FACULTY OF ENGINEERING AND APPLIED SCIENCE

MEMORIAL UNIVERSITY OF NEWFOUNDLAND

ACADEMIC PROGRAM REVIEW

SELF-STUDY

APRIL 2003

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Introduction

The Academic Program Review for the Faculty of Engineering and Applied Science, hereafter referred to as the Faculty, was launched by the Vice-President (Academic), Dr. Evan Simpson during a visit to the Faculty on February 13, 2002. During the meeting, Dr. Simpson provided information on the following:[1]

- An overview of the academic review process
- The purpose of the review process for the Faculty
- The composition of the review panel
- The purpose of conducting the self-study
- The documentation needed to prepare for the review
- Organization and responsibilities related to the review process

The review process for the Faculty started with a steering committee of the Faculty (consisting of the Dean, Associate Deans and Discipline Chairs) establishing the approach for the review. Under the coordination of the Associate Dean (Undergraduate), the committee determined that the disciplines would consider the review questions and produce reports, which will be combined into the Faculty self-study report. In addition, four meetings were scheduled for general Faculty discussions on: the general academic review, co-operative education, administrative structure, summary of discussions, and review of the draft report[2]. Under this approach, it was expected to submit a final Self-study report in August 2002.

As a result of changes at the Faculty administrative level in August 2002, a revised approach was initiated by the new management group of the Faculty (consisting of the Interim Dean, Associate Deans, Discipline Chairs and the Manager of the Co-op program) with the Associate Dean (Undergraduate) as the coordinator of the review process. The objective of the new approach was to engage faculty, staff and students in the review process, and it was determined that the objective would be realized through working committees. Consequently, nine working committees[3] were formed to address the questions[4] and examine the issues related to the major components of the review. Each committee consisted of faculty members, administrative and/or technical staff, and students. In recognition of the different needs, objectives, and concerns of each discipline, it was agreed by the management group that each discipline would provide a brief self-assessment report to be included in the Faculty Self-study report.

In November 2002, the working committees submitted draft reports, which were discussed in an open forum at a Faculty retreat on November 12, 2002[5]. The final report of the working committees was expected to be submitted before the end of 2002.

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[1] A copy of the document, “Procedure for the Review of Units and Programs,” which outlines the process, objectives, organization and guidelines for the review is included in Appendix A.
[2] The records of the Faculty meetings on the first three topics are given in Section 4.
[3] The membership of the working committees is given in Appendix B.
[4] The questions proposed in the “Procedures for the Review of Units and Programs” were slightly revised, and they formed the basis for the examination of the issues in the review by the working committees.
[5] The agenda and summary of the discussions at the retreat are given in Appendix B.

However, the timeline proved to be impractical, as more time was needed to collect additional information and conduct surveys. The final Self-study report was delayed by about three months from its intended submission date, partly for the above reason, but mainly because of distractions and underestimation of the work involved.

The self-assessment reports of the disciplines are given in Section 2 and the final reports of the working committees are contained in Section 3 of this report. No attempt has been made to edit the reports of the committees and the disciplines, except to ensure uniform formats for the texts. An overview section, which precedes the reports of the committees and disciplines, provides a summary of the central issues investigated by the committees. The overview section does not include the discussions and recommendations from the various discipline reports. A set of recommendations at the end of each section in the overview highlights actions that must be undertaken by the Faculty. At a Faculty Council meeting to discuss the final report, a number of minor changes were made to the recommendations proposed by the various working committees. The changes were aimed at providing recommendations that would allow subsequent groups or committees to address the issues raised from broad perspectives. The recommendations are collected in a list given at the end of the overview section.

Finally, it should be pointed out that the report is the result of the efforts of all participants (academic staff members, administrative staff, technical staff, co-op coordinators and students) in the APR process. The bulk of the report deals with statistics and information collected, discussed and interpreted by the working committees and the Research Advisory Committee from various sources. As such, it is possible that there may be contradictory statements in the various working group reports. There was no attempt to harmonize the information presented in the reports.

1.1 Strategic Objectives

It is reasonable to assume that as an academic unit, formal statements of strategic objectives would guide the development and management of the Faculty of Engineering and Applied Science. Although a formal set of strategic objectives does not exist, the Faculty has been proceeding in its growth by unwritten objectives expressed through primarily accreditation reports and Faculty discussions. To a large extent, actions taken by the Faculty in areas such as curriculum development, staffing complement and external pursuits have been determined by the need to provide an engineering education that meets the challenges in the provincial economic growth. For example, in the early eighties, the Faculty increased its enrolment in academic term 1 to 180 students in response to industrial demands and growing interest in engineering education in the province. Since then the Faculty has made many modifications to the programs it offers and has significantly increased its enrolment without clearly written objectives. As demonstrated throughout the report, the absence of formal statements of strategic objectives has not prevented the Faculty from meeting expressed and implicit expectations as the only engineering academic unit in the province. It is fair to say that the development of the Faculty has been guided mainly by a sense of professional obligation and collective commitment rather than by a set of formal objectives. Nevertheless, the Faculty needs to develop a set of objectives that would form the basis for determining its academic, administration and professional directions.

The Faculty began offering engineering degrees at both the undergraduate and graduate levels in 1969. In 1974 it produced its first 73 graduates, and in a span of twenty-six years, 2397 engineers had graduated. In the first nine years, the Faculty offered three cooperative engineering education programs – Civil, Mechanical and Electrical Engineering, and in 1979 the Shipbuilding program was established to meet the need of creating an identity with the environment. Shipbuilding Engineering was later changed to Naval Architectural Engineering, and as recently as 1997, was renamed Ocean and Naval Architectural Engineering. The latter change was partly in response to the need to broaden the scope of the program to include the design of offshore structures vis-à-vis the growing offshore industry in the province. In the process, the Ocean and Naval Architectural Engineering program has evolved into a unique and highly rated program.

With the appointment of a new Dean in 1993, the Faculty undertook a number of curriculum initiatives to “modernize” the programs. The co-operative engineering education programs in Civil, Electrical and Mechanical Engineering underwent modifications, first with the introduction of options in each of the programs. In the Civil program, construction and structures, and environmental and municipal options were introduced in 1994, while options in manufacturing and design were introduced in the Mechanical Engineering program in 1997. The options in the two programs were discontinued in 2001. In 1995 an option in computer and communications was introduced into the Electrical Engineering program. This option evolved into a new program in Computer Engineering in 2001. The removal of all options in the programs, paved the way for the introduction of the oil and gas option in all the programs in response to the need to produce graduates for the growing activities in the offshore oil and gas industry. The Faculty is currently developing a degree program in Process Engineering in response to the growth in the resource-based industries in the province. This unique program integrates the essential knowledge in chemical engineering, mining and metallurgical engineering, and petroleum engineering.

Curriculum changes and modifications to the programs have been guided by the requirements of the Canadian Engineering Accreditation Board[6]. The undergraduate engineering programs at Memorial are regularly reviewed for accreditation purposes, and all the five engineering programs offered by the Faculty have received accreditation.

Implicit in the various changes or modifications in the programs over the years, was an underlying objective of achieving high quality cooperative engineering programs. Anecdotal evidence, based on feedback from graduates, employers and the community, suggests that the quality of the undergraduate programs is quite high. Accreditation reports[7] have rated the co-operative engineering program as "strong, both quantitatively (6 work terms) and qualitatively." An independent evaluation of engineering programs in Canada reported in the Gourman Report[8] rates the undergraduate engineering programs at Memorial as "strong." In a review of Naval Architectural Engineering programs in North America, US-based Ship Structures Committee rated the Ocean and Naval Architectural Engineering program exceptionally high.

As stated above, the Faculty began offering graduate programs in 1969. Prior to 1984, the graduate degree of Master of Engineering was offered initially without distinction between various traditional engineering programs. During this period the degree of Doctor of Philosophy was offered through programs in Ocean Engineering only. Over the years, graduate studies in the Faculty has evolved and graduate degrees are now offered at both the Masters and Ph.D. levels in Civil, Electrical and Computer, Mechanical, and Ocean and Naval Architectural Engineering, and in Master of Applied Science in Environmental Engineering. Along with the growth in graduate programs, enrolments have been on the increase, and in the last five years, graduate student enrolment has increased by about 39%. The catalyst for the significant growth in the past few years has been partly the increasing number of new faculty appointments with research credentials, and the increasing research activities of individual faculty as a result of increased funding. It is fair to state that in the last few years the Faculty has made impressive gains in enhancing its research capacity to the point where the Faculty has now become a research Faculty. However, except in few areas of study, graduate studies in the Faculty has not yet attained the level of excellence nationally and internationally. On the other hand, by virtue of its long history at the Ph.D. level, graduate studies in Ocean Engineering have attained national and international recognition. Evidence of this recognition include the increasing enrolment of national (non-Memorial) and international students, the establishment of the first Research Chair in the Faculty, the

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[6] A copy of the Accreditation Criteria and Procedures of the Canadian Engineering Accreditation Board is found in Appendix F

[7] Copies of the Accreditation Reports for the recent accreditation review of the engineering programs are found in Appendix F

[8] The Gourman Report - Undergraduate Programs, 10th Edition, 1999 ISBN 0-679-77780-6 Random House, Inc. 1999. The ratings are based on scores derived from an objective assessment of the strengths and weaknesses in each program: Very strong (score in the range 4.51 and 4.99 ; Strong (score in the range 4.01 and 4.49) The score for the engineering programs at Memorial is 4.45.

significant external funding for research programs in the area, and the establishment of a national research institute in Marine Dynamics next to the engineering building.

In retrospect the success of graduate studies in Ocean Engineering was underpinned by an articulated objective of establishing the Faculty as a world-class research institution in ocean-related research activities. With such strategic objective the Faculty provided strong support in resources for the growth and development of the area.

An overview of the operation of the Faculty reveals that the implicit expectations are being met. Enrolments at both the undergraduate and graduate levels have been increasing and the satisfaction level of graduates from the programs is very high[9]. However, under the pressures of shrinking budgets, increasing enrolments, high faculty workload, and reduced work term opportunities for undergraduate students, it is increasingly challenging to maintain the quality of the programs.

In light of the above, it is necessary for the Faculty to develop a strategic plan and establish clear objectives for offering its programs. Following the University's strategic plan expressed in *Launch Forth*, the Faculty developed a mission statement as follows:

> To excel and lead in educating engineers, researching, developing and disseminating existing and new engineering knowledge; and to enable the Faculty to achieve recognition as "engine" in the economies of Newfoundland and Labrador and Canada.

One major outcome of consultations within the Faculty, as part of the present academic program review exercise, is the recognition of the need to formulate a set of formal strategic objectives to guide the Faculty in making decisions on new programs, student enrolment levels, faculty complement, and research and professional directions. While a consensus has not been reached, the working committee on strategic objectives has suggested the following outline from which formal strategic objectives might be formulated:

- enhancing the quality of the undergraduate and graduate programs (attracting quality student, meeting students' needs, etc)
- increasing the research profile of the Faculty, including the promotion of high quality research as measured by quality publications and other suitable research metrics.
- raising the profile of the Faculty within the community and fostering better links with the community.
- building on existing and historical strengths.

The Faculty has started the process, initially in the form of formulating a set of assumptions for the development of undergraduate engineering curricula for the future.

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[9] Government of Newfoundland and Labrador Report, Youth Services and Post-Secondary Education, Career Search 2001: Employment Experiences and Earnings of 1998 Graduates (www.edu.gov.nf.ca/career/mun.htm)

Recommendations

1. The Faculty should develop a strategic plan, including an enrollment plan.

2. The Faculty should investigate alternative approaches for enhancing the quality of teaching, learning, research and outreach.

3. An effective database should be established to allow better tracking of students in the program and assessment of Faculty's objectives and goals.

1.2 Student Information and Program Outcomes

Undergraduate Student Enrolments

Quantitative analysis of student enrolment trends in the Faculty shows a steady growth at both the undergraduate and graduate levels over the past five years. Enrolment numbers for the Fall semester in Term 1 shows an increase of approximately 24% (see Table 1: Enrolment in Term 1). It is likely that Term 1 student enrolment in the Faculty will continue to increase because of the co-op nature of the program and the uniqueness of the programs (e.g. the oil and gas option and the ocean and naval architectural engineering program). However, present limitations imposed by laboratory resources, faculty complement and work term placement opportunities create a ceiling in student enrolment of 210.

There is variability in student enrolment by discipline in Term 3 during the same period (see Table 2: Enrolment by Discipline). In terms of the percentage of student population in Term 1, the average enrolment in the disciplines in the last five years is approximately 14% for Civil, 32% for Electrical and Computer, 34% for Mechanical and 9% for Ocean and Naval Architectural Engineering.

Table 1: Enrolment in Term 1

Year	1998	1999	2000	2001	2002
# of Term 1 Students	189	207	195	211	223

Table 2: Enrolment by Discipline

Year	1998	1999	2000	2001	2002
Civil (%)	21 (11.7%)	33 (17.4%)	30 (14.4%)	17 (8.7%)	36 (17.1%)
Electrical & Computer (%)	68 (37.9%)	64 (33.8%)	56 (27.1%)	54 (27.7%)	64 (30.3%)
Mechanical (%)	58 (32.4%)	65 (34.4%)	65 (31.4%)	54 (27.7%)	84 (39.8%)
Ocean & Naval Architecture (%)	15 (8.4%)	18 (9.5%)	25 (12.1%)	14 (7.2%)	17 (8.1%)

Graduate Student Enrolments

There has been a steady growth in student enrolment at the graduate level over the same five-year period (see Table 3: Graduate Student Enrolment). The growth of 38.4% could be attributed to the increase in the fellowship funding (from $4,000 to $6,000 per annum) and a combination of any number of factors including the introduction of the Fast-track option, increased research opportunities, appointment of research-oriented new faculty, and increase in research chair positions.

Table 3: Graduate Student Enrolment

Year	1998	1999	2000	2001	2002
# Students	112	125	130	144	155

Student Recruitment

The Faculty has achieved the increasing enrolments over the past five years without sustained recruitment efforts. Recently, the University, through the Student Recruitment and Promotion division, has increased its recruitment activities locally, nationally and internationally. Within the province, engineering programs are promoted along with other programs through high school guidance counselors, education fares and school mail-outs. Despite these efforts, there is evidence that the participation rate of female students and international students in the engineering programs is low. Presently, female students and international students constitute approximately 20% and 8% respectively of the student population in the engineering programs. The Faculty recognizes that special recruitment strategies tailored to reach female and international students need to be developed. The office of Student Recruitment and Promotion has embarked on major international recruitment campaign and is supportive of the Faculty's recruitment needs. The Women in Science and Engineering (WISE) program has been effective in recruiting women into the engineering program. The Faculty should increase its collaborative efforts with the

WISE program in reaching prospective female students outside the greater St. John's area.

