Self-Study of Engineering Programs

Faculty of Engineering and Applied Science

January 31, 2014

EXECUTIVE SUMMARY

This document presents a self-study of the quality, success and outcomes of academic programs in the Faculty of Engineering and Applied Science. It aims to encourage the processes of academic planning, innovation and improvement in the programs, as well as alignment with Faculty's and University's mission and strategic plan. The self-study also identifies new opportunities and ways to pursue them. The self-study provides fresh perspectives from colleagues outside Memorial University. There was a process of consultative feedback from faculty, staff and students, FEAS Faculty Council, EASAC (Engineering and Applied Science Advisory Council), and other stakeholders.

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1. OVERVIEW

1.1 BACKGROUND

The Faculty of Engineering and Applied Science has a long, proud tradition and reputation of excellence in engineering education and research. Many faculty members are internationally renowned and award winning professors in their fields. The Faculty offers accredited undergraduate, masters and doctoral programs in civil, computer, electrical, mechanical, ocean and naval architectural engineering (unique in Canada), and process engineering, as well as research-based masters and doctoral programs in oil and gas engineering. Further course-based graduate programs are offered in oil and gas, environmental systems, computer engineering and engineering management. In total, these programs are offered to approximately 1,500 undergraduate and graduate students.

The undergraduate co-operative education program was among the first in Canada. This provides all students with exceptional work-study experiences at leading employers across Canada and internationally. A total of up to six work terms allows students to apply concepts and theories from courses to practical engineering work projects in industry and other organizations. Our graduates are highly valued by employers because of their strong academic background, practical work experience, and communication and inter-personal skills.

Graduate programs and research capacity in FEAS have grown rapidly. There are 12 research-based and 5 course-based graduate programs in FEAS. Graduate student enrolment in 2012 was about 330, comprising 27% PhD, 51% research-based masters, and 22% course-based masters students. About 20% of the graduate students are female and approximately 15% are part-time students. In 2012, the ratio of undergraduate-to-graduate student enrolment was approximately 3.6 to 1. About 70% of the graduate students are international, from 30 different countries. FEAS faculty members actively participate in graduate student supervisions. Based on recent data, the average number of graduate research students supervised per faculty member is approximately five.

Students have access to a wide range of facilities and laboratories. Some examples include the Instrumentation, Control and Automation (INCA) Laboratory; Software Engineering Laboratory (SwEL); Multimedia Communications Laboratory (MCL); Energy Systems Laboratory; Manufacturing Technology Centre; Computer Engineering Research Laboratories; Biomedical Engineering Laboratory; 54.7m Wave Tank; Strength Laboratory; Soils Laboratory; Environmental Laboratory; Intelligent Systems Laboratory (ISLab); Northern Region Persistent Organic Pollution Control (NRPOP) Laboratory; and the Thermo-Fluids Laboratory. Others include the Advanced Drilling Laboratory; Enhanced Oil Recovery Laboratory; Autonomous Ocean Systems Laboratory; Health, Safety and Risk Research Laboratory; Structures Laboratory; as well as process engineering laboratories in the Bruneau Centre for Innovation and Research. FEAS also holds close affiliations and access to on-site world-renowned institutes, namely NRC's

Ocean Coastal and River Engineering Institute, with a large ice tank, wave tank and sea-keeping basin, and C-CORE, which houses one of the world's largest geotechnical centrifuges.

1.2 FACULTY GROWTH PLAN

The Faculty is entering an exciting period of expansion. The Province of Newfoundland and Labrador has thriving offshore oil, ocean, energy, mining and information technology sectors, which have driven a rapid need and demand for engineers and research capacity in the Province. Through our "vision 2020" strategy, the Faculty plans to double over the next eight years, with a significant increase in its student enrolment and research capacity. From a baseline of 2011-12, we aim to increase undergraduate enrolment by about 50%, double our graduate student enrolment, hire 40 new professors and 24 new support staff through this decade. This includes up to 12 new faculty positions over the next 1-2 years, particularly focused on ocean, Arctic and offshore energy technologies.

This increase in enrolment and research capacity will require more physical space. Presently, the Faculty of Engineering and Applied Science is housed in the S.J. Carew Building and the Bruneau Centre for Research and Innovation. The new growth will require the Faculty to physically expand beyond the existing walls of the S.J. Carew Building. Along with additional students and faculty members, there will be further administrative support staff, including laboratory and information technologists. There will be new courses added and potentially new streams, options or programs of study. Currently the Faculty is at full-capacity in the S.J. Carew building so expansion will require more space.

Where will engineering acquire this additional space for offices, classrooms and teaching / research laboratories? Part of the answer lies in the province's recent announcement of new core science infrastructure for the St. John's campus. According to Dr. Gary Kachanoski, Memorial's president and vice-chancellor, this will allow for the creation of additional space for engineering and applied science to meet the province's need to expand engineering education and research.

"This is welcome news for Memorial and for the Faculty of Engineering and Applied Science," said Dr. Kachanoski. "Government support for redevelopment of our core science facilities and the doubling of engineering is a game changer for Memorial. Key strategic areas for the university and for the province are ocean technology, offshore petroleum and Arctic resources. This doubling of our engineering academic and research capability will strengthen our capacities in these areas. It's another great reason why we are increasingly being recognized as Canada's oceans university."

During the Faculty's strategic planning process and wide consultative feedback from faculty, staff, students and external stakeholders, the issue of FEAS organizational structure has arisen frequently. In upcoming years, as FEAS continues its rapid growth, changes to its organizational structure will better position the Faculty to realize and capitalize on its growth opportunities.

