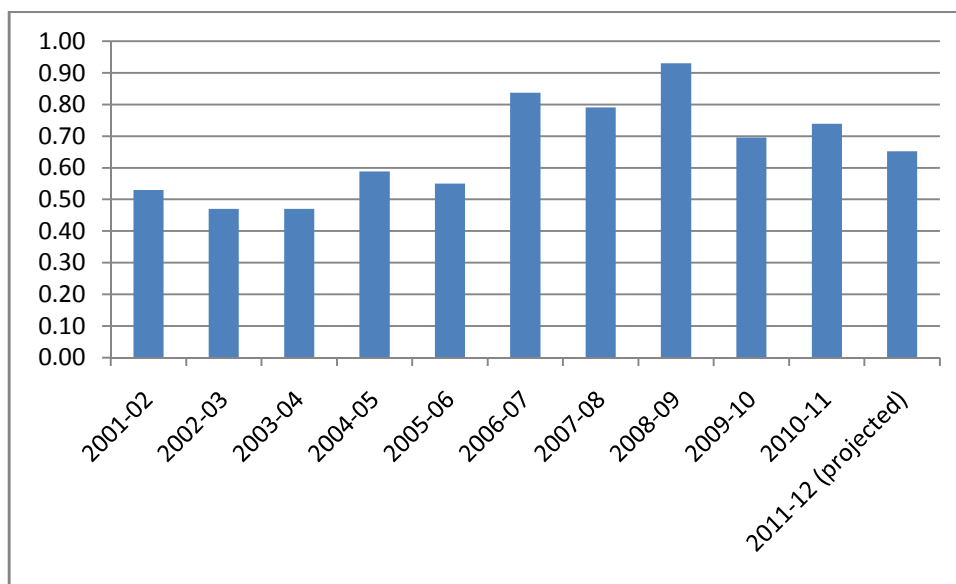


Figure 26: Number of Internally Administered Grants Held per Faculty (as Principal Investigator).

The number of grants shows an upward trend over the reporting period, though recently some weakness has appeared. Absolute dollar amounts of grants administered within Computer Science (see Figure 27) show a stronger positive trend, with total amounts double what they were in 2001-2002.

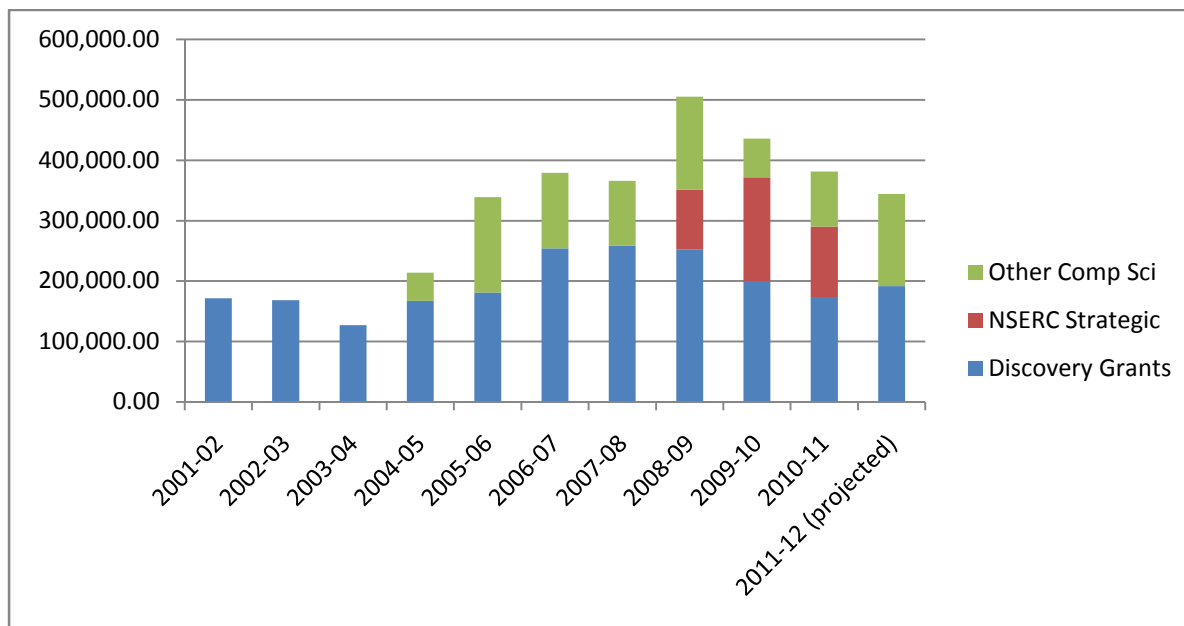


Figure 27: Total Value of Awards Administered in Computer Science.

New faculty members have a clear positive influence on the number and value of research grants during this period. To make this point even clearer, the number and value of grants for faculty hired after the last APR (2002) are shown in Figures 28 and 29.