Scholarships and Bursaries

Scholarship program is a major recruitment tool in any university program. In particular, entrance scholarships to university are extremely important for recruitment efforts. There is no doubt that for some students the availability of financial support factors significantly in their decision to apply to Memorial. In the past five years, the number of scholarships in the Faculty has increased from 115 in 1997/1998 to 158 in 2001/2002. The total cash value increased from $148,100 to $216,285 over the same period. While the increase is significant, it is difficult to determine the impact of the increased scholarship on enrolment in engineering. Notwithstanding, the Faculty should increase its efforts to attract new donors for entrance scholarships aimed at increasing the female and international student population in the Faculty.

Alumni in Student Recruitment

Another key factor in recruitment is the use of alumni. The Faculty is committed to establishing a strong connection with its alumni. A number of initiatives are being planned in co-operation with the Office of Alumni Affairs and Development to meet specific needs in recruitment efforts, fundraising and job creation for work term placements. Presently, communication with alumni is through the Faculty newsletter *Benchmarks.* There have been several positive responses to the *Benchmark* and the Faculty plans to utilize this medium more effectively.

Quality of the Program

While analysis of enrolment statistics provide an understanding of the factors that contribute to growth in the Faculty, consideration must be given to the quality of the programs. The full report of the committee on Student Enrolment/Program Outcomes (see section 3.2) provide details on various factors that contribute to the quality of the programs offered in the Faculty. An informal survey of alumni reveals that over 80% of respondents feel that the engineering program at Memorial has an excellent reputation, and on a scale of 1 to 10 (10 being high), the overall assessment of the program was ranked at 8. As concluded in the full report of the committee, the "level of satisfaction with the program is high and the need for change is low."

Recommendations

1. The Faculty should develop and implement a recruitment plan.

2. The Faculty should develop mechanisms for effective connection with alumni.

1.3 Curriculum and Undergraduate Teaching

The report of the Committee on curriculum and undergraduate teaching activities (see section 3.3) provides a detailed review of various issues related to undergraduate teaching. The report also offers responses to several specific questions on the consistency, relevance and effectiveness of the curriculum, and responsiveness of the curriculum to the needs of students, employers and the profession. This section provides an overview of the principal issues explored by the Committee.

The Co-operative Engineering Program

The Bachelor of Engineering Degree offered in the Faculty is set up as a Co-operative Program, which consists of ten academic terms and six work terms. The co-operative engineering program at Memorial is one of the first three engineering programs in Canada to offer a co-operative approach to learning. The general plan for the co-operative engineering program is shown in Table 4.

Table 4: General Plan for the Co-operative Engineering Program

Year	Fall	Winter	Spring
1	Term A	Term B	
2	Term 1	Term 2	Work Term 1
3	Term 3	Work Term 2	Term 4
4	Work Term 3	Term 5	Work Term 4
5	Term 6	Work Term 5	Term 7
6	Work Term 6	Term 8	

The first four academic terms (first two years) constitute the core of the program wherein all students complete a prescribed core of science and engineering courses along with a number of complementary studies electives. Students begin to specialize in the program in Term 3 (third year), and pursue studies in one of the five programs: Civil Engineering; Computer Engineering; Electrical Engineering; Mechanical Engineering; and Ocean and Naval Architectural Engineering. Electrical and Computer engineering students follow the same curriculum for Terms 3 and 4 (third year), and select either the Computer or Electrical Engineering program upon entering Term 5 (fourth year). In 2001 the Faculty introduced oil and gas options in all engineering programs beginning in Term 6 (fifth year) and continuing on to Term 8 (sixth year). A general layout of the academic component of the undergraduate program is shown in the following chart, and Table 5 shows the general curriculum of the engineering programs[10].

[10] The details of the curriculum for each program are given in the appropriate charts in Appendix C.

Chart of the Academic Component of the Undergraduate Program

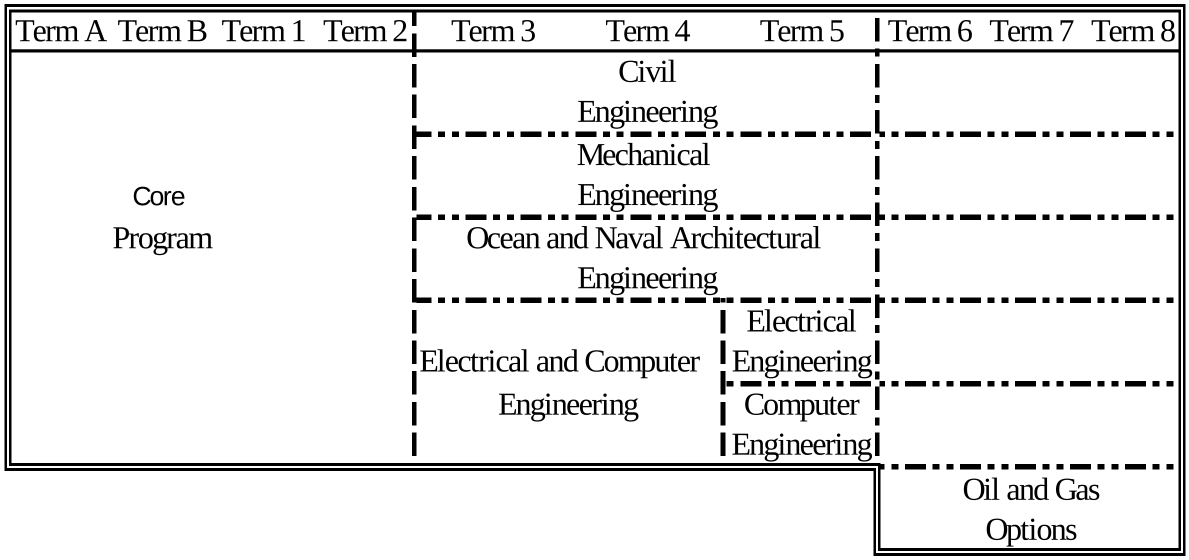

Table 5. Curriculum of the Engineering Programs

Term3 (Fall)	Term 4 (Spring)	Term 5 (Winter)	Term 6 (Fall)	Term 7 (Spring)	Term 8 (Winter)
5 Program Courses	5 Program Courses + 1 CSE*	5 Program Courses + 1 CSE**	5 Program Courses+ + 1 CSE**	5 Program Courses+	5 Program Courses+

Notes:
* The Complementary Studies Elective (CSE) in Term 4 is a mandatory course in Engineering Economics
** Complementary Studies Electives may be taken during work terms
+ Program Courses consist of mandatory courses and technical courses, which may include team or individual project courses, program-specific technical electives, and courses in the oil and gas option.

The majority of the technical courses in Terms 3 to 8 is specific to the individual programs and is normally taken by all students in the program. Others are offered to students in more than one program.

As indicated in Table 5, courses in the engineering programs are normally taken in block. However, recent changes to calendar regulations have introduced some flexibility, in which complementary studies courses and technical courses are allowed to be taken outside the normal blocks of courses.

Admission Modes

There are five modes by which students are admitted into the engineering programs. In the Direct entry mode, high school students with sufficient pre-requisites in Mathematics and the Physical Sciences who meet the University entrance requirements may enroll in the engineering program in Term A. Exceptionally well-prepared high school students may apply for direct entry into Term 1 (second year) through the Fast-track admission mode. Direct admission into Term 1 is normally based upon a student meeting the University admission requirements, having advanced placement equivalent to university credit in Physics, Mathematics and Chemistry, and having an admission average of at least 80% in the final year of high school. Students may also enter the engineering program from within the University. Students registered in other programs within, or other campuses of, the University may apply for entry into Term 1. Such entry is normally based upon the same criteria as promotion from first year engineering into second year. The Faculty has established Bridging Programs[11] that allow certain diploma graduates to enter the engineering program with advanced standing. In each case the bridging program consists of two academic terms: Bridging Term 1(Fall) and Bridging Term 2(Winter), followed by entry into Term 4 of the appropriate program upon successful completion of the bridging terms. Students are occasionally admitted to later terms in the engineering programs through transfer from other institutions. Admission with advanced standing is normally based on a detailed analysis of the student's record and is considered on a case-by-case basis. However, no student can gain advanced standing beyond Term 5.

Direct admission into Term 1 or later may entail a modification of the regular program or require extra courses to be taken as a condition of admission to ensure that the student has achieved an equivalent preparation in comparable subjects. Admission to the Faculty is on the basis of a competition for a limited number of places. The primary criterion used in reaching decisions on applications for admission is the Admission Committee's judgment of the likelihood of an applicant succeeding in the program. The Faculty, without exception, has admitted every student who meets the admission average of at least 65% into Term 1, and has never applied the stipulation and criterion stated above. Anecdotally, there is a perception in the Faculty that many students admitted into the program with averages in the 65% to 68% range do not fare well. The Faculty needs to investigate the relationship between the admission average and success rate, and to give serious consideration to other factors, such as lack of support and guidance in the first year of the program that affect the success rate and retention of students in the program.

Length of the Engineering programs

The length of the engineering programs has received a great deal of attention in recent years. As indicated in Table 4 above, ten academic terms plus six work terms are required to complete the Bachelor of Engineering degree program at Memorial. It therefore takes a high school graduate admitted directly into the program 5 2/3 years to obtain the Bachelor of Engineering degree from Memorial. Given that the large majority of conventional engineering programs in North America consist of eight academic terms, the program at Memorial is 8 semesters longer than non-co-op programs, and on average

[11] The details of the Bridging Programs are given in various charts in Appendix C

3 semesters longer than co-op programs in Canada. One of the objectives stated in the *Strategic Framework for Memorial University* is to "ensure that Memorial's programs do not take longer than necessary to complete, especially when compared to those offered at universities in the Maritime provinces." There is clearly a need to review the Bachelor of Engineering program in the Faculty for consistency with the University's stated objective.

One approach to reducing the length of the program is to allow a direct entry of high school graduates into the engineering program at the Term 1 level. The present structure of the engineering program in the Faculty may be viewed as a two-tier system wherein Terms A and B constitute the first tier and Terms 1 to 8 constitute the second tier. Students in Terms A and B are not considered as engineering students until they so declare prior to admission to Term 1. In essence, the Faculty does not have direct interaction with students in Terms A and B. In addition, courses offered in Terms A and B are not directly under the control of the Faculty. Direct entry from high school into the engineering program would eliminate the first tier and ensure a unified and consistent engineering program.

In the Fall 2000, the Undergraduate Studies Committee (UGSC) undertook a study of the length of the engineering program, and in February 2001, the "Academic Development Sub-committee of UGSC was charged with investigating the concept of a 4-year (4 2/3 years including co-op terms) engineering program at Memorial." Several proposals for reducing the length of the program were developed and discussed by the Sub-committee following informal surveys of students and recent graduates, and a meeting with Dr. Axel Meisen as a member of the Faculty. After deliberating the issue over a period of time, no consensus was reached with respect to the suitability of any of the proposals. In the end, the goal of shortening the program was rationalized to focus on providing "flexibility to students so that they can progress through the program at their own pace."

The issue of the length of the program has been raised again as part of the present review process. In an address to Faculty Council by Dr. Axel Meisen in February 2003, The Faculty was again challenged to consider the length of the program and to re-design its program to enable the majority of students from high school to complete the program in eight academic semesters. The Faculty, through its Management Group, has introduced a discussion paper for the development of a new engineering curriculum.

Effectiveness and Quality of the Programs

Although the Faculty has operated mainly by unwritten strategic objectives, the effectiveness and quality of its programs, in the broad sense, have not been compromised. A major reason for this is the requirement for an accredited program to conform to curricula guidelines established by the Canadian Engineering Accreditation Board. In effect, the curricula guidelines establish the program objectives. Since Memorial's engineering programs have received uninterrupted accreditation, it can be claimed that the curricula of the Bachelor of Engineering programs are consistent with its program objectives. A review of course outlines (see Appendix D) reveals that course objectives and calendar descriptions are consistent and the courses and course content are by and large delivered as promised. One of the areas of concern is the Faculty's inability to offer a number of elective courses at the senior undergraduate levels, mainly because of the teaching commitment to the core courses in the programs. Despite this concern, and other concerns identified in the report of the committee, results from accreditation reviews and student surveys indicate that the engineering curricula are coherent, rigorous and effective in preparing students for professional career. The 1999 CEAB report[12] states that "the rigor of the program is an obvious source of pride amongst students and the graduates of the program are of a uniform and high quality."

Curricular Overlap

The issue of curricular overlaps between engineering disciplines and other departments require special consideration. Except for the foundational courses in the first year, most engineering courses are required by accreditation requirements to have "engineering science" and "design" content. This precludes wholesale sharing of courses with other academic units. At the same time, the Faculty recognizes that such overlaps present opportunities for collaboration. For example, similarities between courses in computer science and computer engineering present special opportunities, not only for sharing resources, but for enriching the educational experience of students in the two programs. In the past, some of the courses were cross-listed, and informally, some courses were offered together. However, attempts to establish formal arrangements for cross-listing courses between computer science and computer engineering have failed in the past, mainly because of the lack of commitment and willingness on the part of the computer science department. The Faculty recognizes the need for further discussions with the Department of Computer Science to take full advantage of course sharing, and is taking appropriate steps in this regard.

Collaboration with other academic units in undergraduate teaching generally takes the form of service teaching. For example, the Faculty of Science provides service teaching to the Faculty in first year courses in Mathematics, Physics and Chemistry. The Faculty of Arts and School of Business Administration provide service courses in the complementary studies component of the engineering curricula. In few instances, formal arrangements have been established for some of the core courses in the engineering programs to be taught by other units. For example, Engr, 3601 in the Civil engineering program and Engr. 7601 in the Oil and Gas option are taught by the Department of Earth Sciences. Also in a few cases, special arrangements have been made for courses in engineering and other units to be offered together (i.e. one class consisting of students registered under separate course numbers). A case in point is the sharing of courses between the Department of Physics and the Electrical and Computer Engineering discipline. For example, Physics 3550 (Electric Circuits) and Engr. 3821 (Circuit Analysis) are offered together. A similar arrangement has recently been established for Physics 3551 (Analogue Electronics) and Engr. 4854 (Electronic Devices and Circuits).

Within the Faculty there is overlap between certain courses in the various programs. For example, there is some overlap between the Fluids courses in the Civil (Engr. 5713) and Mechanical (Engr. 4913) engineering programs. The two courses are offered separately because the context of the problems and examples, and the needs of the two programs are

[12] Copies of the CEAB reports are given in Appendix F.

different. Despite these minor deviations, there is extensive collaboration among the disciplines to offer the five undergraduate programs. All students in engineering take the common courses offered in Terms 1 and 2 by the different disciplines. There are also common courses taken by Mechanical and Ocean and Naval Architectural Engineering students, Electrical and Computer Engineering students, and service courses offered to other disciplines. (For example, the Electrical and Computer Engineering discipline offers Engr. 3844 to Civil, Mechanical and Ocean and Naval Architectural engineering students, and the Mechanical Engineering discipline offers Engr. 4322 to Electrical and Civil engineering students.)