1.3 ORGANIZATIONAL STRUCTURE

The Faculty's current organizational structure of a single Administrative Head (Dean) for 65+ professors, rising to 80 in a few years, is not an effective management structure, especially as the number of professors in FEAS grows to 100 in the coming years. Although there are Discipline Chairs, these positions are not administratively defined in the faculty Collective Agreement.

A proposal for the creation of departments was unanimously approved by FEAS Faculty Council on July 3, 2013. The proposed start date of the new departmental structure is May 1, 2014. This new organizational structure will retain our Faculty's current strengths, while making changes to address areas of required improvement. For example, one of our areas of recognized strength is inter-disciplinary collaborations that are facilitated by shared use of labs, so laboratory space will remain centrally managed at the Faculty level.

The revised structure would include an activity-based budget model that reflects best practices of other engineering departments in Canada, which include incentive mechanisms for departmental research activity levels. The activity-based budget would include the following elements:

- budgeting methodology that is transparent and readily understood;
- minimal administration and workload for all concerned;
- flexibility to respond to changing circumstances and strategic direction by the Dean;
- incentives for academic program improvement such as curriculum streamlining, revenue generation, strategic innovations and efficiency improvements;
- incentives for taking on more graduate students, pursuing entrepreneurial activity and teaching students from other departments.

2. STRATEGIC OBJECTIVES

2.1 STRATEGIC GOALS AND PRIORITIES

The Faculty of Engineering and Applied Science has recently completed a 5-year strategic plan. The plan has four pillars – teaching, research, partnerships, and workplace – including specific goals, targets, action items, metrics and performance indicators. The action items are prioritized by number for each target (first item has the highest priority). Responsible individual(s) and group(s) are identified for each target. The main priorities, goals and targets and summarized below.

1. Creating the Conditions for Student Success

- Support teaching excellence
    - Provide professional development opportunities
    - Reward and foster teaching excellence for faculty and graduate students
    - Hiring focus on teaching excellence and / or potential
    - Support curricular development
    - Measure success
- Encourage student engagement
    - Update courses / curriculum
    - Strengthen co-op education and external engagement
    - Improve teaching and learning environment
    - Develop a continuous improvement process
    - Measure success

Progress toward these goals will be measured annually by the following performance indicators and annual metrics:

- Student retention and graduation rates;
- Number of courses improved and re-developed;
- Undergraduate student intake, by program, gender and visa status;
- Ratios of undergraduate students to faculty, as well as lab support staff, by discipline;
- Number of co-op education work terms, placement rates and ratios of student placements to CECs;
- Number of degrees awarded by program, gender and visa status;
- Number of Memorial engineering undergraduates entering Memorial graduate studies;
- Ratio of graduate courses per graduate student, by discipline;
- Annual reports by department heads and associate deans, including progress towards recruitment targets, new initiatives, streams / programs and improvements to programs and lab facilities.

2. Increasing Research Capacity

- Attract, retain and support research activities
    - Increase our research capacity

    - Recruit / retain top graduate students and increase funding for fellowships and research internships
    - Increase number of faculty holding NSERC grants and diversify funding sources.
    - Develop quantitative measures of research capacity and recognize research achievements
- Support research excellence and focus on areas of strategic importance
    - Align FEAS's research capacity with areas of strategic importance
    - Provide adequate space for research programs and ensure labs are well maintained and equipped
    - Improve administrative support and effectiveness of researchers' time.
    - Enhance the research culture in FEAS
- Expand engagement with partners
    - Increase collaborative research with industry, government and other partners
    - Foster and support student innovators, entrepreneurs and their spin-off companies to facilitate economic growth and job creation
    - Partner with the Province on provincial challenges
    - Increase faculty involvement in policy, regulatory and professional society activities

Progress toward these goals will be measured annually by the following performance indicators and annual metrics:

- Number of recipients of research awards, grants and contracts;
- Graduate students per tenure-stream faculty;
- Number of citations of research publications, by discipline;
- Percentage of faculty members holding NSERC Discovery Grants;
- Proportion of research funding from industrial sources, by discipline;
- Indicators of research activity and impact, to be developed by the Engineering Research Office;
- Number of faculty members participating in interdisciplinary, multi-Faculty and multi-University projects;
- Media coverage of Memorial's Engineering research stories;
- Annual reports by department heads and associate deans, including notable research achievements.

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3. Expanding Partnerships

- Expand partnerships that contribute to research
  - Expand partnerships within the Faculty, across the University and other universities
  - Increase collaboration with industry / gov't agencies
- Expand partnerships that contribute and strengthen our programs
  - Encourage multi-disciplinary collaboration on curriculum, programs and new initiatives
  - Engage in collaborative degrees and student exchange with institutions
  - Expand co-op education and internship opportunities
- Improve engineering and FEAS profiles in the community
  - Participate and increase community outreach activities
  - Participate in provincial curriculum development
  - Inform, direct or develop public policy
  - Continuing Engineering Education
  - Promote diversity in engineering
  - Enhance alumni and industry connections

Progress toward these goals will be measured annually by the following performance indicators and annual metrics:

- Number of partnerships with industry and other organizations in project collaborations;
- Number of schools participating in Memorial engineering outreach activities;
- Number of student teams competing in national and international events;
- Number of community outreach events;
- Number of other benchmarks, to be developed by the Industrial Outreach Office;
- Participation by Memorial engineering students, faculty and staff in outreach programs in the community;
- Annual reports by department heads and associate deans, including external engagement and outreach programs, by discipline.