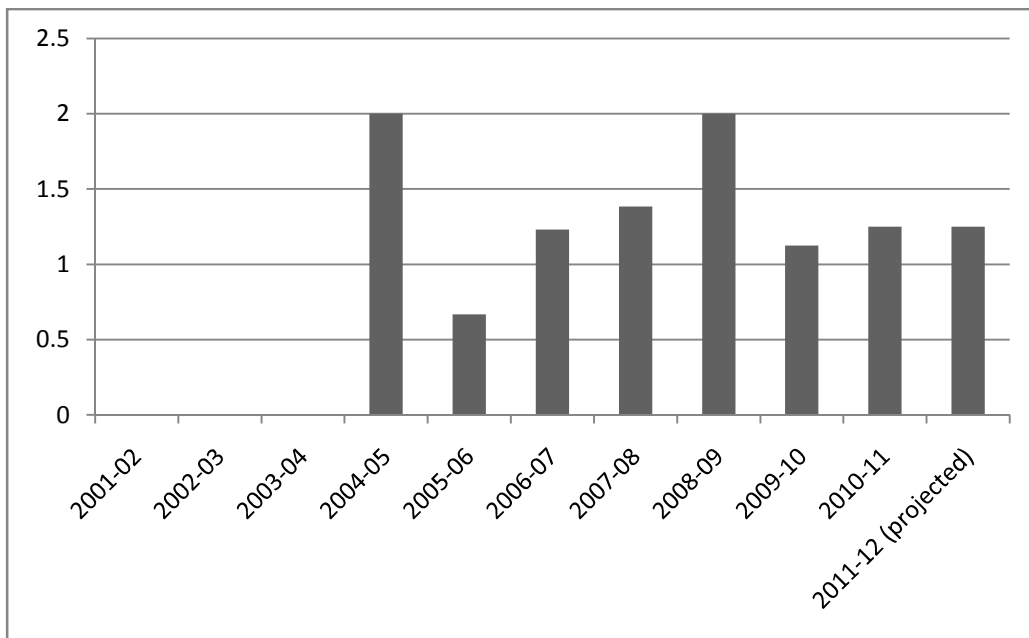


Figure 28: Number of Grants per Faculty Member for Recently-hired (2001-2009) Faculty.

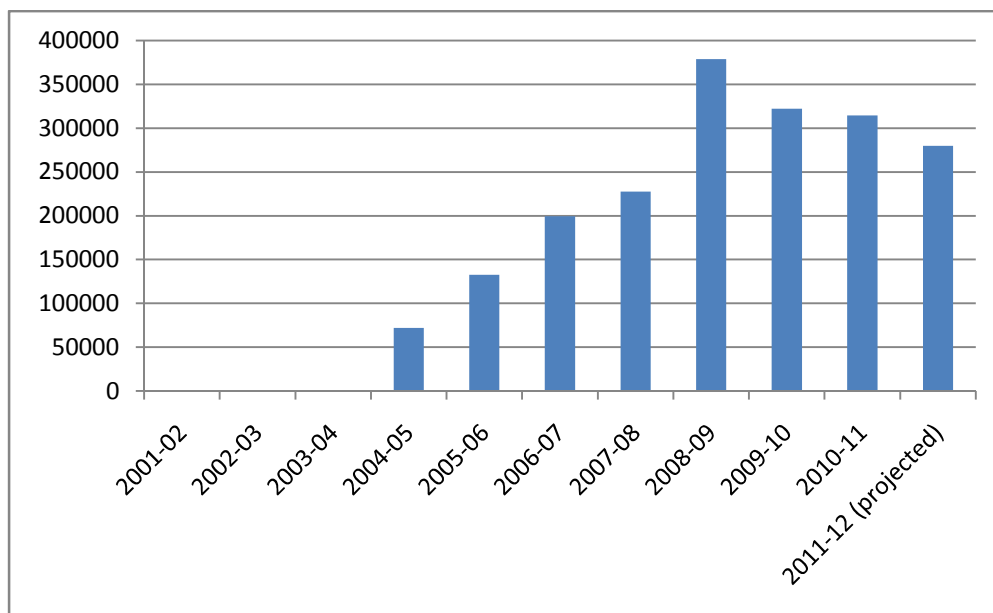
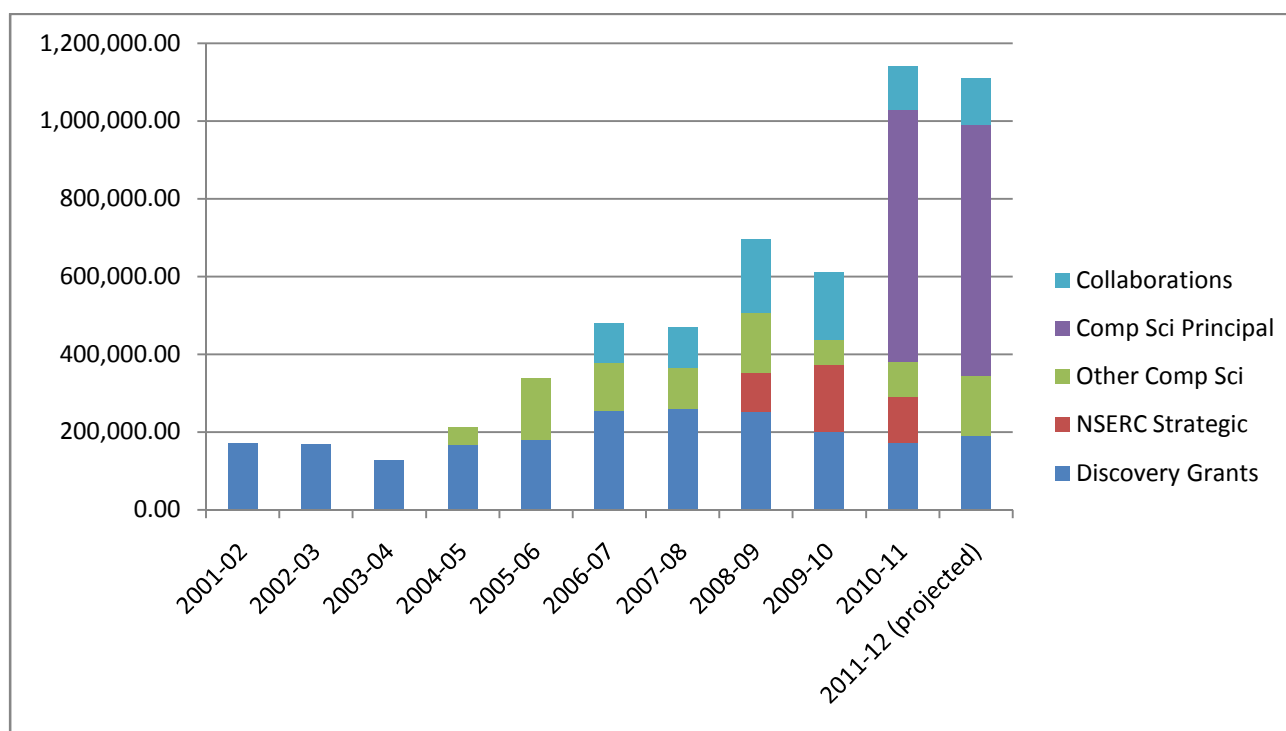