Distance Delivery

Traditionally, the need to provide "hands-on" experience in engineering courses with engineering science and design components has precluded the use of the web to deliver these courses. However, a number of courses in the programs are potential candidates for distance delivery. Presently, Engineering Economics (Engr. 4102), Ocean Engineering Hydrostatics (Engr 3054) and Small Craft Design (Engr. 8003) have been developed for distance delivery over the Internet and by video. The Faculty is beginning to explore the use of distance delivery for other courses in the programs, and it is envisaged that more courses will be offered by distance delivery in due time.

Evaluation of Teaching Effectiveness

Until recently, teaching effectiveness in the Faculty was evaluated through a standard Faculty-approved evaluation questionnaire that was administered through the Associate Dean's office with assistance from the Engineering Student Society. The results of the survey were returned to the individual faculty member. Although the results remained confidential to the faculty member, most professors seeking promotion or tenure submitted the evaluations with their assessment file. The recently introduced university-wide Course Evaluation Questionnaires (CEQ) should provide data for systematic evaluation to determine the effectiveness of teaching in the Faculty. Notwithstanding the lack of data on course evaluations, the Faculty should formally develop peer-teaching reviews of junior faculty as part of the mentoring process of junior faculty.

Recommendations

1. The Faculty should investigate the relationship between the admission average (minimum of 65%) and success rate, and to give serious consideration to other factors that affect the success rate and retention of students in the program.

2. Faculty should undertake a comprehensive review of the program structure, including flexibility, content and length.

3. The Faculty will work with other academic units to achieve effective sharing of courses.

4. The Faculty should consider alternative modes for delivering its courses (e.g. distance delivery, technology-based teaching, etc.)

5. The Faculty should consider developing a mentoring process, including peer review of teaching, to be offered to tenure-track faculty.

1.4 Graduate Teaching Activities

An overview of the central issues investigated by the Committee on Graduate Teaching Activities is presented in this section. Details of the specific questions and issues surrounding graduate teaching are presented in the report of the Committee in Section 3.4. A summary of the research component of graduate studies is provided in Section 1.6.

Programs Offered in the Faculty

The Faculty offers graduate programs at the Masters and Doctoral levels in Civil, Electrical and Computer, Mechanical, Ocean and Naval Architectural Engineering, and in the interdisciplinary area of Ocean Engineering. The latter has been and continues to be a major strength for both M. Eng. and Ph.D. studies and research. The thesis-based M. Eng. program consists of a minimum of 15 credit hours of courses, a one-credit hour seminar course, and a thesis related to the area of study. A fast-track option is offered in the M. Eng. program, which allows undergraduate students who have completed academic term 7 of the undergraduate program to enroll in the option prior to completion of the undergraduate degree program. The fast-track option is a unique feature of the graduate program in Engineering, and it is responsible for attracting a high number of the top Memorial undergraduate students into the graduate program. An Industrial Internship option, which allows students to undertake 8 to12 months of thesis-related work in industry, is also offered within the M. Eng. program. The Faculty also offers a multidisciplinary, course-based program in Environmental Engineering and Applied Science at the Masters level, which leads to a professional M. A. Sc. degree. The program consists of 26 credit hours of courses and 6 credit hours of project.

Program Applications, Enrolment and Graduation Patterns

An analysis of the data collected over a seven-year period on program applications, enrolment and graduate patterns reveals that on average the Faculty receives over 162 applications, admits over 25 students and graduates about 6 Ph. D, 19 M. Eng and 11 M. A. Sc. students per year. Table 6 shows the distribution of students in the graduate program in the last five years. The table shows a steady increase in student enrolment in the graduate program. The enrolment in the Electrical and Computer discipline is the highest among the disciplines and it shows an increasing trend, suggesting a higher participation rate by the Electrical and Computer Engineering discipline in graduate studies.

The Faculty is committed to the University's vision of increasing the number of graduate students. It is recognized that providing incentives to faculty members (for example, providing support or recognition to faculty members engaged in developing proposals to secure support for graduate students), and mentoring for new faculty with respect to generating funds for graduate students could increase graduate studies education and research in the Faculty.

Table 6: Distribution of Graduate Students in the Graduate Program

Year	Discipline	M.Eng (FT)	M.Eng. (PT)	Ph.D. (FT)	Ph.D (PT)	Total (%)
2002	Civil	15	9	6	2	32 (20.6%)
	Electrical & Computer	38	12	7	3	60 (38.7%)
	Mechanical	9	7	5	2	23 (14.8%)
	Ocean & Naval	9	6	9	1	25 (16.1%)
	Environmental	7	8	-	-	15 (9.6%)
2001	Civil	16	11	6	4	37 (25.6%)
	Electrical & Computer	34	8	5	5	52 (36.1%)
	Mechanical	5	8	5	4	22 (15.2%)
	Ocean & Naval	8	6	6	-	20 (13.9%)
	Environmental	6	7	-	-	13 (9.0%)
2000	Civil	11	9	8	1	29 (22.3%)
	Electrical & Computer	26	6	5	4	41 (31.5%)
	Mechanical	6	8	4	3	21 (16.1%)
	Ocean & Naval	10	6	5	-	21 (16.1%)
	Environmental	12	6	-	-	18 (13.8%)
1999	Civil	9	8	10	-	27 (21.6%)
	Electrical & Computer	23	3	8	1	35 (28.0%)
	Mechanical	12	8	4	2	26 (20.8%)
	Ocean & Naval	9	10	4	1	24 (19.2%)
	Environmental	7	6	-	-	13 (10.4%)
1998	Civil	7	10	5	-	22 (19.6%)
	Electrical & Computer	23	4	5	1	33 (29.4%)
	Mechanical	11	5	4	3	23 (20.5%)
	Ocean & Naval	12	7	5	2	26 (23.2%)
	Environmental	1	7	-	-	8 (7.1%)

Innovations in the Programs

In the last few years, the Faculty has introduced innovative approaches that have enhanced graduate studies. As stated above, the fast-track M. Eng. program has succeeded in attracting high-caliber students into the graduate program, most of whom have been successful in receiving funding from NSERC. The Industrial Internship option was designed to attract students who wish to undertake industry-related research. Although the uptake of this option is not as high as the fast-track option, the few students who have pursued the industrial internship option have provided useful links between the Faculty and the particular industry. In some instances, the relationship has resulted in partial industrial funding for the students. Special graduate programs targeted at specific clientele are being implemented. Three such programs are: the joint master's program between Dalhousie University and Memorial University in Asset Integrity Engineering; the new Master's program in Oil and Gas Studies, which is designed to attract into graduate studies executives in the growing oil and gas industry in the region; and the course-based masters program in computer engineering, a program designed to attract a cohort of students from South East Asia.

Graduate Fellowships

Related to the goal of increasing the number of graduate students is the financial package offered to prospective students. Presently, graduate students typically receive financial package totaling approximately $13,000 per year. This consists of graduate fellowship from the School of Graduate Studies, contribution from the supervisor's grant and teaching assistantship. Few students with NSERC graduate fellowship or with other external awards or supported through contract research receive higher funding. In general, the funding level for graduate students in the Faculty is low compared to other Canadian universities. There must be an increase in the funding level provided graduate students in the Faculty so that we can be competitive and attract quality students into the program.

Graduate Courses

Another aspect of graduate studies in the Faculty that deserves consideration is the graduate courses offered in the program. On average the Faculty offers 32 graduate courses per year and 44% of these courses have less than 5 students. The Graduate Studies Committee of the Faculty recently restructured the list of graduate courses with a view to optimizing graduate course offerings, taking into account the needs of the students as well as the availability of instructors.

Program Quality

Several positive indicators of graduate studies in the Faculty related to completion rate, employment potential, rigor of the program and student satisfaction support the view that the program is comparable in quality to programs at other Canadian universities with similar size and research profile. However, there is lack of hard data to confirm this claim. It would be useful for the Faculty to develop tools to assess the quality of the graduate programs.

Recommendations

1. In an effort to increase graduate student enrolment, the Faculty should seek additional funding for graduate studies.

2. The Faculty should provide support for faculty members engaged in developing proposals on behalf of Faculty.

3. The Faculty should continue its efforts to optimize graduate course offerings and to look for innovative approaches to increase enrolments of qualified graduate students.

4. The Faculty should assess the quality of the graduate programs.

1.5 Co-operative Engineering Education

The working committee on Co-operative Engineering Education examined a number of issues pertinent to the delivery of the co-operative (co-op) engineering education program in the Faculty. The details of the investigation, in a question-and-answer format, are contained in the Report on Cooperative Engineering Education (see Section 3.5). The principal issues discussed in this section relate to the structure and quality of the co-op program, work term job development, and policies and regulations with respect to the administration of the co-op program.

The Co-operative Engineering Education program

The Bachelor of Engineering degree at Memorial is set up as a mandatory co-op program (the only mandatory co-op program at Memorial) consisting of six work terms which alternate with equal periods of academic terms after the first two years of the core engineering program (Terms A, B, 1 and 2). The six co-op terms are set up with learning objectives and expectations that progressively expand the knowledge, work-related skills, problem-solving capabilities and communication skills of the students[13]. During the work terms, students receive supervision and mentoring from practicing professional engineers. Thus the work terms are the greatest source of professional development and practical engineering-oriented experiences. In addition to the accreditation of the Bachelor of Engineering programs by the Canadian Engineering Accreditation Board, the co-op program is fully accredited by the Accreditation Council of the Canadian Association for Co-operative Education (CAFCE).

The co-op program offered by the Faculty was established in 1969 (the first co-op program at Memorial), and by the year 2000 had produced over 2300 graduate engineers. Over the years, a large and diversified employer base has been established with a good mix of local, regional, national and international work placement record. The general

[13] Details of the schedule, objectives, expectations, and guidelines for the preparation of various documents are given in the Engineering Student Co-op Handbook (see Appendix E). The comprehensive handbook, which was developed by the Engineering co-op program, has become a model for other co-op programs.

management of the work terms in the co-op program is the responsibility of the office of co-op education in the Faculty. The coordinators in the office are responsible for the three major components of work terms: 1) job development, 2) student selection, interview, preparation for work terms, monitoring and counseling, and 3) evaluation of the work term. The job development component involves ongoing contact and site visits to existing and potential employers, promoting the co-operative engineering program, developing funding support programs (through various industry and government agencies) for work terms, and other activities that strengthen relationships with existing employers. The student-centred responsibilities involve activities that start several months prior to each work term. These activities include job postings and matching, professional development seminars (in which students are introduced to topics ranging from interviewing skills, professional ethics, occupational health and safety to communication component of the program and professional registration requirements), counseling of students, and monitoring of students on their work assignments. The evaluation of the work terms includes the monitoring of the student's progress (which may involve an on-site interview), review of all evaluation input from employers, and evaluation of student's communication component.

Enrolment in the Co-op Program

The number of students placed in work terms in the last five years is shown in Table 7. As a result of enrolment increase, the number of students available for work terms increased by approximately 25% over the period. Despite this growth, the percentage of students placed in work terms has remained above 90%, except in the last year when approximately 110 students (12.4%) were without jobs. The shortfall could be attributed to the downturn in the economy and, in particular, the "meltdown" in the high technology sector and general global recession in the last two years. Given that new work term jobs (albeit not large in numbers) are being created, it is reasonable to assume that factors, such as increased competition with other co-op programs, lack of clearly defined job development strategy, and inadequate resources to develop co-op employment opportunities, may be the underlying reasons for the sub-par placement record. Notable within the placement trends is the poor performance in the spring semesters during the period. Traditionally, it has been a challenge to secure work term positions for students in the program during the summer months, primarily because of competition and the large number of work term 1 students with limited technical background preparation. The Faculty has recognized this as a significant problem. Several ideas, including a non-mandatory work term 1, replacing work term 1 with a four-month technical workshop, and restructuring the curriculum so that work term 1 occurs in the winter or fall semesters, have been put forward as solutions to the problem. The Faculty must explore these ideas in the context of new curriculum development.

Table 7: Work Term Placement Trend

	1998		1999		2000		2001		2002	
	# Stud.	% Placed	# Stud.	% Placed	# Stud.	% Placed	# Stud.	% Placed	# Stud.	% Placed
Winter	222	99.1	243	95.1	295	90.2	303	99.3	280	94.3
Spring	262	84.6	279	82.7	301	90.0	301	87.7	341	79.5
Fall	226	97.3	236	93.2	299	96.7	285	98.6	268	90.7
Totals	710	93.3	758	90.0	895	92.3	889	95.2	889	87.6

As indicated above, the co-op program receives support from a broad base of employers, which include government agencies and departments at the municipal, provincial and federal levels, small and large industries, and local, national and international companies. Employment statistics for the three academic years (1997-1999) (see Table 8) indicate that on average approximately 54% of students were employed on work terms in Newfoundland and approximately 10% were placed internationally.

Informal surveys of graduates from the program show a very high level of satisfaction with the quality of the co-op program. Feedback from employers of engineering co-op students affirms the strengths, quality and effectiveness of the co-op program. In spite of the challenges from modest level of industries, high unemployment in the community, and the geographical remoteness, the co-op program in the Faculty has evolved into "one of the success stories of co-op education in Canada"[14]

Table 8: Student Placement by Region (% of placed students in parenthesis)[15]

	1997	1998	1999
Newfoundland & Labrador	331 (52.9%)	325 (49.5%)	403 (60.1%)
Atlantic Canada (NB, NS)	35 (5.6%)	28 (4.3%)	32 (4.8%)
Ontario & Quebec	161 (25.8%)	165 (25.1%)	156 (23.3%)
Western Canada (MB, SK, AB, BC, NT)	39 (6.2%)	55 (8.4%)	26 (3.9%)
International (Overseas & US)	59 (9.4%)	84 (12.8%)	54 (8.0%)
Totals	625	657	671

[14] External Review Report on Co-op Education at Memorial University. The report was commissioned by the VP (Academic) and authored by E. Sam Sovilla in 2001.
[15] Source: Internal Document of the Co-operative Engineering Education Office.