4. Fostering a Distinguished Workplace

- Promote a culture in which all work is valued
  - Recognition of excellence in the workplace

- Promote excellence through personal growth
    - Develop an informal mentorship system
    - Develop mechanisms for professional and personal development
- Provide adequate work space for employees and FEAS activities
    - Provide space for all new faculty and staff
    - Provide space for new graduate students
    - Provide state-of-the-art teaching facilities
- Promote a safe, healthy and respectful work environment
    - Promote a safety culture and safe environment
    - Promote work / life balance, diversity and respectful work environment

Progress toward these goals will be measured annually by the following performance indicators and indicators:

- Faculty/staff ratios;
- Use of communications tools and news stories to promote Faculty awareness and visibility;
- Number of new faculty members who have a mentor;
- Number of faculty and staff who attend professional development workshops and leadership programs;
- Attendance at faculty social events;
- Surveys and feedback from faculty, staff and students;
- Annual reports by department heads and associate deans on workplace initiatives

2.2 ALIGNMENT WITH UNIVERSITY STRATEGIC PLAN

The FEAS strategic plan was developed to be consistent with Memorial's strategic plan. The key priorities were shaped by the University's frameworks on teaching, research and external engagement. To strategically position the Faculty in alignment with MUN's strategic areas and future opportunities, FEAS aims to expand its capacity in faculty and infrastructure to build upon four key areas – ocean technology; environment and sustainable infrastructure; information and communication technology (ICT); and energy. These areas align closely with identified strategic areas of priority for the University – Arctic and northern regions; Environment, energy and natural resources; Information and communication technology; Oceans, fisheries and aquaculture.

1) Ocean Technology. The Faculty offers a unique accredited program in Canada, namely Ocean and Naval Architectural Engineering (ONAE). It has a number of outstanding research facilities, such as the Offshore Engineering Research Centre (OERC). FEAS also has affiliation to on-site world-renowned institutes, namely NRC's Ocean Coastal and River Engineering Institute and C-CORE. Ocean technologies are major elements of the provincial economy, with over 50 firms in the Province with projected annual revenues increasing from $250M/year in 2011 to $1B/year in 2015 (source: Department of Innovation, Business and Rural Development website, Government of Newfoundland and Labrador.)

   Engineering operations in the North Atlantic and Arctic regions require specialized and advanced ocean technologies. The Faculty's expertise with the North Atlantic will be further strengthened and leveraged into new areas of strategic importance to the Province. Current expertise in the Faculty includes engineering of offshore oil and gas installations, safety, ocean vessels, subsea systems in Arctic regions, autonomous marine vehicles and hydrodynamics.

2) Environment and Sustainable Infrastructure. FEAS has extensive expertise in the protection of the environment and engineered systems to reverse environmental damage. This includes clean water supply, human health risk assessment, water resources, bioremediation in cold regions, climate change, coastal and marine pollution mitigation, and cold regions infrastructure.

   The province's infrastructure, including roads, highways, bridges and homes, will be expanded and transformed over the next decade. Sustainable design and operation of this infrastructure is a key area that will be further strengthened in future hiring in targeted areas that complement these capabilities. Sustainable infrastructure is an inter-disciplinary challenge and involves multiple fields of engineering.

3) Information and Communications Technology (ICT). One of the Faculty's areas of major strength is ICT, as well as a key economic contributor to the Province, with over 550 firms generating annual revenues of about $577M/year in 2012. ICT is also one of the four strategic priorities of the Industry Canada's Science and Technology Strategy. As a result, it is a significant and strategic area of the Faculty that will be strengthened by the planned future expansion.

   The specific areas of ICT strength in the Faculty include software, computer engineering, communication networks and control systems. Areas of active research include the acquisition, processing, and communication of information, as well as communications technologies of wireless, underwater and optical communications, autonomous aerial vehicles, and the security and privacy of wireless communications. In addition, the need for fast and reliable computing and software are key areas of existing strength in the Faculty. Present research activities include modeling and simulation, digital hardware design, reconfigurable, parallel / distributed computing, and safety critical computer systems.

4) Energy. Oil and gas exploration, development and transportation, as well as renewable energy, are key areas of strength within the Faculty. FEAS holds a number of industry sponsored research chairs related to oil and gas technologies, as well the recipient of major corporate investments such as the $6.8M Suncor Energy Offshore Research and Development Centre. The energy industry is a major economic driver of the Province, as indicated by provincial "mega-projects" such as Hebron, Lower Churchill, Hibernia, Terra Nova and White Rose.

   Current areas of strength in FEAS include enhanced oil recovery, safety, enhancement of reservoir recovery rates, reduction of drilling costs and environmental issues, such as potential discharge from offshore installations. In addition, renewable energy is a valuable provincial resource and area of strategic importance. Hydroelectric power is a major resource, particularly the Lower Churchill. Wind energy resources in Labrador have become an increasingly important opportunity in the Province. The challenges of energy distribution and integration of power generation will be important areas for development of these energy resources.

In addition, further growth will be targeted to selected emerging areas of importance (for example, petroleum, mechatronics, environmental and biomedical engineering) to capitalize on promising new areas of strategic importance and economic significance in the Province. Multi-disciplinary collaboration with other Faculties will be pursued in these emerging areas, for example, Earth Sciences (petroleum), Medicine (biomedical) and Business (engineering management).