Figure 29: Grant Monies Administered in Computer Science for Recently-hired (2001-2009) Faculty.

New faculty hires have been clearly beneficial to the Department's profile and moving in the right direction with respect to funding. We conclude that:

1. The Department was very successful in hiring research-active faculty members.
2. Continued faculty renewal replenishes the energy dedicated to research and increases research activity.
3. The challenges depicted in our 2009-2010 snapshot will not be addressed by a hiatus in faculty renewal for Computer Science. Our trajectory of increasing research dollars and number of grants per faculty member needs support from the administration.
4. A goal of two grants per faculty member is achievable. Individual faculty have reached that level.



Notes:

- (1) This chart recapitulates tabulated data shown in Figure 7, page 20.
- (2) "Collaborations" include partial data re awards with Computer Science faculty members as significant co-investigators. These funds would also be reported by the home department of the principal investigator.
- (3) The "Comp Sci Principal" category indicates awards to a Computer Science principal investigator, but administered by another unit. These funds would not be reported by another department.

Figure 30: Grant Participation by Computer Science Faculty

Increased participation in small to medium awards in itself will not make the Department competitive in terms of external support. The effect of recent success in large external awards administered outside Computer Science can be seen in Figure 30, which is not included in the 2009-2010 “snapshot” of the Department. This success needs to be replicated and expanded to more than the current handful of Computer Science faculty now involved in such grants. To encourage this, our strategic planning over the next two to three years must include research group development, defining strategic research focus areas, and a structured approach to identifying significant grant opportunities. A proposed Research Centre would also play a role in this regard (see Section 10.3).

9.3 Student Enrolment Development

Our second challenge presented in Figure 25 reflects a concern common to Computer Science departments in North America: low enrolment numbers. Again, the low number of student registrations per faculty member is a snapshot from a particular year, and we need to examine trends. Figure 31 below shows the development of student numbers over the last decade.