Challenges to the Co-op Program

The quality, effectiveness, and reputation of the co-op program notwithstanding, the co-op program is presently facing a number of challenges that threaten the integrity of the program. Firstly, there is the impact of the increased enrolment in the engineering program on work term placements; job placements have not kept pace with increasing student population. With the slowdown in the high-tech sector, the problem has been exacerbated to the point where the placement rate has decreased from over 90% in 2001 to about 75% in 2003. Despite the economic downturn in the high-tech sector, there are strong indications that additional work term placements can be obtained at the major economic centers in Canada (e.g. Ottawa, Toronto, Calgary, etc.) and in the U.S. It is imperative that the Faculty increases its job development efforts and diversifies the strategies employed in job development. A recent initiative undertaken by the Faculty involves contracting an individual located in a major Canadian center (e.g. Ottawa) to develop co-op jobs. This pilot project has the potential to increase work term placements, and the University and Faculty should work together to provide the additional financial resources required.

Secondly, there is a lack of consistency in decisions of Faculty Committees with respect to student exemptions from work terms and the minimum number of work terms required in the program. Although six work terms are required in the program, exemptions may be granted to students for lack of available job opportunities and other acceptable reasons (e.g. medical). There have been instances where students have been granted a second exemption while in few cases requests for second exemptions have been denied. Such inconsistencies send the wrong signal to students and erode the confidence in the co-op program. The Faculty, through the Undergraduate Studies Committee has undertaken an investigation of the problem. The Undergraduate Studies Committee has recently developed guidelines for dealing with exemption requests. Associated with the issue of exemption are the absence of clearly stated minimum number of required work terms and work term regulations that are inconsistent with current practice. An Ad-hoc committee has been established to investigate the work term policies and regulations.

Recommendations

1. The undergraduate engineering program should continue as a mandatory co-op program.

2. Faculty members should be encouraged to participate in grading work reports and assisting in job development and monitoring.

3. The Faculty should update work term policies and regulations.

4. A strategic objective of the co-op program and an effective means to assess the quality of the program should be established.

1.6 Research and Creative Activities

The report of the Committee on research and creative activities (see Section 3.6) presents information obtained through informal faculty surveys. Included in Section 3.6 is a report detailing the state of research and creative activities in the Faculty, and the following is the summary from the latter report[16].

Over the last 30 years, research and development in the Faculty of Engineering has been closely tied to key economic sectors in the Province, including oil & gas, fisheries and aquaculture, forestry, mining, transportation, manufacturing, and information technology. As such, the Faculty's research and development activities have been generally consistent with the stated mission of Memorial University of Newfoundland.

This section of the report assesses the climate for research in the Faculty, reviews research performance in the Faculty, and outlines some ongoing initiatives to improve the climate for research and research performance. It concludes with recommendations for fostering and augmenting research activity in the Faculty of Engineering over the next 5-7 years.

The Climate for Research in the Faculty of Engineering and Applied Science

Research Facilities

The Faculty of Engineering has large well-equipped laboratories with dedicated technical support staff, and significant new facilities are planned in the context of the recently announced Canada Research Chairs (CRCs). However, despite some recent success in the Canada Fund for Innovation (CFI) competitions, the Faculty of Engineering has received a very small share of the total CFI funding that has been spent at Memorial, indicating that the Faculty of Engineering is missing out on a very important opportunity to secure funds to support the facilities necessary to carry out nationally competitive research.

Opportunities for Collaborative Research

Faculty members in Engineering are actively collaborating with faculty members in other academic units at Memorial and with researchers and companies outside of Memorial. Participation by faculty members in collaborative research and development should be encouraged; however, it should also be recognized that faculty members who attempt to develop national and international collaborations will require encouragement and support, including financial support for travel in the early stages of the collaboration.

Formal Expectations Regarding Research Productivity

Historically, the Faculty of Engineering and Applied Science did not emphasize research as a responsibility of faculty members which is equal in importance to teaching, Now, while research activity of some kind is expected to be undertaken by all faculty members, there are few rewards for those who participate in research. There are no faculty-

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[16] Dr. R. Gosine, Interim Associate Dean (Graduate Studies and Research) drafted the original report, which was discussed and revised by the Research Advisory Committee. Dr. C. Moloney, Chair of the Research Advisory Committee prepared the final report and summary included in the APR report.

administered research funds, and mechanisms within the Collective Agreement which allow for teaching relief to be given to faculty members who are active in research above the norm are not utilized.

Access to Qualified Graduate Students
Over the last 5 years, there has been a growing demand for admission to the research-based graduate studies programs in which 90% of our graduate students are registered. Graduate students are a key and integral part of research programs in the Faculty of Engineering. However, we face a challenge of finding sufficient funds to support the research of larger numbers of students. Noteworthy is that the Faculty of Engineering currently receives only about 7% of the School of Graduate Studies baseline budget although we supervise almost 18% of Memorial’s graduate students who are involved in research.

Research Funding
Faculty members in Engineering are generally involved in funded research, with NSERC Discovery Grants being the primary source of support. Approximately 70% of faculty members in Engineering are active in seeking research funding through NSERC with about an 88% success rate among those that apply. However, the average values of NSERC Discovery Grants held by Memorial researchers is significantly lower than the national averages, and with the exception of Civil Engineering, lower than the average values for NSERC grants to other faculties of engineering in the Atlantic Region.

A worrisome trend is that the number of awards per full-time faculty member (from all sources) has been declining over the last 5 years despite increases in the faculty complement. Many of our new faculty members receive nationally competitive first-time grants, which suggests that our declining competitiveness has much to do with the local research environment.

Measures of Research Productivity in the Faculty of Engineering and Applied Science

In 2002 the Faculty of Engineering and Applied Science adopted the *NSERC Guidelines for the Preparation and Review of Applications in Engineering and the Applied Sciences* to provide for detailed criteria for the assessment of engineering research contributions for the purpose of promotion and tenure considerations. The Faculty's collective research productivity may be summarized by the following categories:

Traditional Measures of Research Productivity
The participation rate in the NSERC Discovery Grant process is very good compared with the rates in other eligible units at Memorial. With the exception of Mechanical Engineering, participation of faculty members in the supervision of graduate students is high. The completion rates and time to completion in the Faculty of Engineering are both very good. Approximately 80% of faculty members report publishing at least 1 refereed journal or conference paper over the last 6 years and 9 patents were reported by 3 faculty members.

Technological Entrepreneurship and Spinoff Companies
Over the last 3-5 years, the Faculty of Engineering has played a role in providing support to our graduate students who have wanted to engage in technological entrepreneurship and to form companies to commercialize the results of their research or to build on the expertise that they have developed in the course of their research in the Faculty. An important link in establishing an entrepreneurial R&D culture has been the development of close linkages with the Hubert W. Kelly Memorial Chair in Youth-Focused Technological Entrepreneurship (YFTE).

Research Awards and Participation in National and International Committees
Research productivity in the Faculty can also be judged by the good levels of recognition of individual faculty members who have received peer-reviewed awards and honors (e.g. University Research Professorships, the President's Award for Outstanding Research, the Petro-Canada Young Innovator Award, Canada Research and externally sponsored Chairs, etc.) and through the participation of faculty members on national and international committees related to research and development in their disciplines (e.g. SAC 2002 conference organization, the IACS Working Group on Polar Class Ships, the CSA Committee for Offshore Canadian Code, the PRECARN Research Management Committee, NSERC Selection Committees, the AquaNet NCE Board of Directors, and others).

Applied Research and Outreach
The Industrial Outreach Group (IOG) which originated in the latter part of 1998, provides for the coordination of applied research and/or development that requires access to the unique expertise or facilities in the Faculty of Engineering. The Faculty also has established good research relationships with individuals in the local and national technical community through use of Adjunct Professorship and other honorary appointments.

Actions to Improve Research Climate and Research Productivity

Research in the Faculty of Engineering has been driven by the interests of individual faculty members. While many have experienced success to varying degrees, research could have a much greater profile in the Faculty of Engineering. Increasing the profile and importance of research, coupled with providing incentives and rewards for those who are productive in research, will go a long way to improving both the climate for research and the resulting research productivity.

Several recent initiatives have been undertaken or are underway to improve the climate for research in the Faculty of Engineering. These include:

- changing the role of the Associate Dean (Graduate Studies & Research) to increase responsibilities related to research matters;

- forming a Research Advisory Council (RAC) as a standing committee of Faculty Council to provide a collegial body to consider research matters of importance to the Faculty of Engineering;

- developing a Strategic Research Plan for the Faculty of Engineering to provide a context for decisions related to faculty recruitment and to major research opportunities and initiatives;

- determining teaching equivalencies for the Faculty;

- considering research mentorship;

- more active, broad-based participation by faculty members in engineering in major research initiatives at Memorial (Canada Research Chairs, INCO Innovation Centre, Atlantic Innovation Fund proposals, identification of industrial research chair opportunities).

Recommendations

1. Recognizing that the research activity in the Faculty has increased greatly over the long term since the establishment of the Faculty, and over the shorter term of the past 5-10 years, it is recommended that efforts be continued to nurture even greater research activity commensurate with the changed stature and self-image of the Faculty and University.

2. The Faculty should state its self-image and goals as a research Faculty through collegially-developed documents such the Faculty Research Plan (currently under development).

3. The Faculty should continue to develop and implement the initiatives recently undertaken to improve the climate for research, as detailed in the above section. Special efforts should be made to ensure i.) that faculty members have access to funding opportunities through knowledge of such opportunities and mentoring assistance in preparing funding applications, and ii.) that faculty members be provided with adequate time in their working schedule to conduct research through the implementation of teaching equivalencies appropriate to the Faculty of Engineering.

4. The Faculty should work to improve the levels of research funding from both NSERC (where the basic goal should be to attain average Discovery Grant levels at the Atlantic averages, at least, within each GSC, if not at the national averages) and from a diverse range of other sources. Overall, the average grant number and amount per faculty member should be increased.

5. The Faculty should encourage and support increased levels of collaborative research and development, within the University, across Universities, with government laboratories, and with provincial, national and international companies.

6. The Faculty should address the challenge of recruiting and retaining highly qualified personnel, at the level of faculty members with strong research records or potential, at the level of laboratory and research staff, and at the level of graduate students. In addition, the challenge of nurturing such personnel and their research output after they arrive at Memorial University should also be addressed.

1.7 Role of the Engineering Faculty in the Profession and the Community

An overview of the role and contribution of the Faculty in the profession and the community is provided in this section (see Section 3.7 for the report of the Committee that investigated this issue). The goal is to describe the quantity and impact of the Faculty on the profession and community.

Consistent with its stated mission, the Faculty on the whole is engaged in scholarly, professional and creative activities. While the individual curricula vitae in Appendix G highlight the individual achievements, collectively the summaries provide a snapshot of the contributions of the Faculty in the areas of teaching, scholarly work, professional and creative activities. Faculty members are involved in leadership and administrative roles in local, national and international technical and professional societies (for example, Association of Professional Engineers and Geoscientists of Newfoundland and Labrador and Oceanic Engineering Society). A number of faculty members are involved in organizing local, national and international conferences and workshops (for example, the Institute of Electrical and Electronics Engineers (IEEE) and Society of Naval Architects and Marine Engineers), and involved in community services (for example, TETRA).

Through the Industrial Outreach Centre, the Faculty's laboratory facilities are used to provide a range of industrial support services normally not available to local businesses, as well as provide education and training in industry-specific skills. Faculty members are also active in delivering courses, seminars, and workshops to various local and international clients through the Continuing Engineering Education division. Community and educative programs, such as FutureSet, GirlQuest, and school enrichment programs in technology, also use the Faculty's facilities.

In addition to the direct impact of the Faculty on the profession and the community, graduates from the programs offered in the Faculty have made significant contributions to the industrial sector of the province. A 1999 APEGN survey reveals that 43% of the graduates are working in the province as registered Professional Engineers. The working committee notes that at least 22 registered engineering firms in the construction, service and high technology sectors were started by graduates from the Faculty. In recognition of the need to encourage entrepreneurship among students in the program, the Faculty is providing support for incubation of technology businesses.

Finally, the Faculty must be pro-active in exploring opportunities to strengthen its role in the profession and community. The Faculty should find ways of raising its visibility in the community. At the same time, the Faculty must monitor and document its impact on the profession and in the community.

Recommendations

1. The Faculty should be pro-active in exploring opportunities to raise its visibility in the community and strengthen its role in the profession.

2. The Faculty should assess its impact on the profession and community.

1.8 Administrative Organization, Human Resources and Financial Support

The detailed review and discussion of the administrative organization, human resources and financial support of the Faculty is well documented in the report of the working committee (see Section 3.8). The list of recommendations given at the end of the report suggests that the central issues identified in the investigation are concerned with the academic structure, workload, and budget in the Faculty. These issues are further highlighted in this section.

Academic and Administrative Structure of the Faculty

The Faculty has grown considerably in terms of student enrolment since it began to offer the Bachelor of Engineering degree in 1969. Correspondingly, there have been increases in the number of faculty members and support staff even though these increases have not kept pace with the increasingly diversified and specialized activities in the Faculty. For example, in the early beginnings of the Faculty, the core curriculum of the undergraduate programs extended to academic term 5. Although specialization in Civil, Mechanical and Electrical started in Term 5, there was an accepted underlying interdisciplinary mode of operation in the Faculty. The non-departmentalized structure of the Faculty provided an effective mechanism for delivering the program. Currently the Faculty offers five undergraduate programs, which share a core curriculum up to Term 2. The programs are more specialized with very little interdependency after Term 2. The change from the interdisciplinary approach was due in part to the technological revolution, which demanded specialized education and technical knowledge. However, the interdisciplinary or non-departmentalized structure did not change, and it appears that the time has come for the Faculty to engage in broad discussions to determine an effective academic structure.

In contrast to engineering Faculties at many Canadian Universities, this Faculty is unusual for having discipline chairs, rather than heads, who are responsible for the delivery of the specialized programs. For example, for accreditation purposes, the Discipline Chair, who is responsible for the program, does not have administrative responsibilities as far as budgetary planning for the program is concerned. This, coupled with overlapping academic responsibilities with the Associate Deans regarding admissions and course offerings, creates duplication and results in ineffective operation of the Faculty. The following sets out the principal considerations for contrasting viewpoints, which must be investigated further. In favor of a departmentalized academic structure is the contention that a departmental structure will increase the prestige of the programs and the perception of the existing interdisciplinary research collaborations by the university, give prominence to the specialized programs, provide flexibility and capacity to set goals, and establish strategic objectives based on the needs and demands of the program. Against the creation of departments in the Faculty are concerns over duplication of resources, increase in the level of academic service within disciplines, and reduction in the effectiveness and impact of the programs. It is clear that these issues deserve resolution and the Faculty must engage in further consultations to determine an effective administrative structure consistent with its size and strategic objectives.