2.3 EVIDENCE OF ACHIEVEMENTS AND EXCELLENCE

Since its inception, the Faculty has provided the highest quality of education, excellence in research, a vibrant learning environment and innovative programs. These elements provide our graduates with the skills needed to succeed and become tomorrow's leaders. The Faculty offers undergraduate, masters and doctoral programs in electrical, civil, computer, mechanical, ocean and naval architectural engineering (unique in Canada), as well as a recent process engineering undergraduate program (first accreditation in 2013). Further graduate programs are offered in oil and gas, environmental, and engineering management. The Faculty has an active entrepreneurial spirit that has led several students and graduates to start spinoff companies, such as VMT, Verafin, Extreme Ocean Innovation, among numerous others.

The Faculty holds external research funding from a number of government agencies, industry partners and other organizations, such as NSERC, CFI, CRC, AIF, ACOA, RDC, PRAC, and MITACS. Building this research capacity and training highly qualified personnel have been significant contributions from the Faculty towards the Province's mandate of skills development, economic growth and industrial competitiveness.

The annual external research funding of faculty members exceeds $16 million per year and is positioned to grow rapidly beyond its present level. Many of these research programs are multi-disciplinary, providing students and researchers with valuable experience of teamwork with different disciplines.

Annual external research funding is positioned to grow rapidly beyond its present level of about $16 million per year. Currently, several faculty members hold Canada Research Chair and Industrial Research Chair appointments. These include the Wood Group Chair in Arctic and Harsh Environments Engineering, Canada Research Chair in Ocean Technology, and Vale Research Chair in Process Risk and Safety Engineering. Recent new initiatives include a new $7 million Suncor Energy Offshore Research and Development Centre, and over $20 million in recent research grants involving enhanced oil recovery and design of ships and offshore structures in ice environments. Several new research chairs include the Husky Energy Research Chair in Offshore Engineering, Chevron Research Chair in Petroleum Engineering, and Statoil Research Chairs in Reservoir Engineering, among others in development. Further new research chair(s) involve Arctic resource development for CARD (Centre for Arctic Resource Development). CARD is a new $12 million centre that positions Memorial University among the foremost global leaders in Arctic resource research and development.

The Faculty's research programs are finding new solutions to global problems and educating future leaders, who will turn great ideas into new products and solutions to make the world a better place. FEAS is generating new knowledge and advancing the frontiers that will transform industry and society of the future.

3. UNDERGRADUATE PROGRAMS

3.1 OVERVIEW

The curriculum content and quality criteria are designed to assure a foundation in mathematics and natural sciences, a broad preparation in engineering sciences and engineering design, and an exposure to non-technical subjects that supplement the technical aspects of the curriculum. All students must meet all curriculum content and quality criteria. The academic level of the curriculum must be appropriate to a university-level program. Evaluation of curriculum content and quality is based on textbooks and other support materials for all core, program compulsory, and elective courses (not necessarily including non-technical elective courses) including:

- course outlines (lecture by lecture is best)
- lecture notes and visual aids,
- course materials posted on the web
- laboratory instruction sheets

The Faculty uses a system of block promotion (i.e., students are promoted or failed on a semester by semester basis). This cumulative promotional procedure ensures that graduation requirements are successively built up as the student proceeds through the program so that graduation requirements are automatically met upon successful completion of Term 8. Additionally, the Registrar's Office undertakes a final audit of each student's academic record to ensure that all the graduation requirements are met. Students complete and submit a Complementary Studies Audit form which is approved through the office of the Associate Dean (UGS) and then forwarded to the Registrar's Office to verify the completeness of their complementary studies component.

3.2 ENROLMENT PLAN

A "double cohort" of engineering students graduated in 2013, whereby two graduating classes were combined together when the undergraduate program shifted from 6 to 5 years in duration. There has been a steady rise in student demand for engineering programs and a growing need for bridging programs to accommodate students with three-year technical diplomas into an engineering program, in order to better meet the needs of employers and non-traditional student pathways. There is also a growing labour market demand for engineering graduate students with advanced levels of expertise.

The Faculty aims to increase undergraduate enrolment by about 50% (approximately 500 additional undergraduates by 2020; about 100 additional students in each of the 5 years of programs). Through a consultative process with a wide range of stakeholders, as well as examining national trends, a plan of future enrolment growth was developed (see Table 3.1).

Discipline	Class of 2016 (actuals)	Projected market growth to 2020 [1, 2]	Planned growth of graduating class by 2020
Civil	42	11%	19% (50)
Computer	14	15%	43% (20)
Electrical	29	5%	38% (40)
Mechanical	65	10%	15% (75)
ONAE	21	10%	90% (40)
Process	13	10%	92% (25)
TOTAL	184 students		250 students

Table 3.1: Projected FEAS Enrolment Growth (2012 – 2020)

The following references were used in the planning of this projected enrolment growth:

1) Engineering Labour Market Conditions, 2009 – 2018, Prism Economic and Analysis, 2010 (note: index of employment, across Canada, year 2007 = 100);

2) Newfoundland and Labrador Labour Market – Outlook 2020, Department of Human Resources, Labour and Employment, 2011.

During this growth of student enrolment, the Faculty will uphold its high program reputation and quality, so as to not sacrifice quality at the expense of quantity. A separate base funding envelope from the Province for MUN's engineering expansion strategic initiative would ensure the necessary extra resources are available to support the growth plan. The demographics of Newfoundland and Labrador alone may not allow the Faculty to increase enrolments without affecting standards, so there will be increased efforts to recruit more students from across Canada, North America and the world. MUN Engineering has a proud tradition of excellence in its standards of education, which will continue to improve throughout this growth plan.