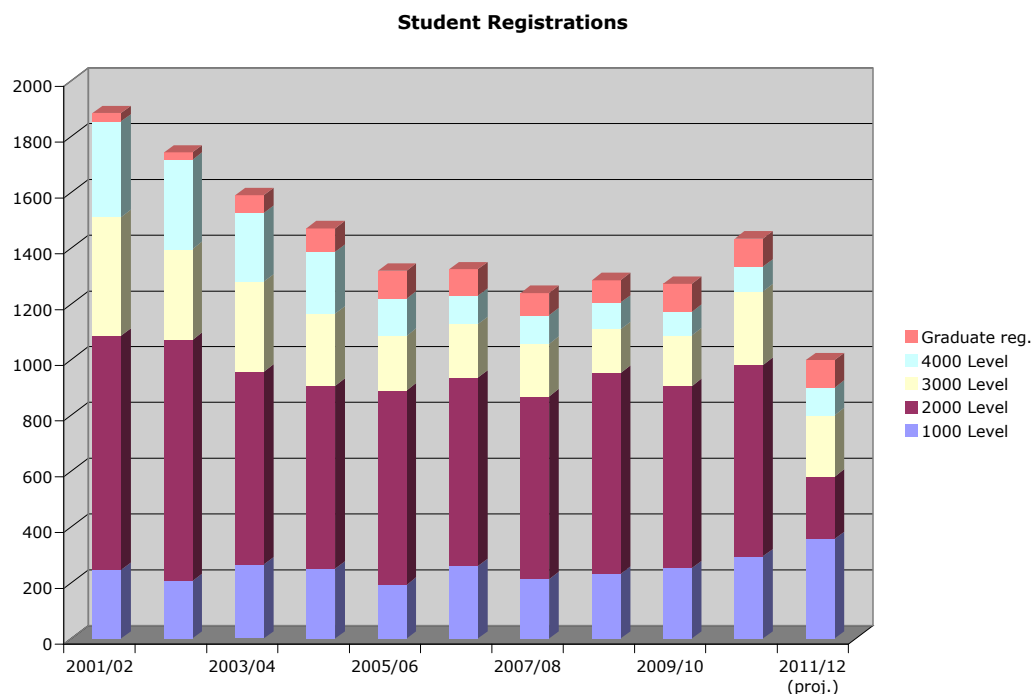


Figure 31: Student Enrolment in Computer Science Courses.

Echoing the North American trend, the number of registrations dropped over a number of years after the Y2K bubble burst. Numbers consolidated around the year 2005, and started to increase again. Increases in the number of declared majors (Figure 18) and registration in our entry-level courses for our undergraduate core program are on the upswing in 2011. These are positive signs that reflect reports of return of demand for Computer Science programs from other institutions.

In the meantime, there has been a collapse in our year 2 numbers, due to required courses removed from programs administered by the Faculty of Business Administration and the School of Human Kinetics and Recreation. These challenges can be faced positively by focus on growing enrolment in our major programs (already reflected in our year 1 increases) and investigating possible new programs, such as the now vacated Information Systems area.

Graduate student enrolment increased in the early years of the decade, and we anticipate an increase with our new course-based program (MSc).

Similar trends are apparent in class sizes and number of course sections offered. Figure 32 and Figure 33 show the number of course sections and average size (in terms of registrations) of sections over the same period.

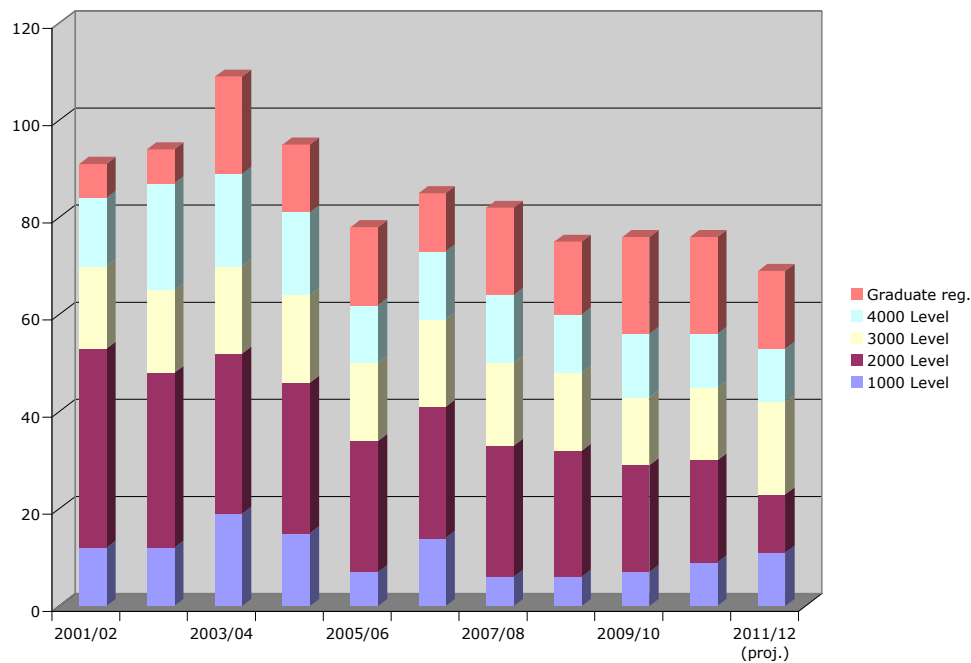


Figure 32: Number of Sections Offered in Computer Science Courses.