Teaching Norms in the Faculty

Traditionally, the teaching norm in the Faculty for each faculty member has been established at four courses per year. Until about 15 years ago, this norm was adequate to cover the teaching requirements in the Faculty because there was general uniformity among courses in the Faculty. In recent years, the Faculty has grown in student population, curriculum diversification and research strength. One result of this growth is the wide diversity in the courses offered both within each program and among programs in the Faculty. Engineering courses are mostly delivered using one of the three formats: lectures with tutorials, lectures with tutorials and laboratory sessions; and projects. These modes of delivery have varying degrees of time commitment which impact on teaching workload. The differences in workloads across programs are highlighted by non-uniform class sizes, few laboratory courses in some programs, and imbalance in research and professional activities among the various programs. All of this point to a need to establish a teaching norm that accounts for class sizes, laboratory and project requirements, graduate teaching and research, and other such factors.

The workload problem is exacerbated by inadequate faculty complement. Even under the existing teaching norm, there is on average a yearly shortfall of 20-30 teaching tasks. The shortfall is normally dealt with through sessional instructors, extra teaching by faculty members and cancellation of technical elective and graduate courses. In varying degrees of emphasis for each program, the accreditation board that reviewed the engineering programs in 1999 raised concerns about the "symptoms of staffing deficiencies, … [which] include a shortage of senior year laboratories, a large number of sessional instructors, many electives listed in the calendar but not offered in recent years, and an expressed lack of time to do program/laboratory development." It is imperative that these concerns be addressed before the next accreditation review in 2005.

Administrative, Technical and Co-op Staff

Complementary to the workload of faculty is the workload of the co-op staff, technical support staff and administrative staff. Comparative analysis detailed in the report of the committee reveals that with 60 students per coordinator, the workload of coordinators in the Faculty is unacceptably high for a mandatory co-op program. The result is an overburdened coordinator that can barely cope with student evaluation, student placement and student monitoring activities, let alone new job development or job creation initiatives.

The quality of service provided by the technical staff (laboratory, computing and audio-visual) appears to be diminishing. As the Faculty has grown, so also have the demands on the technical staff. The administrative staff complement is comparable to that found in other units at Memorial of similar faculty size (School of Business Administration and the Faculty of Education). The concern over administrative staff workload stems primarily from inefficient distribution or deployment of administrative staff in the Faculty. The Faculty recognizes this as a legitimate concern and the Interim Dean has recently initiated steps to address the concern.

Cost-effectiveness

Much of what has already been discussed relate to the level of financial support available to the Faculty and the cost effectiveness in the delivery of its programs. One approach to determining the cost effectiveness of the Faculty is through comparison with other academic units at Memorial of similar size, and against engineering Faculties in the region and across the country. The numbers presented in comparative tables may not reveal the unique characteristics of particular programs. Neither do they tell the full story of the cost effectiveness of the program. However, they provide useful basis for determining the relative cost of the programs.

Since undergraduate student enrolment and faculty salary are the primary considerations in budget allocations, several indicators associated with these two items are used for comparison. The School of Business Administration and the Faculty of Education are selected for primary comparison because of their similar size and structure. Data is also provided for the School of Nursing and the Faculty of Science. The figures for the various indicators are shown in Table 9 for the 2001-02 fiscal year.

Among the three units under consideration (Business, Education and Engineering), the expenditure per student in the Faculty of Engineering is the lowest, while the ratio of students to full-time faculty is the highest. In the context of delivering programs at Memorial, these two indicators confirm that the Faculty of Engineering is very effective and fiscally responsible. This performance is perhaps a result of a teaching norm that does not account for the hidden cost for delivering laboratory and project courses.

Table 9: Comparison of Cost Effectiveness[8]

	Expend./ Registrant	Expend./ FT U'grad Student[1]	Net Expend./ FT Faculty[2]	FT Students/ FT Faculty[3]	Budget as % of All Units	FT U'grad Majors as % of All
Engineering	930	6,275	137,723	25.7	3.4%	7.3%
Business	540	7,357	134,339	20.6	3.0%	7.0%
Education	754	10,634	132,141	14.1	3.1%	7.3%
Nursing	2,237	3,468	109,322	35.7	1.4%	1.9%
Science	907	11,751	127,179	12.2	14.3%	16.9%

Notes:

1. The figure is obtained as the ratio of the total expenditure (for fiscal year ending March 31, 2002) to the total full-time undergraduate enrolment in Fall 2001.
2. The figure is determined as the ratio of the net expenditure (i.e. total expenditure less revenue) to the total regular full-time faculty.
3. This is the ratio of the full-time undergraduate students enrolment in Fall 2001 in the unit to the total regular full-time faculty.

Comparative figures for the Faculty of Engineering at Memorial and the Atlantic region, along with national average figures for a number of cost indicators are summarized in Table 10.

Table 10: Summary of Primary Indicators for External Comparison[18]

	Weighted FTE Students/ FTE Professor	Total Budget/ Weighted FTE Student	Equipment Budget/ Weighted FTE Student
Memorial	26.5	4,760	68.4
Atlantic*	20.1	7,064	188.6
National*	24.4	6,932	286.8

* The Atlantic and National figures quoted are mean values

It is clear that the ratio of total Faculty budget to the weighted full-time equivalent student is lower than the Atlantic and National averages, indicating an excellent performance in cost effectiveness. The student-professor ratio at Memorial is higher than the Atlantic and National averages, again reinforcing the inadequate faculty complement. The significantly low ratio of equipment budget to student enrolment is indicative of the

[8] Source: Memorial University of Newfoundland Centre for Institutional Analysis and Planning (CIAP): Academic Unit Profile (2001-2002) and Fact Book 2002.

[18] Source: 2001-2002 Canadian Engineering Faculty Resource Survey. The detailed results are included in the full report of the sub-committee in Section 3.8.

lack of capital budget for the Faculty over the last few years. This is of particular concern, and as noted by the sub-committee, "could lead to deterioration of the laboratories and projects, and eventually the quality of the programs."

Recommendations:

1. The Faculty should strike a committee to review the Administrative structure of the Faculty, including the concept of departmentalization.
2. The Faculty should review the deployment of administrative support staff.
3. The issue of duplication of efforts with regard to student documentation done by the undergraduate and cooperative education offices should be reviewed and where possible consolidated.
4. The teaching equivalencies of the faculty members should be reviewed and redefined, taking into account various factors such as class size, laboratories, tutorials, projects in courses, supervision of projects and graduate students, development of new courses and laboratories, etc. A clear timetable should be identified to implement the newly defined workload within a reasonable duration; this implementation will require more faculty members (and perhaps other staff) to be appointed. This is an important step in our Faculty being able to realize the strategic objectives in research and community service.
5. The current workload of coordinators should be addressed, and adequate resources should be deployed to ensure that our undergraduate students receive the maximum benefit from a mandatory cooperative program.
6. Appropriate bridging appointments of technical staff should be made in critical areas.
7. The Faculty budget process should be made transparent and disciplines and co-op should be able to explicitly and meaningfully participate in the budgeting process.
8. The Faculty should receive a budget that is commensurate with the average Atlantic figures. The Faculty budget should include a capital budget.

1.9 Physical Resources

Until recently, the Engineering building provided adequate space for the full function of the Faculty. The laboratories were well equipped, and allowed for hands-on experience that complemented the classroom teaching very well. The dedicated and competent technical staff provided the necessary support for the safe and effective use of the equipment and facilities. Visitors to the building were impressed (sometimes jealous) with the spacious laboratories and impressive array of equipment. Over the years, a number of renovations to the building have been made to improve space utilization and create additional classrooms. With increasing student population, introduction of new programs, and increased research and industrial outreach activities, the facility has grown too small. Age and excessive use have rendered most of the laboratory equipment obsolete or non-functional. The lack of capital budget over the past few years for renewal of equipment has exacerbated the problem to the point where the quality of the laboratory component of the programs is being compromised.

The use of computer technology in teaching has increased in the Faculty in the past few years. While there is adequate computing facilities for students, the classroom are not well equipped to support the growing need for computer-based teaching. At the same time, the audio-visual equipment, along with the screen in the classrooms, are in need of major repairs or replacement.

The details of the conditions and needs of the facility are addressed in the report of the sub-committee on Physical Resources (see Section 3.9). The list of needs outlined in the report points to two main recommendations.

Recommendations

1. The Faculty must develop and implement a plan for the repair or replacement of equipment.

2. The Faculty must obtain the resources required to cope with the high student enrolment, introduction of new programs, and growth in research activities. The recent initiative of assessing the capacity of the programs should continue and expanded to include a long-term plan.

1.10 Summary

In summary, it should be pointed out that the recommendations listed at the end of each section are in large part a result of the investigations and discussions that took place throughout the review process. At a Faculty Council meeting to discuss these recommendations, some of the original recommendations from the working committees were deemed to be narrowly focused. Minor changes were therefore made to provide general recommendations while preserving the thrust of the original recommendations. The revised recommendations are gathered together in the list that follows.

1. The Faculty should develop a strategic plan, including an enrollment plan.

2. The Faculty should investigate alternative approaches for enhancing the quality of teaching, learning, research and outreach.

3. An effective database should be established to allow better tracking of students in the program and assessment of Faculty's objectives and goals.

4. The Faculty should develop and implement a recruitment plan.

5. The Faculty should develop mechanisms for effective connection with alumni.

6. The Faculty should investigate the relationship between the admission average (minimum of 65%) and success rate, and to give serious consideration to other factors that affect the success rate and retention of students in the program.

7. Faculty should undertake a comprehensive review of the program including flexibility, content and length.

8. The Faculty will work with other academic units to achieve effective sharing of courses.

9. The Faculty should consider alternative modes for delivering its courses (e.g. distance delivery, technology-based teaching, etc.)

10. The Faculty should consider developing a mentoring process, including peer review of teaching, to be offered to tenure-track faculty.

11. In an effort to increase graduate student enrolment, the Faculty should seek additional funding for graduate studies.

12. The Faculty should provide support for faculty members engaged in developing proposals on behalf of Faculty.

13. The Faculty should continue its efforts to optimize graduate course offerings and to look for innovative approaches to increase enrolments of qualified graduate students.

14. The Faculty should assess the quality of the graduate programs.

15. The undergraduate engineering program should continue as a mandatory co-op program.

16. Faculty members should be encouraged to participate in grading work reports and assisting in job development and monitoring.

17. The Faculty should update work term policies and regulations.

18. A strategic objective of the co-op program and an effective means to assess the quality of the program should be established.

19. Recognizing that the research activity in the Faculty has increased greatly over the long term since the establishment of the Faculty, and over the shorter term of the past 5-10 years, it is recommended that efforts be continued to nurture even greater research activity commensurate with the changed stature and self-image of the Faculty and University.

20. The Faculty should state its self-image and goals as a research Faculty through collegially-developed documents such the Faculty Research Plan (currently under development).

21. The Faculty should continue to develop and implement the initiatives recently undertaken to improve the climate for research, as detailed in the above section. Special efforts should be made to ensure i.) that faculty members have access to funding opportunities through knowledge of such opportunities and mentoring assistance in preparing funding applications, and ii.) that faculty members be provided with adequate time in their working schedule to conduct research through the implementation of teaching equivalencies appropriate to the Faculty of Engineering.

22. The Faculty should work to improve the levels of research funding from both NSERC (where the basic goal should be to attain average Discovery Grant levels at the Atlantic averages, at least, within each GSC, if not at the national averages) and from a diverse range of other sources. Overall, the average grant number and amount per faculty member should be increased.

23. The Faculty should encourage and support increased levels of collaborative research and development, within the University, across Universities, with government laboratories, and with provincial, national and international companies.

24. The Faculty should address the challenge of recruiting and retaining highly qualified personnel, at the level of faculty members with strong research records or potential, at the level of laboratory and research staff, and at the level of graduate students. In addition, the challenge of nurturing such personnel and their research output after they arrive at Memorial University should also be addressed.

25. The Faculty should be pro-active in exploring opportunities to raise its visibility in the community and strengthen its role in the profession.

26. The Faculty should assess its impact on the profession and community.

27. The Faculty should strike a committee to review the Administrative structure of the Faculty, including the concept of departmentalization.

28. The Faculty should review the deployment of administrative support staff.

29. The issue of duplication of efforts with regard to student documentation done by the undergraduate and cooperative education offices should be reviewed and where possible consolidated.

30. The teaching equivalencies of the faculty members should be reviewed and redefined, taking into account various factors such as class size, laboratories, tutorials, projects in courses, supervision of projects and graduate students, development of new courses and laboratories, etc. A clear timetable should be identified to implement the newly defined workload within a reasonable duration; this implementation will require more faculty members (and perhaps other staff)

to be appointed. This is an important step in our Faculty being able to realize the strategic objectives in research and community service.

31. The current workload of coordinators should be addressed, and adequate resources should be deployed to ensure that our undergraduate students receive the maximum benefit from a mandatory cooperative program.

32. Appropriate bridging appointments of technical staff should be made in critical areas.

33. The Faculty budget process should be made transparent and disciplines and co-op should be able to explicitly and meaningfully participate in the budgeting process.

34. The Faculty should receive a budget that is commensurate with the average Atlantic figures. The Faculty budget should include a capital budget.

35. The Faculty must develop and implement a plan for the repair or replacement of equipment.

36. The Faculty must obtain the resources required to cope with the high student enrolment, introduction of new programs, and growth in research activities. The recent initiative of assessing the capacity of the programs should continue and expanded to include a long-term plan.

2.0 Self-assessment of the Disciplines in the Faculty

The reports presented in this section are the outcomes of discussions held as part of the academic program review process at the discipline level. They reflect the specific needs, objectives, and concerns of each discipline.

2.1 Civil Engineering Discipline

Background

The main objective of this program is to produce Civil Engineers to serve the Atlantic and the Canadian market. Civil engineering is the oldest branch of the profession of engineering. Many of the important things in our lives that we take for granted are the products of civil engineering. Bridges Dams Tunnels Water towers Hydroelectric plants buildings, coal fired plants, gas fired plants, and nuclear power plants are the products of the civil engineering design. The construction of the dams and power stations that provide the electricity we use every day requires civil engineers. The water and sewage treatment plants that provide us with safe water supplies require the expertise of civil engineers. The paths and roads we travel are civil engineering projects. Civil engineers also help to preserve our environment by assisting in the cleaning up of existing pollution and planning ways to reduce future pollution of our air, land and water.

Memorial University graduates an average of 30 undergraduate civil engineering students per year during the past ten years. During the construction of the Hibernia project the number of the graduating class reached over 45 students. The number of students fluctuated between 20 to 40 relating to the economic development of Atlantic Canada in particular and Canada in general. Memorial University Civil Engineering enrolment followed the North American trend of a ten year cycle between the maximum and minimum number of students enrolled in the Civil discipline.