In the strategic plan, better accessibility for a diversity of students from various parts of the Province will be pursued, as well as better student retention rates. These initiatives will allow FEAS to admit students with entrance averages compatible with past admission requirements which existed before the onset of major resource constraints prior to our growth plan.

3.3 PROGRAMS

I. CIVIL ENGINEERING

The Civil Engineering Program provides comprehensive coverage of the traditional civil engineering areas of specialization (geotechnical, hydrotechnical, structural, construction and environmental engineering). The program also offers an offshore oil and gas option with related specialization of petroleum, safety and risk, reservoir, environmental and process engineering.

The objectives of the civil engineering program at MUN are to:

- Maintain a strong grounding in mathematics, basic and engineering sciences, and engineering design fundamentals.
- Introduce students to aspects of the ever changing nature of civil engineering, computerization, material science, and the concepts of sustainable development.
- Provide, through mandatory complementary studies courses, an appreciation of the legal, social, cultural, and economic challenges faced by civil engineers in society.

The program is continuously monitored through feedback from current and former students, work term employers and CEAB. It is improved upon at every opportunity to ensure the achievement and continued relevance of the objectives.

The civil engineering program has a strong emphasis on design. In the structural area, students take courses in construction materials, design of concrete structures, steel structures and structural building systems. The students are introduced to the theory and rationale behind the actual design codes and are given open-ended real life design problems. In the geotechnical area, students are introduced to design of slopes for stability and foundation design. In the

water resources and environmental area, the students take courses in hydraulics that cover the analysis and design of pipeline and pumping systems, channels, hydrology and water resources that deal with hydrologic design of storm sewer systems and design flood estimation. In hydrotechnical engineering, students take courses that deal with the design and analysis of open channels, energy dissipation, surge tanks, and regional frequency analysis design flood and low flow estimation. Municipal engineering covers the design of water distribution systems, waste water systems, and the design of water and waste water treatment systems and environmental geotechniques that cover environmental legislation, landfill design, soil contaminant interactions, landfill site management, and geosynthetics. In the construction area, the students are introduced to the different types of contracts, project delivery, project management techniques for network planning and scheduling.

Civil engineering offers a unique capstone project format. That format has been adopted by some other universities in the country. The project course involves practicing professional engineers, from the local consulting and construction firms that act as clients. Those engineers bring in real-life design problems to teams of 4 – 6 students. The design teams operate under a self-assigned student team leader or project manager. The course instructor and the faculty members that are involved in the course are registered professional engineers with industrial experience. The main criteria for successful completion are the degree of satisfaction of the outside client with the professionalism of the completed project. In general, clients have been extremely impressed by the quality of work done by the student teams.

The civil engineering offers labs in most of its courses. The objectives of the labs are to reinforce the theory that the students learn in class and to give them hands-on experience necessary in understanding engineering testing and related design issues. The labs are offered in mechanics of solids, materials of construction, reinforced concrete, Geomatics, Geotechnical, Hydrotechnical and Environmental areas.

The co-operative education model is an important aspect of the civil engineering program. In addition to the professional values that the students learn, it provides an opportunity for the students to be exposed to the different areas of civil engineering. Our students have great success in securing workterms in the construction, consulting, oil and gas and offshore areas. The workterms add academic knowledge and instil a strong professional attitude in our students. There is a strong demand for civil engineering. The target enrolment estimates to term 3, based on the Faculty growth plan, are as follows:

2017	2018	2019	2020	2021
T3 (2013)	T3 (2014)	T3 (2015)	T3 (2016)	T3 (2017)
54 Actual (56)	**55**	**56**	**57**	**58**

Table 3.2: Projected Civil Engineering enrolment growth

Civil Engineering has identified three key priority areas of focus in its future growth: 1) sustainable infrastructure (design and construction); 2) environmental engineering and sustainability; and 3) Arctic and offshore engineering. The civil engineering will be introducing three new undergraduate streams in 2014 in in structural / construction engineering, environmental engineering and water resources; and/or Arctic and offshore engineering. The streams would suit the interests and needs of undergraduate students and the civil engineering needs of the province and country.

II. COMPUTER ENGINEERING

The Computer Engineering curriculum leads to a strong broad-based program with a good balance of courses in hardware, software, communications and computer applications. Although there is an opportunity to specialize, the degree of specialization is limited so that all students have reasonable knowledge of all central areas of Computer Engineering.

The software component of the program is especially strong with courses in structured programming, object oriented programming, data structures, software design, algorithms, concurrent programming and real-time systems. In addition to these core courses, elective courses in computer science topics (such as artificial intelligence and computer graphics) give a full complement of courses in the area.

Digital and computer hardware design and communications are also areas of focus for the program. In the hardware area, core courses in digital logic, microprocessors, digital systems (including FPGAs and hardware description languages) and computer architecture, as well as the elective course in LSI design, provide a solid foundation for students wishing to pursue a career in microelectronics or computer hardware. In communications, core courses in communication principles, networks, signals and systems (analog and discrete-time) and digital communications provide the foundation with electives in digital signal processing and communication electronics providing choices for students to tailor their studies in the area.

Electrical and Computer Engineering students take a common program up to and including academic term 3, and share many courses throughout their program. This leads to a strong commonality between the two programs, and also enables the two programs to be offered in a manner that uses Faculty resources efficiently.