The number of sections has declined from around 90 at the beginning of the report period to around 75 at the end, with a further decline projected for the current academic year. Second year sections have diminished over the years, while the number of first-year sections reached a minimum in 2007-2008 and has started to grow again. Sections in the graduate program reflect the growth of that program.

Figure 33 shows, in a 3D projection, the number of registrations per course section over the decade.

Again, second-year courses are in decline while first-year courses are showing signs of improved program intake. Our first-year courses have increased substantially in efficiency over the last decade, whereas efficiency in second year courses is thwarted by the elimination of external program requirements. Third and fourth year courses reflect enrolment losses over the decade, with the increases in first year intake not yet advancing to third and fourth year courses. Our

graduate course offerings show a moderate increase in terms of number of registration per section, reflecting growth of that program.

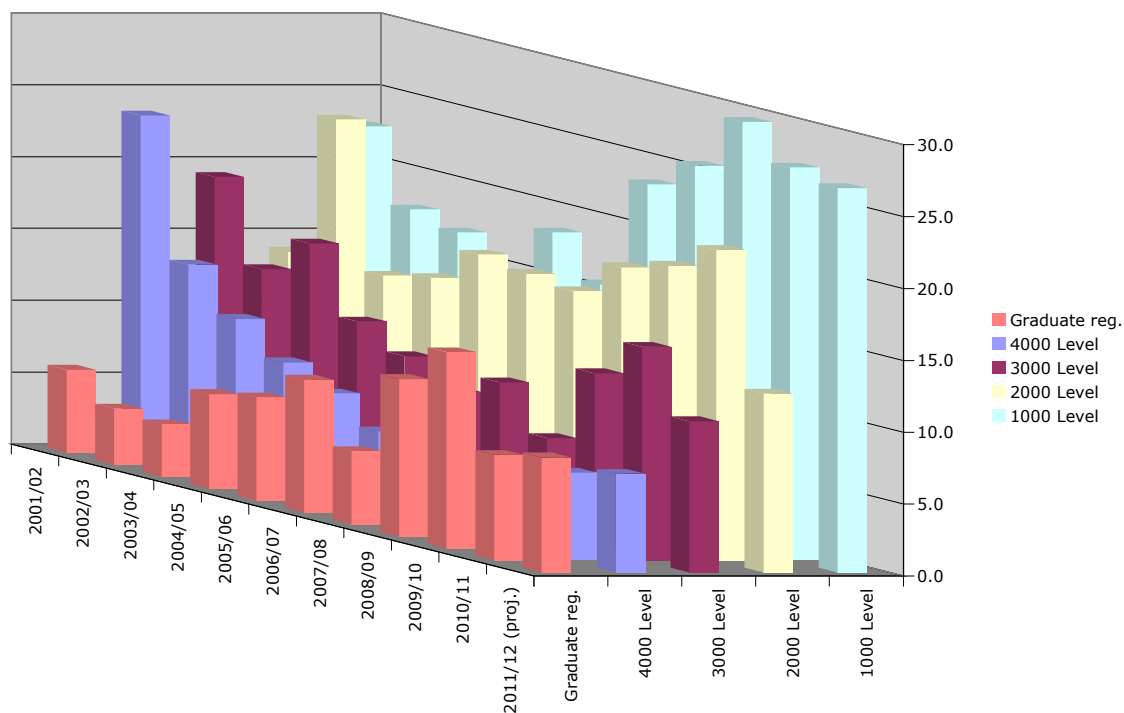


Figure 33: Student Enrolment in Computer Science Courses by Year and Student Level.

9.4 Comparison with External Institutions

Student/faculty ratios are already discussed as declining over the past several years and tending to recover, a trend common to programs throughout the Country. At Dalhousie University, a significant investment has been made in their computing programs since 2002, with the development of a Faculty of Computer Science, program endowments in excess of six million dollars, and new building opened in 2007 to house all their faculty, students, and modern lab facilities. With these extra resources and institutional commitment, their numbers are better than our own, showing 27 graduates and 248 majors in the undergraduate Computer Science program in 2010-2011, compared to our own count of 107 declared majors (with roughly an additional 45 undeclared) and 14 in the graduating cohort. Dalhousie has 29 faculty compared to our 24, and their research funding is estimated at 2.6 million in 2010-2011, a number we are closing on with dramatic increases in external funding this year.

Due to the faculty structure, Dalhousie also offers a number of additional undergraduate and graduate programs in its Faculty of Computer Science, including Medical Informatics, e-Commerce, IT Bachelors, Computational Biology and Bioinformatics. These programs bring its total enrolments in the Faculty of Computer Science (including graduate students) up to 511 and its graduating cohort up to 89. Comparable programs at Memorial appear in different units,

sometimes with (but often without) collaboration between units. Co-operation at Memorial is discouraged by the accounting of enrolments and other performance indicators ascribed to the unit that “owns” the programs or courses.