The graduates from the Civil engineering program at memorial have an excellent employment reputation in many varied occupations. Their success is due to the structure of the program which is based on sound, accepted, engineering instruction principles and, to a large extent, on the fact that this is a Co-operative Engineering education curriculum. The practical engineering to which the students are exposed during Work Terms has many benefits. Students apply knowledge learned in academic terms. Students are supervised in a real work atmosphere and are taught techniques that add to there academic training. Frequently there is a real transfer of technology whereby students bring experience into the classroom to the benefit of their peers. The co-operative experience is structured to ensure that on graduation the students are capable and comfortable in matters related to seeking employment and assessing employers. The students develop maturity in professional attitudes and engineering communications. The Civil engineering students become more self-reliant before graduation.

Between 1994 to 2001 academic years the Civil Engineering students had to choose between two Civil engineering options. The first is the Construction and Structural option and the second is Environmental and Municipal option at the last academic year of their study. During academic terms 7 and 8 the students focused on their particular interest of Civil Engineering. However, due to the recent drop of demand on the national level for Environmental Engineers by the end of the 90's (experienced at all Canadian Civil Engineering Departments). It has been decided to consolidate the Civil Engineering two options, into one general Civil Engineering option with few electives in Construction, Structures, Environment and Municipal Engineering.

Together with the other disciplines in the Faculty, the program has undergone extensive revision over the last few years and some of these changes are still working their way through all of the academic semesters. A new option in Offshore Oil and Gas (Civil) Engineering was introduced in 2001 which affects academic term 6 onwards.

Teaching Activity

The Civil Engineering Program consists of ten academic terms and six work terms. The first two academic terms are designated as core program. The core program is the same for all engineering disciplines, but from term three onwards, the students begin to specialize in the Civil Engineering discipline. There are 34 courses taught by the Civil Faculty members. The faculty of the Civil Engineering discipline consists of eleven faculty members. Out of the eleven members, one faculty member is shared with the Mechanical Engineering discipline and other is shared with the C-Core. The recent retirement of three civil faculty members in the areas of Hydrotechical, transportation and Surveying and Geomatics created a desperate need for new faculty members. The three positions were replaced with a single position in the area of Hydrotechnical or Transportation Engineering. The vacant position is being filled at the present time. The discipline is relaying on sessional instructors and retired professors for filling the teaching assignments. The minimum national Canadian size of Civil Engineering disciple or Department is 14 faculty members.

The Civil Engineering program consists of a primarily fixed general Civil Engineering program with few technical electives in academic terms 7 and 8. Since 2001 an option in Civil Engineering- Offshore Oil and Gas Engineering has been available from term 6 onwards. The offshore structures and materials course (E8675) is taught by the Civil faculty and the ocean science courses are taught by Earth Sciences (E7601 Geosciences in offshore engineering).

The curriculum development is a continual process, where required changes and all Civil Engineering Faculty members conduct evaluations. Recommendations for change, as agreed upon at the discipline level and endorsed by the Chair, are submitted to the Undergraduate Studies Committee of Faculty Council.

All Civil Engineering faculty members are involved in teaching of graduate courses in variety of Civil engineering specialization like structural design, ice mechanics, offshore design, mechanics, environment engineering, risk assessment, hydrotechnical engineering, hydrology and geotechnical engineering. Some members are heavily involved in teaching graduate core courses every year and other members offer graduate courses at regular intervals.

Research and Creative Activity

Civil Engineering faculty members in the discipline are heavily involved with supervision of both M.Eng. and Ph.D. students in Civil Engineering. The average number of Civil Engineering graduate students is 20 per academic year. For example, the number of full time graduate student during the 2000 academic year was 19 students specializing in different areas of civil engineering. In addition, during the last seven years more than 60 students have graduated with Master environmental degrees.

The following list includes the most recent research topics conducted at Civil Engineering discipline:

1. Offshore Structures and Structural Design.
2. Environmental loads on offshore Structures
3. Concrete offshore design, including high strength concrete, punching shear, bonds, tension, fracture energy and crack width limits.
4. Steel offshore design including ice loads, fatigue, crack growth, fracture, corrosion, progressive failure mechanisms and limit loads.
5. Approximate analysis for secant analysis for non-linear strain estimation.
6. Environmental Risk Assessment.
7. Remediation technology.
8. Environmental effects for offshore oil and gas development
9. Probabilistic methods, safety and reliability engineering, and risk-based remediation.
10. Flood risk analysis.
11. Application of design of experiment methodologies in hydrology and Civil Engineering.
12. Geotechical modelling, experimental and numerical studies on pipe-soil interaction.
13. Ice-seabed interaction, submarine slope stability accounting for various possible triggering mechanisms and seismic evaluation.

List of Civil Engineering Research Areas by Faculty Member:

Dr. I. Jordan

1. Environmental loads on offshore Structures.
2. Environmental risk Assessments.
3. Ice Mechanics.
4. Ice Loading.
5. Transport modelling, probabilistic methods, safety and reliability engineering.

Dr. A. Swamidas

1. Suction Caisson Analysis and Suction Pressure Development.
2. Crack Detection in Beams, Plates, Tubular T-joints and Framed Structures.
3. Resonant Cracking of Composite Beams and Plates.
4. Active and Passive Damping of Structures.

Dr. H. Marzouk
1. Design of concrete offshore platforms.
2. Steel reinforcement optimisation for offshore structures and crack width analysis.
3. Use of FRP in structural rehabilitation.
4. Constitutive modelling of high strength concrete.
5. Finite Element Analysis of rehabilitated structures.

Dr. T. Husain
1. Air pollution modelling.
2. Environmental risk assessment.
3. Waste management and contaminant transport modelling
4. Remediation technology.
5. Environmental effects for offshore oil and gas development.

Dr. L. Lye
1. Application of design of experiment methodologies in hydrology, geotechnical and structural engineering
2. Regional flood risk analysis for NF and Malaysia
3. Flood estimation in tidal interaction zones
4. Development of a generalised goodness-of-fit test for three parameter distributions
5. Risk based approaches in ocean outfall design and analysis.

Dr. R. Popescu
1. Continental slope stability.
2. Mitigation of earthquake induced damage from soil liquefaction.
3. 3D continuum finite element analysis of pipe-soil interaction.
4. Effects of small scale soil heterogeneity in geotechnical design.

Dr. S. Adluri
1. Shear lag in steel design.
2. Limit loads using approximate analysis.
3. Approximate secant analysis for non-linear strain estimation
4. Steel structure rehabilitation through the use of analytical studies in the initial stages.
5. Wood pole reliability. This might start in a few months.

Dr. C. Coles
1. Adsorption of lead, cadmium and zinc from kaolinite clay and release of Hydrogen-ions
2. Metal desorption from kaolinite, reaction kinetics, and laboratory experiments
3. Leaching of chromium, copper, and arsenic from utility poles.
4. Soil contamination and metal migration, field and laboratory experiments

Dr. K. Hawboldt
1. Minimization of waste gas emissions from petroleum operations (i.e. flaring).
2. Recovery of associated gas from petroleum facilities.
3. Identify pollutants in produced water from offshore platforms and treatment technologies
4. Treatment and/or disposal of drilling waste produced from offshore platforms.

Dr. A. Hussein
1. Use of advanced composite materials as reinforcement for concrete structures.
2. Constitutive modelling of concrete structures.
3. Finite element analysis of concrete structures.
4. Testing of concrete under generalised stress conditions.
5. Shear in concrete with particular emphasis on concrete plates and slabs.

Research Uniqueness

Our main unique potential lies in the ability to assist with design and analysis for the offshore industry and to deal with our unique ocean environment. There is a strong group in civil engineering covering the area of environment engineering, environmental risk assessment and multi-media fate and transport modelling, probabilistic methods, safety and reliability engineering, and risk-based remediation. Interested members from other engineering disciplines, science, and medicine can also join in work on this topic to formulate a strong and effective strategic research plan for the university.

The Civil faculty has strengths in the area of pipelines and associated geotechnical analysis and design; the related area of ice scour is also important in our offshore regions but also in many parts of the world. Strong collaboration with the other research groups like C-CORE, IMD and industry gives us unique strength and the ability to create critical research mass.

Future Research Plans

Offshore Oil and Gas: In the Oil and Gas area, the design of engineered systems for harsh environments is our main focus. The work on environment and ice loads will be extended to account for deep-water developments and applied to arctic conditions of interest to Canada as a whole; it is very likely that the present demand for oil and gas will continue. Optimal design of steel and concrete structures will also constitute an important focus.

Better modelling of the ice environment, for example ice drift trajectories, would assist considerably in operational aspects of offshore developments. Collaboration with other Memorial staff working in Oceanography, e.g. in the Physics Department is an attractive possibility for future research. Further work on the response of offshore structures to extreme loads, damages states and the fatigue and crack growth mechanisms is envisaged. Other possible research areas include transportation of oil and gas, environmental effects monitoring and subsea systems engineering.

Infrastructure and Construction in Harsh Environments: Research on infrastructure and construction for harsh environments is definitely one of the main research objectives for the civil engineering group during the next 5-10 years. The anticipated development of the lower Churchill power project and the Voisey’s bay project will generate unique research activities in this area.

2.2 Electrical and Computer Engineering Discipline

Process followed

At two well-attended discipline meetings in November and December 2002, issues related to Academic Program Review were discussed in detail. Most Electrical and Computer Engineering (ECE) faculty members attended the Faculty Retreat in November, and actively participated in discussions. At a couple of ECE meetings in January 2003, several aspects covered in this report, such as capacity and enrolment, teaching equivalencies, etc., were discussed; furthermore, there were several email discussions among ECE faculty members on these topics. This report covers the main points of these discussions and concludes with a set of recommendations. Excepting a couple of items that are clearly indicated in the report, there was a consensus among ECE faculty members on the issues discussed here. The first draft of this report was prepared by Venkatesan, discipline chair, who also prepared this final version of the report after taking into account comments and suggestions from ECE faculty members.

ECE – a success story

Electrical Engineering was one of the original undergraduate programs started about thirty years ago. For the first ten years or so, under ten faculty members, fewer than thirty undergraduate students in each cohort and a very few master's students contributed to the strength of the program. However, in the mid 80's the demand for the program started to increase. The graduate student strength also increased, and this led to the introduction of doctoral program in EE (along with civil and mechanical engineering). In the past ten years, major strides have been made in terms of quality and variety of activities. An option in Computer & Communications was started in the mid-90's and a few years ago this evolved into a full-fledged Computer Engineering undergraduate program. ECE faculty members have been recognized by Memorial, APEGN, and IEEE as exemplary teachers. Every year, between 50 and 60 students graduate with undergraduate degrees in EE and COE. Currently, there are approximately 50 master's students and 12 doctoral students in ECE. Nearly 50% of all engineering thesis graduate students are in ECE. As all of the 18 ECE faculty members are engaged in research, the number of graduate students is expected to grow. Two of the ECE faculty members have been recognized as university research professors, and one of them holds a senior research chair in intelligent systems. Several AIF, CRC, and NSERC proposals are being developed in areas covered by ECE (sensor-based information, ASIC design, wireless communications, unconventional energy systems, etc.), and success of these efforts would further enhance graduate studies and research in ECE. Recently, ECE has been engaged in developing a course-based master's program in COE exclusively for students from China. This program is expected to begin in Fall 2004, and this would further augment the existing thesis-based graduate programs in ECE. Some of the ECE faculty members actively collaborate with the local industry – offshore oil & gas, mining, fisheries, high tech, and other sectors. Generally, collaborations between industrial organizations and ECE faculty members have been steadily increasing.

ECE – self-assessment and external feedback

ECE has been continually – almost every 3 or 4 years – revising and updating the curriculum, thus evolving and adapting the changes in the field. EE, COE and other undergraduate programs offered by our Faculty are among the best in the country, both in terms of contents and delivery. Our graduates and students are well appreciated by their employers, and there are numerous anecdotal evidences to this effect. The co-op nature of our programs has been a major plus point. Statistics collected by the Government indicates that ECE graduates have been very satisfied with the program in relation to their investment in education. Over the years, the discipline has collected feedback about our courses and programs, from certain handpicked students (all sincere students, but academically average, above average or exceptional) immediately upon graduation; this feedback has been uniformly very positive. On the other hand, we cannot confidently make a similar positive statement about the other aspects of our Faculty: graduate programs, research, CEE, or industrial outreach. We should go for quality, and not simply quantity, when we measure any of our achievements – programs, students, research publications, etc. For example, we should ask what we did with the research funding and not just how much money was got.

Undergraduate student enrolment

The recent unplanned and ad hoc growth in undergraduate student enrolment is the root cause for several problems that the Faculty is experiencing, as well as to other problems that are likely to occur. As this growth was somewhat synchronized with the crash of the datacomm industry, decline in the computing industry, and the upsurge of activities in the offshore oil & gas industry in the province, we have seen a huge increase in enrolment in the ME program and not in EE and/or COE programs. But, this could change within a short period, and we might see the tide shifting towards COE or EE or both. Unplanned increase in student enrolment causes many difficulties including classroom space, lab space, availability of technical assistance and laboratory technicians, availability of lab equipment, project supervision, and so on. If we continue operating in the present mode of unplanned and uncontrolled student enrolment, this would ultimately affect the quality of our undergraduate programs.

The university is aggressively recruiting students from within the province, other provinces and from other countries to ensure that the enrolment does not drop irrespective of the imminent drop in high school graduates in the province. It is conceivable that a good proportion of students coming from overseas (for example, from China and India) might pick engineering as their program of choice. Until now, about 90% of our students have come from the province, and we have offered admission to every student who has met our minimum entry requirements. It is clear that we cannot continue operating like this in future. We should set limits for the number of students in each program based on critical courses or resources and also a limit on the total number of students in a cohort.

Our Faculty's problems in recruitment would be somewhat different from those of the university. For example, we have not been able to attract all (or almost all) qualified Newfoundland & Labrador students into our engineering programs – especially with respect to women students who form only about 15% of the total. After deliberating these matters, the Faculty should come up with clear policies on how to select students from the pool of applicants. Any increase in enrolment should be planned and adequate increases in resources should be sought and received.

Although some students might have declared Engineering as their major when they are in Term A or Term B, we effectively admit students into the program only when they reach Term 1. When they reach Term 3, they choose their disciplines. We could consider other entry models, for example, admitting students directly into the engineering program (or into the disciplines) after they complete high school.

Need for the Faculty to evolve into a "high quality research faculty"

The Faculty has never come out and declared that we wish to be a research faculty, and have never made plans to become one – in terms of seeking and deploying resources such as: starting research grants for new faculty members, investing Faculty money in selected research areas (excepting OERC in over 30 years), graduate student travel support, subsidy for PDFs, graduate student support (except for a couple of years when the FRET account was about to disappear). Until now, undergraduate teaching has remained the main (nearly the sole) preoccupation of our Faculty. Graduate teaching, research, community support, continuing engineering education, and industrial outreach have remained voluntary activities left to the enthusiasm of individual faculty members. Although the Faculty has not taken concrete steps to become a research unit, the P&T committees have been raising their expectations in terms of publications and funding levels. This dichotomy will have to be addressed in a concerted fashion.