The co-operative education aspects of the Computer Engineering program prove to be a major asset. Through their co-op work terms, students are able to develop a deeper understanding of their profession. Co-op work terms often provide an opportunity for students to sample their areas of interest to refine their future career directions. Generally, the level of professional exposure to students during their work terms dramatically increases their maturity in their approach to solving engineering problems and ensures that Memorial graduates are prepared to enter the work force upon graduation from both the perspective of academic knowledge and professional attitude.

Consistent with the Faculty growth plan, the enrollment estimates and targets for Computer Engineering are as follows:

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
T3	19	24	28	30	30	30	30
T4	16	20	24	26	26	26	26
T5	14	14	17	20	22	22	22
T6	10	13	13	16	19	21	21
T7	10	13	13	16	19	20	20
T8	16	10	13	13	16	19	20

Table 3.3: Projected Computer Engineering enrolment growth

In the past several years Computer Engineering has not been attracting as high a proportion of the Engineering student body as it previously did, and we see this as a significant challenge to meeting our growth targets. While this is consistent with trends across the country, we would like to address it and so we are undertaking a study to determine why Engineering One students are not choosing Computer Engineering. Early indications and anecdotal evidence suggests that there is a strong perception that Computer and Electrical Engineering are more challenging than other disciplines. Comparatively high attrition rates, particularly in terms 3 and 4, help to reinforce this perception.

In order to achieve the above growth targets we will need to attract more students to enter the program who have a high likelihood of success, and do a better job of retaining those who we do attract. The following are some steps that we intent to take to address this.

- Revisions to Engineering One curriculum and teaching to better highlight the applicability of Computer Engineering and to reassure students that it is achievable and rewarding.
- Development of new options or specializations that more attractive to students. Some possibilities include Biomedical Engineering or specializations related to renewable energy and sustainable development.
- Review of pedagogical techniques to ensure that we are using the most appropriate techniques at various stages of the program so as to give students the best opportunities for success.
- Targeted recruitment efforts in the Province in high- and junior-high school levels to raise awareness among the students of the possibilities in Electrical and Computer engineering.
- Targeted national recruitment efforts, particularly going to regions where EE and CoE are favored disciplines (e.g., the ‘905’ area) and where Memorial’s strong reputation in Engineering will be recognized.

- Targeted international recruitment efforts, particularly reaching to populations where English is commonly spoken and EE and CoE are favored disciplines (e.g., India).

III. ELECTRICAL ENGINEERING

The Electrical Engineering curriculum leads to a strong broad-based program with a good balance of courses in fundamental areas of electrical engineering such as power, controls, electromagnetics, communications, and computer hardware and software. Although there is an opportunity to specialize, the degree of specialization is limited so all students have reasonable knowledge of all typical areas of Electrical Engineering.

The power component of the program is covered through introductory courses on circuits, courses in electromechanical devices and rotating machines, a course on power system analysis and elective courses in power system operation and power electronics and renewable energy systems. In the area of controls, courses include signals and systems courses, introductory controls, industrial controls and instrumentation, supervisory control and data acquisition and an elective in higher-level control systems.

Electromagnetics courses begin in Term 5 and consist of 2 core basic electromagnetic courses and an elective in antennas. Communication courses consist of core courses in signals and systems and communication principles and elective courses in communication networks, communication electronics, digital communications, and digital signal processing. Computer-related courses include courses in programming and data structures, digital logic, and microprocessors, with an elective in design of digital signal processing systems.

The non-credit, block promotion nature of the program is an important strength. It ensures uniform background preparation and competence. It also enables some degree of integrated treatment and connectivity in the areas of mathematics, engineering science and engineering design. The result is a program that is coherent.

The co-operative education aspects of the Electrical Engineering program prove to be a major asset. Through their co-op work terms (four to six in the program), students are able to develop an appreciation of their profession. Co-op work terms often provide an opportunity for students to sample their areas of interest to refine their future career directions. Generally, the level of professional exposure to students during their work terms dramatically increases their maturity in their approach to solving engineering problems and ensures that Memorial graduates are prepared to enter the work force upon graduation from both the perspective of academic knowledge and professional attitude.

Other important strengths of the program include:

- the small class size for discipline based courses (typically 10 - 40 students per class), which allows close student-faculty interaction and valuable educational experience

- the strong design component in the electrical engineering design course in Term 5
- the capstone design course (offered in term 7 and term 8) which is team based and involves professional engineers from outside the university
- the high number of courses in the program (51 University credit courses, 141 credit hours required for a degree) which allows greater flexibility and an opportunity to provide a strong foundation in the fundamental principles of engineering
- the good laboratory and computing facilities supported by good technical shops and staff
- the commitment to graduate studies and research, shared by all faculty members in the Discipline, creating an environment in which undergraduate students participate in engineering research and development through final year projects.

Consistent with the Faculty growth plan, the enrollment estimates and targets for Electrical Engineering are as follows:

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
T3	33	40	50	60	60	60	60
T4	28	34	43	51	51	51	51
T5	25	24	29	36	43	43	43
T6	31	23	23	27	34	41	41
T7	30	23	22	27	33	40	40
T8	31	30	23	22	27	33	40

Table 3.4: Projected Electrical Engineering enrolment growth

Electrical Engineering has followed similar enrollment and retention challenges in recent years as has Computer Engineering and so the analysis and plan outlined above for Computer Engineering will also apply to Electrical Engineering.