Downturn and rebound in Computer Science enrolments were less pronounced in the Western provinces, with increasing enrolment trends beginning about two years ago. For example, the University of Manitoba’s Department of Computer Science is slightly larger than Memorial, with 30 faculty, six of which are teaching-only appointments, and 8.5 support staff consisting of four technical staff, three office staff, and 1.5 co-op program staff. Manitoba has six specialization areas in their Computer Science program. Their undergraduate enrolment has already recovered substantially, with 310 majors in the 2010-2011 year. They report 19 current NSERC Discovery Grants, worth 320,000 in funding.

Our unit has some ways to go to meet comparable ratios for faculty/enrolment numbers. Support for our plans to develop collaborative programs and specializations or streams in our major programs, appropriate faculty renewal, and resolving our space allocation problems would allow us to reach appropriate efficiency ratios.

9.5 Load and Faculty/Student Ratios

The teaching norm for Computer Science faculty is four one-semester courses each year, where a course entails a three-hour lecture period each week. A course equivalency formula is adopted by each unit, which provides credit for activities such as supervision of graduate students, development of new course curricula and course lab supervision. Teaching load may be increased for faculty members who are not actively conducting research. Sabbatical leaves are at seven-year intervals, so expectation with our current complement is that four faculty members may be on leave in any given year.

9.6 Cost Ratios

Low enrolment and the effects of aging faculty complement will, of course, affect cost ratios as well. On the basis of the CIAP data (Appendix K), the Department trails the Faculty of Science on most of the cost ratio factors. However, factoring out the cost of salaries, based only on the operating budget of the Department (just over \$100,000 per year), a different picture emerges. Using this comparison, Computer Science is less expensive for the number of majors and registrations than the traditional bench sciences (as expected, having less lab consumables) and somewhat more expensive than Science departments without specialized teaching equipment (as expected, having computing lab equipment). In other words, the budgetary ratio for operating expenses is not unreasonable for the unit.

Our operating budget is tight, sometimes requiring us to defer equipment and software updates. This can be mitigated to some degree by planning ahead several budget cycles and making requests well in advance of needs. There is little room for special activities for research and student events. Our travel budget has allowed invitation of speakers in some years, but not in others depending on how travel costs accrue. There is always the possibility of special appeal

for funding such activities through administrative channels but that does not always provide planning opportunities.

Given our space and faculty complement, the Department's computing resources and technical staff are well utilized, especially considering the number of outside units and amount of cross-campus infrastructure supported by the technical staff through LabNet.

9.7 Gender Imbalance

The gender imbalance in Computer Science is pervasive in Canada, with fewer than 30% of students enrolled being female. This imbalance is not seen in other disciplines to such a great extent, and is quite striking given that female students make up over 50% of the student population in many universities across the country. At Memorial, the Computer Science Department has a similar demographic of very few female students at both the undergraduate and graduate level.

There are many reasons female students are not choosing Computer Science, but it is hoped that the current state of our Department can eliminate any barriers that may be preventing interested female students from enrolling in our programs. For example, four out of nine recent faculty hires have been female, for a total of six out of twenty-seven, while the female to male ratio for our instructional and technical staff is 2:2 and 2:4 respectively. The presence of female role models will hopefully attract some students to the discipline. Furthermore, the female undergraduates that are currently in our program are quite active, participating in the student society and programming competitions. Their success may help to make Computer Science an appealing option for other female students.

It is generally the case that many students are drawn to a given discipline by their own interests, and in the case of female students, social or life sciences are often the choice. However, there may be many instances where students are not aware of what Computer Science is or that it is something that they would like to do as a career. It is mainly for these cases that we would like to ensure that our programs are well advertised. There are many recruitment strategies that may help in this regard, for example, targeting pools of students that contain a higher proportion of females (such as Arts or Life Sciences). As a start, a new course being offered for the first time in Winter 2012 has been designed for students in the Faculty of Arts. Placing more emphasis on joint degrees may also increase female enrolment.

A recent search for a joint faculty position in Computer Science and Biology resulted in the hiring of a female Bioinformatician. Consequent joint course offerings and interdisciplinary research between these two units may help to improve the visibility of our programs to life science students. Becoming more active in programs targeting female students, such as supplements to the NSERC Undergraduate Student Research Awards would be useful. Although the number of female students interested in Computer Science may be limited, improving our recruitment strategies in this area can help with our enrolment.

9.8 Institutional Constraints

From the perspective of University resourcing, the primary physical resource problem is space. The ability to project a welcoming presence for research and academics, and a coherent identity, is compromised without contiguous space sufficient for our programming and research needs. Ideally, this should be in a building under the control of our own administrative reporting hierarchy, so that even if contiguous space is not available, at least our colleagues and students will have a sense of place on campus, rather than the constant feeling that we are someone else's guests. In turn, the Department can create a physical presence that projects our identity. Specialization, innovation, and development can all be advanced with visible academic activity, and means for students and colleagues to participate in this activity.