Need for implementation of teaching equivalencies

One of the factors limiting our Faculty into excelling in research is the non-implementation of teaching equivalencies. The Faculty should approve and implement a teaching equivalency policy that calculates the teaching load (lab courses, project supervision, graduate student supervision, instruction of reading courses, participation in major external committees, etc.) and reduce this load for those who wish to do substantial research. Other ECE departments in the country and even other units within Memorial do this. The MUN-MUNFA collective agreement expects every unit to develop such an approved teaching load policy. Engineering happens to be one of the last units not to have an approved policy in this regard, although an attempt to develop such a policy was made in 1996. Implementation of teaching equivalencies is an essential first step to ensure that our faculty members have sufficient time to pursue other scholarly activities such as research, industrial outreach and so on. However, it is easy to recognize that teaching equivalencies cannot be implemented all of a sudden, as this would significantly worsen our teaching shortage situation. Therefore, implementation of teaching equivalencies should be planned along with concomitant growth in faculty strength.

"Uniqueness of ECE" within the Faculty

The ECE discipline has, for many years, acted as a cohesive unit, and ECE faculty members have a sense of identity in much the same way as those in a department. Candid and detailed discussions on academic and all other issues are commonplace in the regular ECE meetings. ECE faculty members, in general, display a higher sense of civic responsibility through their active contribution to the discipline, Faculty and University committees. Similar to a department in its role, the ECE discipline has been taking responsibility not only for the undergraduate programs but also for the graduate programs in the discipline. Almost all ECE faculty members are active in research through seeking research funds, supervising graduate students and disseminating the results of their research through journal publications and conference presentations. Most of the changes to the engineering undergraduate programs were initiated by ECE faculty members; some examples are: changing the academic term when students decide their disciplines, the newly introduced computer engineering program, research chair initiatives, and so on. Therefore, many ECE faculty members believe that they are a unique group within the Faculty, and that this fact needs to be recognized through appropriate administrative restructuring of the Faculty. Disciplines are poorly defined and fuzzy subunits that are visible only to those within the Faculty. There is a strong desire within ECE that the university should be persuaded to start treating individual disciplines as separate academic (or teaching) units, if not as separate administrative units.

Visibility outside of Memorial is also a problem when the faculty is not departmentalized. For example, at conferences, when all other ECE faculty members identify themselves with their departments, Memorial ECE faculty members feel disadvantaged not to be able to do this, thereby implying that Memorial has a small and possibly weak ECE group. Some ECE faculty members believe that the current APR process is flawed because the various disciplines are not treated as separate 'programs', but the whole Faculty is treated as one 'program'. The original request by the Faculty that an expanded review committee be struck recognizing that there are four disciplines (that offer five UG programs) within the Faculty was turned down. The internal process was also changed from a discipline based self-study process to a centralized one.

Departmentalization

ECE faculty members believe that comparing our EE (or COE) program to the other EE (COE) programs across the country is more reasonable than comparing our EE (COE) program with our civil or mechanical engineering program. Similarly, the workload, research production, and other such metrics should be compared between ECE faculty members at Memorial and those other ECE departments in the country. Unfortunately, as the Faculty is not departmentalized, such comparisons are not possible. In other words, across the university, our Faculty is viewed as one large department; consequently, CIAP does not provide the necessary figures in the Fact Book. While recommending that comparison of metrics are important to identify any existing problems, ECE faculty members strongly believe that just numbers, by themselves, are not important, but quality should be the main consideration. Most of the ECE faculty members believe that the current discipline-based faculty structure masks the true caliber of ECE, and limits the ECE discipline from realizing its full potential.

One of the main disadvantages of a non-departmentalized faculty is that the discipline has virtually no role in the budget process. The Dean is the only person in the Faculty who sets the priorities and determines how the budget should be spent. Occasionally, the Dean collects information from discipline chairs regarding the needs of the discipline, but makes no allocation; the discipline chair or individual faculty members are required to check with the Dean on every item that needs to be procured. There is a wide consensus emerging within the Faculty that disciplines should be given an annual budget allocation. Unlike civil, mechanical or naval architectural engineering programs, the ECE programs require very little start-up costs. On the other hand, ECE programs demand that equipment, instruments, computers, software and electronic components should be procured on a continual basis. In a non-departmentalized faculty, ECE has to compete with the other disciplines for every purchase, and there is no recognition within the Faculty that ECE should be treated differently in this regard. During the past six or seven years, the procurement procedure has been centralized without any allocation for the needs by the various disciplines. This has started to seriously impact on the quality of the ECE laboratories and projects.

The control of the undergraduate and graduate programs is currently with the Faculty-wide committees. The academic control of the programs should be left to the disciplines who design these programs and offer the courses contained in these programs.

Currently, there exist strong collaborations (in terms of research and teaching) between the various disciplines in the Faculty. However, these collaborations are not visible to those outside the Faculty, as the whole unit is considered as one entity. If the Faculty is departmentalized, it will be easier for these collaborations to be recognized. For example, for initiatives such as CRC and AIF, collaboration with other units is expected for any proposal to succeed. Although there might be a very strong collaboration between civil, mechanical and ocean & naval architectural engineering disciplines on a particular proposal, it would appear to the Faculty as if the collaboration component is lacking in the proposal. Compared to our situation, another proposal that shows collaboration between Physics, Mathematics and Computer Science would be preferred.

On the other hand, some people have noted that departmentalization would create walls between different units, thus discouraging collaborations. Some opine that such deterioration can be limited and deferred as the Faculty smoothly transits from a non-departmentalized to a departmentalized unit. It has been pointed out that relationship among faculty members has not been harmonious in some of the departmentalized engineering faculties. However, it has not been established that the root cause for such problems is departmentalization, but often such difficulties arise due to personalities and polarization based on non-academic factors.

Some faculty members have pointed out that departmentalization would increase administrative overhead and create inefficiencies. Several shared facilities, for example, some laboratories, might have to be duplicated. Most ECE faculty members believe that a departmentalized faculty could still retain shared resources, where possible. It has also been argued that, if departmentalization means inefficiency, then we can ask why certain units within the university are allowed to operate inefficiently whereas efficiency is expected out of the Engineering Faculty. Memorial has the last non-departmentalized engineering faculty in the country, and several ECE departments are much smaller than Memorial's ECE discipline. Some have noted the avoidable duplication of responsibilities that currently exist between the associate deans and the discipline chairs, and the inefficiency and confusion resulting from this could be saved if the Faculty is departmentalized. This is not a unanimous view of the ECE discipline, but a good majority of the ECE faculty members would like to see the Faculty departmentalized as soon as possible.

Recommendations

1. We believe that the undergraduate EE and COE programs are modern and of high quality. We should ensure that any measures taken by the Faculty will maintain, and improve, on the existing quality of these programs.
2. The Faculty should plan undergraduate student enrolment and put in place adequate resources to handle the current enrolment as well as any planned increase. The Faculty should develop plans to increase the numbers of graduate students and increase the vitality of our graduate programs through a commitment to increased course offerings, improved computer and lab support for graduate courses, etc.
3. The Faculty should clearly spell out its objective to evolve into a high quality research faculty, and take necessary actions to fulfill this objective.
4. The Faculty should identify and state its intentions regarding research expectations from individual faculty members, make necessary plans, and support research of faculty members consistent with the faculty's expectations in terms of promotion & tenure.
5. The Faculty should evolve a policy on teaching equivalencies and implement it as soon as possible.
6. The visibility of the disciplines should be improved within the University and outside. The university should treat disciplines as separate academic (or teaching) units.
7. Disciplines should be given an active role in the budget process. Disciplines should be given control of the undergraduate and graduate programs in their areas.
8. Costs and benefits of departmentalizing of the Faculty should be investigated immediately and suitable action taken by appointing an external review committee, if necessary. This study should be commissioned immediately without waiting for a majority acceptance of the concept within the faculty.

2.3 Mechanical Engineering Discipline

The report of the Mechanical Engineering Discipline to the Academic Program Review is divided into six sections: (1) Academic Program; (2) Faculty Complement; (3) Enrolment Capacity; (4) Facilities; (5) Technical Support; and (6) Budget. Presented within each section are the comments of the Discipline on the current situation of the Faculty, and suggestions on how these concerns can be addressed.

Academic Program

The Mechanical Engineering program has seen several changes in the last few years. A Manufacturing option was developed, and a new option in Offshore Oil and Gas Engineering (OOGE) was implemented. This section will discuss recent changes to the program, identify areas of concern, and conclude with the plan for the future direction of the Discipline.

The OOGE option has been successful in attracting mechanical engineering students. Close to 50% of the mechanical students have chosen the OOGE option. It appears that it will be successful, since the Faculty has now hired more faculty to teach the option. Mechanical students in the OOGE option have expressed interest in the Term 6 Industrial Materials and the Term 8 Corrosion courses. Both of these courses are very appropriate for mechanical engineers working in the offshore oil and gas field, and some means of accommodating student requests should be incorporated in the OOGE program. The current management of the OOGE option causes some difficulty as there are three OOGE faculty that are members of the Mechanical Discipline, and the assignment of teaching tasks has been somewhat disorganized as the Associate Dean is running the OOGE option. Some thought should be given to placing the OOGE option within a discipline.

The Manufacturing option was not successful. It was implemented without an analysis of student interest, and the faculty complement was not increased appropriately to offer the option. To operate effectively, the option required two faculty, but only one was hired, and that person was diverted to management positions. The manufacturing option was rolled into the regular Mechanical Engineering program in 2001, by offering four elective courses in the manufacturing area during the last two academic terms. It has not been possible to offer many of these courses during the past two years, as the faculty member in the manufacturing area resigned. We have been trying to replace this position for two years and have recently interviewed candidates.

Some recent changes in the mechanical program have had a very positive effect. The Production Technology course has been moved from Term 6 to Term 3. This has had the effect of improving student attitudes to projects in later semesters, and to ensure that the students will fabricate designs in the senior design courses. The automatic controls section of the program has been greatly enhanced with the introduction of the Term 4 Electromechanical Systems course. This course gives the students hands on experience with controllers, sensors and actuators prior to the theory of controls. It has resulted in a much better attitude of the students towards a difficult subject area, and has facilitated the introduction of a challenging design project in the later controls course.

The offering of the senior design course has been revamped in an attempt to get students and faculty more involved with courses. This has been somewhat successful, however, more iterations will be required before the courses will be offered in a suitable manner.

The Discipline has incorporated more advanced software packages into courses. For example, the students were introduced to MatLab in Term 3, which they use in Terms 4 and 6 controls courses. Solid modelling software and finite element packages are used in Term 7 courses. Further, more faculty are incorporating the web into their teaching, and using electronic aids in the classroom. The Faculty has always encouraged the use of computers in courses, and the Mechanical Discipline expects to increase their use in the near future.

The Discipline has instituted a yearly review of the different areas within the program, i.e. thermo-fluids, mechanics, controls, mathematics, and design. The goal is to discover any weaknesses and address them before they develop into larger problems. Also, the Discipline is aiming to keep the material, presentation, and practice up to date. This process will lead to changes in the mechanics stream in the near future.

The Discipline is considering the implementation of one significant project per semester. This has been tried in a few semesters with excellent results. The students have been very enthusiastic about the projects. The projects have served to engage students with the courses, and aided in the teaching of design, application of course material, problem solving skills, and group interaction.

The Discipline plans to adopt one software package for use by the students. The MatLab software appears to be the favoured package due to its potential application in many fields. An experiment was performed in the Fall of 2002 to determine if the software package could be implemented beginning in Term 3. That experiment was successful, and it appears that the package can be introduced after the Term 2 Structured Programming course. More advanced applications of the software can be given in later courses.

Two major problems the Discipline will be addressing are weaknesses in mechanics and mathematics. These problems stem from the changes to Terms 1 and 2 several years ago. Both mechanics and mathematics were reduced to two four-hour per week courses from three three-hour per week courses. In the case of mechanics the result is that the students are ill prepared to tackle system problems, for example when a system must be broken into its component parts. This creates difficulties in vibrations, controls, and design.

Another problem, which results from a reduced faculty complement, is that courses in mechanical engineering may be taught by Civil faculty. This causes the focus of courses such as Finite Element Methods (FEM) and Solid Mechanics to be directed towards structural engineering applications, with a resultant de-emphasis on dynamics, stress analysis, and thermo-fluids applications in the case of FEM. The Discipline plans to propose modified Solid Mechanics courses, but the only way to address the FEM difficulty is for the Discipline to begin teaching the course.

Due to limitations in faculty complement the Discipline cannot offer well defined options, therefore, it proposes to continue to offer a program that develops well-rounded engineering graduates with a good knowledge of engineering fundamentals, well-developed problem solving skills, and experience with the latest software appropriate to the field.

Faculty Complement

The Mechanical Discipline has a complement of sixteen faculty, including the vacant position in manufacturing. Of this number ten faculty should teach four courses, two research Chairs should teach two courses each, the Chair has a load of three courses, and only one mechanical course is taught by the three OOGE personnel. This gives a total available teaching assignment of forty-eight courses. Assuming the following teaching tasks for the mechanical faculty:

- Terms 1 and 2 - six sections
- Term 3 - four courses
- Term 4 - five courses
- Term 5 - five courses (including math)
- Term 6 - four courses
- Term 7 - four required and four elective courses
- Term 8 - two required courses and five elective courses

The total number of teaching tasks is thirty-nine, which can increase to forty-two courses with multiple sections or if additional Term 2 teaching is required. On paper, the balance between teaching tasks and available teaching assignments is acceptable. In 2002-03, however, two faculty are on leave, one faculty is not teaching, and the manufacturing position is open (i.e. a loss of fourteen teaching assignments). Further, given a reasonable, but still small, graduate teaching load of five courses, the number of available teaching assignments is reduced to twenty-nine. This year the Mechanical Discipline is short by nineteen teaching assignments. Obviously, some faculty are taking on extra teaching, electives are not being offered, and the Discipline is relying on sessionals. The Discipline is not offering thirty-nine courses. For example, only four courses are being offered in each of Terms 7 and 8.

Assuming that all faculty were teaching their full complement of courses, the Mechanical Discipline requires two new positions (i.e. eighteen total) to offer the current undergraduate program, and a reasonable choice of graduate courses.

Enrolment Capacity

The number of students in Mechanical Engineering has increased significantly in the past ten years. The latest class has seventy-three students. The current capacity of the Discipline is eighty students, as defined by limitations in laboratory courses. To increase significantly the capacity beyond eighty students will require investment in funds to expand laboratory facilities (i.e. duplication of laboratory setups, space, machine tools, etc.).