IV. MECHANICAL ENGINEERING

The mechanical engineering curriculum at Memorial University stresses building a solid foundation of engineering science and engineering design. In addition, the program provides the opportunity through mandatory complementary studies courses for students to be prepared in issues related to the professional engineer in society, effective communication and other issues extending beyond specialized technical matters.

The mechanical engineering program is a broad-based offering that provides a strong grounding in fundamentals, a balance between engineering science and engineering design, and practical “hands-on” experience. A unique feature of the mechanical engineering program is the multidisciplinary curriculum with an emphasis on integration of components into systems and opportunities for innovation in design and problem solving. Courses on mechanical design

introduce the fundamentals of engineering design as applied to practical mechanical devices. As students advance through the program, they are introduced to Computer-Aided Design (CAD), Computer-Aided Engineering (CAE), and rapid prototyping technologies that enable them to develop detailed designs of mechanical components using the latest computer software and tools. Another aspect of the mechanical engineering program is the thermo-fluids stream (thermodynamics, fluid dynamics, and heat transfer). In these courses students learn how to perform energy balances, the fundamentals of fluid flow and drag, and how to determine rates of heat transfer in mechanical components.

Approximately one year ago, the Mechanical Engineering Discipline formulated a vision statement and growth plan for the next five years. The mechanical discipline vision for undergraduate education is to instill a solid background in the fundamentals of mechanical engineering as well as practical and applied knowledge in key areas that support the competitive industries that are currently driving the economy of Newfoundland and Labrador. As such, four areas or themes in which the discipline can grow strategically and effectively were proposed: 1) Thermo-Fluids; 2) Mechatronics; 3) Mechanics and Materials; and 4) Petroleum.

The recently adopted changes to the mechanical engineering curriculum endeavored to better align the technical electives offered in the undergraduate program with the thematic areas identified in the mechanical engineering vision statement. The four technical streams are made up of a set of six technical stream electives; one technical elective in term six, two in seven, and three in eight.

The undergraduate mechanical engineering program currently has the highest enrolment within the Faculty of Engineering and Applied Science. The Term 3 mechanical cap is currently set at 75 students; however, in recent years, the actual intake has been higher (i.e. 82 in Fall 2012 and 2013). Since the introduction of the new program in 2009, enrollment in mechanical engineering core courses for academic terms 3 to 6 has always exceeded 60 and has been as high as 234 in some fundamental course (i.e. ENGI 3934 Dynamics in Fall 2009 due to the double cohort).

Given that the mechanical engineering program already has the highest undergraduate enrolment of the six undergraduate programs, a relatively modest increase in the number of graduates per year is projected; on the order of 75 students graduating in 2020. This increase will be achieved primarily through improved retention rates as opposed to a significant increase in the Term 3 mechanical engineering cap which is forecast to grow to no more than 90 students by 2020. Clearly no incremental growth in the number of students can take place without additional resources including new faculty positions, teaching labs and classrooms. One of the keys to improving retention rates is providing better student mentorship through smaller class sizes and significantly smaller laboratory and tutorial sections particularly in semesters three and four.

The Mechanical Engineering Discipline aims to grow strategically in the following four thematic areas of research: 1) Sustainable Energy Systems; 2) Mechatronics, Modeling, and Intelligent Systems; 3) Materials, Mechanics, and Design; 4) Petroleum Production and Operations.

The priorities and goals of Mechanical Engineering over the coming decade are summarized as follows.

GOAL 1: *Improve the teaching and learning environment at the undergraduate level.*

A higher faculty complement will allow more opportunity to add graduate courses, supervise more graduate students, and take full advantage of the numerous research opportunities that are currently available within the province. Specific initiatives are described below.

- Class sizes for mechanical engineering students need to be reduced. Courses that are offered to more than one discipline (i.e. math, mechanics of solids, materials) can be split into multiple sections.
- Eventually an upper limit on the class enrolment should be placed on classes, once sufficient resources become available.
- Core courses should be offered in an appropriate venue with the appropriate furniture and pedagogical aids, i.e., not in the auditorium.
- Core courses should have multiple tutorial sections staffed by sufficiently qualified and well-trained Teaching Assistants (TAs).
- A faculty-wide initiative to develop new undergraduate teaching labs is recommended. Faculty members who volunteer to develop new labs should be recognized and supported appropriately.

GOAL 2: *Improve the research culture within the discipline.*

- Reduce the normal teaching load for faculty members who are maintaining an active, funded research program and who are supervising an appropriate number of graduate students. The teaching load should be more comparable to other research intensive faculties of engineering across the country.
- Take more proactive measures to attract a significantly higher number of exceptional M.Eng. and Ph.D. students.
- Provide the resources and support necessary to allow faculty members to take full advantage of the numerous research and funding opportunities that are currently available within the province.

GOAL 3: *Investigate the viability of new programs, options, and/or technical streams.*

A number of new programs or technical streams as follows could potentially be spun off from the existing mechanical engineering program.

- Marine Engineering. This initiative would be well aligned with the Faculty strategic research plan and could be offered in conjunction with the ONAE Discipline. Since many of the required courses (i.e.; fluid machinery, fluid power control) are of general interest to all mechanical engineering students, high enrollment numbers are expected.
- Product Development, Management, and Innovation. This research and potential technical stream focuses on the engineer as a manager, leader, and driver of technological innovation, as well as a critical thinker. The group working in this area, namely Professors Hsiao and Fisher can grow by at least one new member to complement and support work developed in the other theme areas.
- Mechatronics. A program in Mechatronics Engineering could also be envisioned. In general, there is a high demand for mechatronics graduates and several successful programs have been launched at a number of Canadian Universities (Waterloo, Simon Fraser, Western Ontario).
- Biomedical Engineering. A promising future initiative between the Faculty of Medicine and the Faculty of Engineering and Applied Science is an interdisciplinary program in Biomedical Engineering. Biomedical Engineering encompasses a wide variety of research and teaching areas including cardiovascular engineering (i.e.; vascular stents and catheters), bone fracture and biomechanics, biological materials and biomimetics, drug delivery systems, and biomechatronics.