A problem for the unit is the lack of clear institutional support regarding the value of our participation in the University community. Our belief in computing competencies as a benefit to all students is clearly something we need to advocate ourselves. However, we face some administrative barriers at Memorial. For example, the administrative funding formula that ties funds to enrolment is discouraging co-operation in academic programming, and encouraging competition for student enrolment. In recent years, we have been contributing both instructors and students disproportionately to Engineering courses, which is good for rationalizing resources and eliminating program overlap, but hurts the numbers used by administration to assess the Department performance. It is not surprising under this system that units directly affected by this assessment mechanism tend to eliminate computing courses or offer their own computing curriculum content; while groups currently collaborating on program and course offerings are those not directly affected by enrolment-based funding policies (departments and/or groups below the faculty level).

Computing infrastructure is another area in which institutional support is needed; clearly we believe the innovative work done in the LabNet infrastructure provides both specific and general academic value at the University, but planning and resourcing of this infrastructure remains ad-hoc; we need to establish some sense of whether and how this activity is valued.

10 Planning for the Future

The culmination of our self-study is our current plans, which we offer for critical feedback. Informed by the issues identified by our self-study, our current initiatives and the University's strategic plan, it summarizes the potential contribution of our unit to the institution and the wider community. The three central parts of the plan are:

1. Addressing our challenges
2. Strategic renewal
3. Establishing a computing research centre

10.1 Our Challenges

Enrolment and research activity/funding have been identified as our core challenges, and are also key elements of the University's strategic plan. We plan to respond to these challenges as follows:

1. Visibility and community
 - We will build on our new open house and school outreach activities, and promote our increased program accessibility, flexibility and new choices to the student population at large.
 - Undergraduate distance courses and online materials will continue to be developed as options to improve accessibility to our programs and courses.
 - Support for programming competitions will be increased. A province-wide school competition will be developed for which resources will be sought.
 - Alumni event planning will be initiated.
 - We will continue to expand our formal and informal ("brown bag" lunch) seminar activities.
 - An industry liaison committee will be struck to advise and inform the Department regarding student career skills and research connections.
 - We will aim to bring a major Computer Science conference to St. John's every five years.
2. Program development
 - The Department will constantly update its course offerings by revising curriculum to reflect advances in computing and its broad applicability to other disciplines, appropriate to both majors and general students. On a higher level, we see a benefit for each student of the University to take a course in Computing.

- Our current initiative for an outcomes-based analysis of our curriculum and instruction (on both knowledge and skills) will lead to a full curriculum review. The review will examine the possibility of specialization through a mechanism such as program streams, and focus on improving the overall student experience.
 - We will increase tutorials and workshops available for practical skills development.
 - We will address gender imbalance in our programs.
 - We will develop improved tracking mechanisms for undergraduate programs—as is already being created for our graduate programs—including retention tracking and gauging the success of our new flexible approach to Computer Science minors.
 - We will increasingly fast-track students into the PhD program where appropriate.
 - We will seek appropriate resourcing for our work placement programs (Internship and Co-op) as a means of improved experience and financial support for our students.
3. Research and funding
- We will set a target of two grants and four graduate students per full-time tenured faculty member.
 - We will advocate increased collaboration with other units, including a computing research centre to engender interdisciplinary research and course offerings, and to supply expertise to the larger research community. Generally enhancing the research environment of Memorial, increased collaboration and partnering will be its primary objectives.
 - Our research planning committee will examine what role particular characteristics of the province should have in our research strategy as a Department, including aspects of geographic location and the significant funding opportunities in the Oil and Gas sector.

10.2 Strategic Renewal

Renewal of faculty has contributed to improved numbers in terms of grants and funding and supervision. However, if all eligible faculty retired, the Department would lose a third of its membership; and still face retention concerns with younger faculty. In more than one case in our Department, a spousal hire was a possibility, but never materialized.

Over the next few years, faculty replacement will continue to be an ongoing concern, so the Department needs to identify its renewal objectives. A strategic planning committee will be struck, preparing a three to five year plan for faculty renewal, and connecting to the Faculty of Science new strategic plan.

We believe that an important aspect of addressing our challenges is the promotion of a number of active research groups. This would improve our visibility, research, supervision of graduate students, and collaboration with industry. Increased visible activity in growth areas should also attract more undergraduate students. Therefore we want to hire new faculty with expertise in selected areas of focus. We must seek external funding for hiring purposes, such as the NSERC Industrial Chairs program.

The University's Research Plan was developed throughout 2010-2011. Part of the process involved units' self-identification of disciplinary research strengths and areas for future development. Computer Science identified *Algorithms and Complexity*, *Modelling and Analysis of Concurrent Systems*, and *Database Systems* as current strengths, and *Computer Imaging and Visualization*, *Bioinformatics/Medical Informatics*, *Mobile Networks* and *Scientific Computing* as areas of growth and potential for our unit.