Due to increased enrolments the amount of time given to student evaluation has increased significantly. The Mechanical Discipline has probably been most affected by this, leading some faculty to reduce the number of tests given in certain courses. A means of addressing this difficulty is to allow Teaching Assistants to mark mid-term tests, which is done in other, larger, universities. This does require high quality Teaching Assistants, which may be a difficulty.

Since the Discipline is approaching its maximum capacity for student enrolment, consideration must be given to limiting the enrolment in the disciplines at the Term 3 level. Entrance to the disciplines could be on a competitive basis, with students required to submit their first and second choices of discipline. This process would also address a problem caused in the Co-op Office due to large fluctuations in Co-op placement requirements in each discipline.

A related problem to the increased enrolment is that the Faculty of Engineering still operates as if the class size is small. This does not have a significant effect on the Discipline Chair, but it has dramatically increased the workload in the Office of the Associate Dean (Undergraduate Studies) and the Co-op Office.

Facilities

The Faculty needs more classrooms with modern audio-visual equipment. Currently, only EN2006 and EN1040 have suitable equipment installed, however, in both rooms the camera-based system is not functioning properly (poor focus and exposure). Two portable machines are available, however, these will soon be inadequate as more faculty incorporate computer presentations in the classroom. Also, the image size for these machines is not large enough in many rooms. It is also difficult to use something as simple as an overhead transparency in several rooms due to inadequate equipment or image size problems.

The Faculty does a good job of maintaining internet connectivity and updating computers, however, computers should be updated more frequently as the use of software in courses has increased, and the modern software packages are memory intensive.

Many of the laboratory facilities used in Mechanical Engineering date from the opening of the S.J. Carew Building. Several of the thermo-fluids experimental setups have had to be retired recently. The Mechanical Discipline requires funds to rebuild its laboratories, and to develop new laboratories in the areas of controls and robotics.

Technical Support

The quality of our technicians is excellent, however, many of them will be retiring in the near future. To aid the continuous operation of the laboratories it would be very helpful if the Faculty was permitted to hire a replacement technician before our current technician retires. Our technicians have gained much experience and knowledge during their tenure at the University, and it is very inefficient (and costly) to not use that in-house experience for training of new personnel.

Since many of our technicians were hired (approximately thirty years ago) there has been a significant change in the technological requirements of their positions. We are having difficulty attracting new personnel, as we are expecting many requirements of new hires, but the salary and benefits, or terms of positions are not attractive. Human Resources must be made aware of the difficulties we face when trying to replace technicians, and should proactively attempt to reduce these difficulties.

Budget

Currently, the Disciplines provide input to the budgeting process. This allows the Disciplines to provide, in essence, a wishlist for the upcoming year. But that is the extent of the participation in the process. The Disciplines have no control of how the money budgeted to the Faculty is spent, there is no feedback to the Disciplines as to where money is allocated and how it is allocated, and there is no budget allocation for a Discipline. Student enrolment in a Discipline is not taken into account when allocating money within the Faculty, whereas the University allocation to the Faculty is based on enrolment. It is difficult to do any planning for laboratory upgrades, for example, when the Discipline is unaware if money has been allocated for those expenditures. The Disciplines should be more involved in the budgeting process.

2.4 Ocean and Naval Architectural Engineering Discipline

Background – self assessment

The aims of this program, the only full undergraduate degree program in Ocean and Naval Architectural Engineering in Canada, are to provide a place where Canadians may be educated in this discipline and to ensure that there will be an adequate pool of highly qualified personnel to draw on for these vital and innovative national ocean industries. The program has been developed to include aspects of importance to ocean and offshore engineering, in addition to naval architecture, and this is emphasised also in the title of the program. More than half of recent graduates from the program now work in the offshore oil and gas industry on jobs pertaining to the design, construction and operation of offshore facilities or in support industries to these operations.

The students are instructed in all areas of the marine and ocean industry from ship and offshore platform design, construction, management, marine engineering, underwater vehicles, physical oceanography, environmental and safety aspects, to performance of ship and ocean structures, dynamics and model testing, to provide them with the grounding for a career in one of a variety of ocean related occupations. A general engineering education forms the major part of the curriculum.

Graduates of the program are currently finding rewarding opportunities in the offshore industry and these are especially popular due to the increase in activity in the Canadian offshore oil and gas industry. A large section of our graduates now work in this industry in Houston, Texas. From informal feedback we know that many US employers class our graduates to be amongst the best from any engineering school teaching this subject in North America.

Presently, class sizes vary from about 10 to 20 per year and this has doubled over the last 10 years. This is a unique program in Canada and there remains more opportunity to attract students to the program from other regions of Canada. Presently 33% of our students come from outside of Newfoundland and Labrador, mainly from other parts of Canada and with a small percentage from outside of Canada. We regularly receive enquiries about the program from all over the world as well as enquiries for students in other ocean and naval architectural engineering programs to spend a part of their studies here at MUN.

Teaching activity

The core program is the same for all engineering disciplines, but from term three onwards, there are 34 courses, 17 of which are common to another engineering discipline and 17 of which are discipline related. Fifteen of the discipline related courses are unique to the discipline and two more are ocean science related. The program consists of a primarily fixed program with one technical elective in academic term 8. Since 2001 an option in Offshore Oil and Gas Engineering has been available from term 6 onwards. The ocean science courses are taught by Earth Sciences (E7601 Geosciences in offshore engineering) and the Department of Physics and Physical Oceanography (Phys4300 Advanced physical oceanography) and are included by design to provide breadth to students in the understanding of the oceans and their resources. Partly due to the interdisciplinary nature of the program, the discipline is a strong supporter of the non-departmentalized nature of the Faculty.

The curriculum includes the main areas needed for an engineering degree program in ocean engineering and naval architecture and prepares students for a career in this industry. Also, many of our students have progressed on to do a master's degree and some have completed Ph.D. programs either at Memorial or elsewhere. In the last 9 years, in which there have been 80 graduates, 8 have completed M.Eng. degrees, 2 are completing their Ph.D.s, 4 are completing their M.Eng. degrees and at least 1 is studying for an MBA.

Many of our students from outside of the province transfer in with advanced standing from other engineering programs, especially mechanical engineering. In order to facilitate this at advanced level, we have designed two of our ocean and naval architectural engineering courses as distance education courses for internet delivery. These include: E3054 Ocean Engineering Hydrostatics and E8003 Small Craft Design. Ocean Engineering Hydrostatics was available in this format in Fall 2002 and Small Craft Design is available in Winter 2003.

Research and creative activity

The faculty members in the discipline are extremely active (above the faculty average) in research and consultancy through numerous projects and links to industry. Some examples are: an NSERC Strategic Project on offshore environmental engineering using autonomous underwater vehicles involving several industrial and government research laboratory partners; contracts from Transport Canada on the development of new Polar Shipping Rules involving interaction with the main ship classifications societies and international harmonisation meetings; development of roll tank stabilisation systems for several Newfoundland fishing vessels with funding from the Canadian Centre for Fisheries Innovation; work on the development of offshore safety evacuation systems; an NRC/NSERC project on innovative podded marine propulsors involving industry and government research laboratory partners; maneuvering of ships in ice; image analysis for navigation purposes; bulbous bow design and pitch reduction for fishing vessels. Many projects respond to practical need, others pursue curiosity driven research. Most projects involve multiple disciplines both from within and outside engineering and the present structure of the Faculty supports the formation of these interdisciplinary teams.

The Ocean Engineering Research Centre is integral to the Faculty of Engineering and Applied Science. All of the faculty members in the discipline are involved with the Centre and the last two Directors of the Centre, over the last 10 years, have been from the discipline.

The following areas are current areas of research in the discipline that are special or unique:

- design of structures for iced environments (ships and offshore structures)
- propeller-ice interaction
- ocean environmental risk engineering
- underwater vehicles design
- ship rolling assessment and reduction
- extrapolation for compound propulsors – including podded propulsion

The following are areas of research strength we plan over the next 5-10 years:

- autonomous underwater vehicles use for ocean environmental monitoring
- design of marine vehicles for iced environments
- podded propulsor design and evaluation
- offshore and ship safety systems
- offshore ecological risk assessment
- advanced fishing vessel design

Some examples of awards/special appointments in the discipline are:

Don Bass - Ocean Engineering Research Award 1998
Neil Bose – President's Award for Outstanding Research 1992; Association of Professional Engineers and Geoscientists in Newfoundland, Teaching Award 2000; Member of the Environmental and Sustainable Development Strategic Projects Panel B of NSERC.
Claude Daley – Director, Ocean Engineering Research Centre and Director of the Engineering Outreach Centres.
Mahmoud Haddara – Ocean Engineering Research Award 1997; APEGN Award of Merit
Brian Veitch – Petro-Canada/Terra Nova Chair in Ocean Environmental Risk Engineering.
Mary Williams – appointed Director-General, IMD, NRC, from September 2002.

Graduate students:
Ayman Mahfouz – OMAE best student paper award in Ph.D. category 2001.
Susan Molloy – The Birks Medal 2001.
Rehan Sadiq – David Dunsiger Award 2002; nominated for the Governor General's Award 2002; finalist for NSERC doctoral prize 2002.

Professional and community service

Faculty members in the discipline are heavily involved in a variety of service. Examples are:

- Executive members of the Canadian Atlantic Section of the Society of Naval Architects and Marine Engineers and founding members of the Canadian Atlantic Branch of the Royal Institution of Naval Architects – Brian Veitch; Neil Bose; Mahmoud Haddara.
- Liaison/advisor to the MUN Student Section of the Society of Naval Architects and Marine Engineers – Brian Veitch.
- Members of technical committees, e.g.:
  - Brian Veitch - CSA Offshore Structures Working Group on Floating Structures, 2001 - ; International Towing Tank Conference, Environmental Committee.
  - Neil Bose – International Towing Tank Conference, Chair of the Powering Performance Prediction Committee 2002-2005; Propulsion Committee 1999-2002; Chair, Specialist Committee on Unconventional Propuslors 1996-1999; Secretary, Powering Performance Committee 1993-1996.
- Employers of numerous engineering work term students from Memorial and elsewhere; and WISE students, grade 11 women high school students.
- Conference organizing committees, e.g.: Offshore Mechanics and Arctic Engineering international conference, St. John's, 1999; 25th Office of Naval Research Conference, St. John's, 2004; Canadian Marine Hydrodynamics and Structures Conference, every 2 years (St. John's in 1991 & 1999); SP2001 Lavrentiev Lectures St. Petersburg, 2001; CANCAM 2001; etc.
- The research journal *Oceanic Engineering International* is published by the discipline (Editor – Neil Bose) and several other members are Associate Editors in this or other journals.
- Most faculty have been involved as reviewers for NSERC and other funding councils or serve on evaluation committees of funding organizations such as the Atlantic Canada Petroleum Institute.
- Most of the research projects in the discipline are heavily linked with industry and/or government research laboratories.
- Work for the Association of Professional Engineers and Geoscientists in Newfoundland: Mid-term and Examining Board interviews; specialist committees; etc.

Physical resources

The discipline has access to extensive laboratory facilities which includes, specifically related to the discipline, a 58m long towing and wave tank, part of the Fluids Lab. Students also make use of facilities at the National Research Council's Institute for Marine Dynamics, primarily for graduate projects, but also on occasion for undergraduate work.

The discipline has a Senior Design Lab. for undergraduate student use. This serves as a senior classroom and as an area to do laboratory work specific to the discipline, such as ship lines plan drafting, senior design projects and computer analysis. As this laboratory is specifically set up for naval architectural work, the drafting tables are of a size (nominally 6ft x 3ft) suitable for the layout of large floating structure and ship drawings. The Lab. is used for the assembly of the hardware associated with many senior design projects. There are nine computer stations in this laboratory and a printer.

Future plans

Teaching Capacity and Succession Planning

Recruitment of faculty members to the Ocean and Naval Architectural Engineering discipline is aided by the uniqueness of this program in Canada, although the pool of qualified candidates is extremely small. We have had one resignation which took effect from September 2002 and another faculty member may soon take a research role with reduced teaching and administrative responsibilities (Canada Research Chair). We also expect 2 retirements over the next 5 years. An application has been made to for one junior faculty member to teach within the discipline and an application has been made for an NSERC Chair in Design Engineering: Offshore Systems and Structures. It will be necessary to replace retirements with younger members.

By early 2003 we will have the capability to teach only 10 of the 15 undergraduate and minimum of 2 graduate teaching assignments. This does not account for leaves due to sabbaticals: one faculty member is on sabbatical in 2002-3 and two faculty will be on sabbatical in 2003-4. We are covering the shortfall by extremely heavy use of sessional instructors and based on student feedback quality is beginning to suffer. We need the addition of at least **two** full time equivalent tenure track faculty members in the discipline to maintain the status quo. The research program of our unit is growing and yet this status quo does not include an increase in graduate teaching needed to support this increase. The two additional FTE faculty members are considered a minimum primarily needed to maintain the integrity of the unique undergraduate program in Ocean and Naval Architectural Engineering.

Senior Design Lab.

The Senior Design Lab. is in need of an upgrade to cope with our growing class size and the increased use of computers in the discipline. There is still a need for the large drafting tables in order to teach the basics of ship design and layout. However, there is a need for increased seating in the room, desk space, access to computers and network server, and improved heating and ventilation. There is also a need for improved projection facilities for the instructor, based around a computer projection facility. Various discussions have been held on this with Facilities Management and approximate quotes for a major upgrade (where all desks are replaced and computers are provided throughout the lab.) have been placed in the region of $160-180,000. However, substantial improvements can be made in the following ways (note that costs are very approximate):

	Item	Approximate cost
1	Replacement of drawing table mats to improve surface quality, replacement drafting splines, weights, planimeters, curves, etc.	$7,000
2	Computer and projection facility for instructor (including window blinds)	$30,000
3	Upgraded heating and air conditioning – air quality and temperature control is problematic	$45,000
4	Replacement and increased seating	$10,000
5	Additional desks	$5,000
6	Network server	5,000
7	Computer work stations x 5	12,000

Towing/Wave tank facility

The towing/wave tank facility in the Fluids lab. is used extensively for undergraduate teaching, graduate student projects and commercial contract work through the Ocean Engineering Research Centre. There has been a complete turnover of the technical staff in this facility with the result that there is a need for training of the new staff for their existing roles and to accommodate changes in technology. There needs to be improved storage for existing equipment, models and instrumentation; and there needs to be a protocol for maintenance of the facility including carriage maintenance and water quality monitoring and filtering. The following table focuses on the requirements that have a funding need:

	Item	Approximate cost $
1	Storage area for models, instrumentation, etc.	10,000
2	Updates to computers for data acquisition	5000
3	Software and hardware for data acquisition, including training of technical staff	10,000
4	Dynamometer for side force measurement	10,000

Distance Courses

Distance (web based) courses and a laboratory course in naval architectural software are planned as discussed in previous sections.