10.3 A Computing Research Centre

At many Canadian and American universities, a School or Faculty of Computing incorporates the discipline of Computer Science. At Memorial, disparate units have various programs and research activities in the arena of computing, sometimes in a competitive posture. We believe that Memorial University should promote interdisciplinary collaboration between units which are directly involved with and/or benefit from computing. Computer Science is prepared to take the lead in promoting collaboration.

The approach will be to expand the nucleus of existing interdisciplinary research groups into a comprehensive Research Centre anchored in Computer Science. Some of the relevant extant activities we can recite are:

- In the area of software services, faculty members and students from Computer Science, Engineering, and Business Administration are conducting joint research.
- In information visualization, an interdisciplinary group of four faculty, five graduate students and two postdocs (Computer Science, Geography, Fisheries at the Marine Institute) has funding for visualizing fisheries data.
- In speech recognition, Computer Science and Linguistics faculty members are party to a NIH grant.
- The science of Complex Systems incorporates research on network analysis and emergent phenomena relevant to ten faculty members of Computer Science with connections to the Life Sciences, Mathematics and the Arts.
- The Master's program in Computational Science recruits graduate students with an applied computational research focus in a Science discipline.
- A Health Informatics group with participation between Computer Science and the e-Health unit in Community Medicine has been active for almost five years, with joint research activity and a one-time graduate course offering.
- A recently created Computer Science theory "reading group" has been attracting participants from other disciplines.

- A joint lab for Bioinformatics and Bio-inspired Computing was recently established.

This is a short list; a complete accounting would include many more items reflecting recent and ongoing collaboration with additional academic units. Initially the Research Centre will identify faculty in allied disciplines (Sciences, Engineering, Business, Medicine, Arts, Education and so on) that have relevant computing interests. The Centre will engage in major strategic grant initiatives and provide expertise and skills to interested parties inside and outside our University, increasing research engagement and productivity. The Centre will organize workshops, maintain online discussion forums and market our research groups and programs to the international community. Starting as a “virtual” organization, eventually the Centre might grow to have an administrative identity and staffing.

We believe that the Centre can play a crucial role in identifying areas and strategies for faculty recruitment in the field of computing for the academic units. Joint recruitment and supervision of graduate students should be an integral part of the Centre's mandate. It will also facilitate offerings and cross-listings of courses and development of joint programs between the cooperating units. This shall increase the cohesiveness of the varied curricula related to computing and provide better resource utilization.

10.4 Support Requested

In order for our plans to see fruition, we need explicit support from the University administration. This includes:

- Support and resources for a Computing Research Centre.
- The Computer Science department must move into up-to-date, adequate, contiguous space within five years. The diaspora of faculty and students from our core space impedes our ability to create a sense of community and presence on campus. We are one of few units at Memorial University whose space is under control of other faculties. This lack of cohesion impedes our ability to plan the research and academic activity critical to our function as an academic unit. This issue has existed since the inception of the Department, with continuous promise that a solution would be found in the near future. This has not happened. The majority of Computer Science departments in Canada have been provided, over the last decade, with new, modern space, as a result of strategic investment initiatives. We have not.
- Recognition of the computing infrastructure support and resources contributed to the community by Computer Science, including informed discussion of the opportunities for innovation and strategic planning for cross-campus needs, such as e-learning and cloud computing. Continuing to rely on Computer Science for supporting campus wide infrastructure without adequate support, recognition or representation in the University's planning and governance of technology infrastructure is not viable. We need to know if our technology innovation and the opportunities it affords are valued and will be supported, or whether our efforts and resources should be placed elsewhere.

- We suggest requiring a course in computing for every student at Memorial. Superficial understanding of technology that will influence most of their work life is inadequate education for Memorial students. The rationale that students have sufficient cultural exposure to technology is not tenable in the face of multiple units in the University continuing to recruit faculty and develop curricula with a computing component.
- Increased staffing of our internship and course-based graduate programs is needed so that students, the unit and the University can benefit from connections with local and national industry. For additional work on internship placements, and with significant increases expected for our co-op MSc program, a minimum ½ full-time employee is needed for this effort.

These plans are subject to advice from the Review Panel, and University administration, and the final formulation of a planning document at the culmination of the review process. We look forward to discussing these items in detail.

11 List of Appendices

Appendix A: 2002 APR Recommendations

Appendix B: Faculty of Science Strategic Plan

Appendix C: University Strategic Plan

Appendix D: Faculty CVs

Appendix E: Graduate Program Regulations and Courses

Appendix F: Graduate Student Feedback

Appendix G: Undergraduate Student Enrolment

Appendix H: Course Outlines of Last Three Years

Appendix I: CIAP Exit Survey of Undergraduate Students

Appendix J: Budget Development

Appendix K: CIAP Data

Appendix L: Library Report