V. OCEAN AND NAVAL ARCHITECTURAL ENGINEERING

The Ocean and Naval Architectural Engineering (ONAE) Discipline was introduced at Memorial University in 1980 with the first graduating class of two students in 1982. Since that time, annual enrolment has grown to approximately 30 students. The Faculty members are a small but vibrant group. As the only undergraduate ONAE program in Canada, and one of a few in North America, the group has a strong regional, national and international reputation in education, research and professional involvement. Faculty members hold leadership roles provincially, nationally and internationally in organizations such as Oceans Advance, CMAC, UNCLOS, IMO, OMAE, ISSC, ITTC, CSA-ISO. Graduates from the ONAE program enjoy a high level of industry demand and are recognized for the quality and practicality of their education. ONAE graduates play key roles in industry and government, nationally and internationally, creating global 'brand' recognition for Memorial in the ONAE field.

Currently the ONAE group teaching and research are at full capacity as enrolments and research activities have grown. The undergraduate program is currently capped at 30 students per year based on limitations of faculty and available classroom and lab space.

The current capacity limit means that ONAE faculty are unable to contribute to the core first year engineering courses, offerings of ONAE electives are restricted, and graduate course

offerings are very limited. All ONAE faculty members have some level of teaching relief, due to high research commitments. Due to its high level of activity, the group has had to decline opportunities such as research projects, continuing engagement and outreach requests.

The Vision and Mission for the ONAE group are provided as follows. It mission is to be an academic centre recognized internationally by students, scholars and partners as a leader in education and research in ocean and naval architectural engineering and technology. Its mission is to excel in the delivery of engineering education and engineering research through: relevance in teaching; innovation in research; links to industry; focus on cold ocean engineering; and engagement in our community.

Memorial University has identified Oceans and the Arctic as core themes to differentiate this University and to focus on issues that are relevant to our expertise and the interests of the community around us. The ONAE group can contribute significantly to this university-wide theme.

The aim of the ONAE program is to provide an academic environment where Canadians can be educated in a field that is vital to a country with enormous marine interests on three coasts and in three oceans and to ensure that there will be an adequate pool of Canadians to draw on for vital national ocean industries and interests. The nature of the field requires an international outlook, and the program recognizes this in a variety of ways. In the last six years, the program has grown from typical class sizes of 15-20 to typical sizes of 25-30. This has occurred in conjunction with the introduction of the new “vision 2020” program and the simultaneous growth in research activity in the ONAE group. Many recent graduates from the program 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. There is also a new emphasis in Canada on shipbuilding, with branches of the federal government planning significant new construction activities.

Students are educated in all areas of the marine and ocean industry from ship and offshore platform design, construction, management, marine engineering, environmental and safety aspects, to basic research in ship and ocean structures and dynamics. This provides graduates with the grounding for a career in a variety of ocean related occupations. Our overall goal is to develop and maintain a leading education and research program in Ocean and Naval Architectural Engineering as a unique technological field, providing rewarding opportunities for graduates and supporting ocean engineering and technology industries in Newfoundland and Labrador and worldwide.

The ONAE group has developed strategic plans in three areas: Undergraduate Programs, Graduate Programs; Research and Industrial Outreach. Although these are identified separately, all four issues are closely related and the expectation is that all members of the faculty group will be active participants in all activities. Ocean technology is a multi-disciplinary arena and Memorial University has identified the oceans and the Arctic as theme areas of broad

interest. They should also be of broad interest within the Faculty of Engineering and Applied Science and ONAE will seek to engage other disciplines in ocean and Arctic related research.

ONAE's goals for the undergraduate program in the coming 10 year period are listed as follows:

1) Double the undergraduate program intake to 55 by 2018, by recruiting in Newfoundland & Labrador, Canada, and internationally. This goal is realistic as there is adequate student and industry demand to support this level of enrolment.
2) Increase the breadth and depth of the Undergraduate course offerings to provide students with more elective choices and streams in Ocean Engineering and Naval Architecture.
3) Contribute to teaching in the core engineering program and collaborate with other disciplines in the ocean engineering area.

VI. PROCESS ENGINEERING

The process engineering program provides graduates with a strong background in process equipment design and selection, process modelling and simulation, plant design and operation, process safety and risk assessment. A balance between engineering science and engineering design is maintained and the necessary background in fundamental sciences is provided. These theoretical components along with the hands on experience in the laboratories and the mandatory co-op work terms provide graduates with the knowledge and skills to succeed as process engineers.

The overall focus of the program is on sustainable engineering practices and approaches; i.e. applying environmental, health and safety, and process intensification concepts to the processing industry. This emphasis on green and clean engineering is a response to societal, industrial and student demand for "Sustainability" in process engineering. This is one of very few such programs existing today in North America and it is a response to the resource depletion and environmental mitigation challenges that are becoming more and more critical as time goes on.

The program includes the common first year program (Engineering One) for the Bachelor of Engineering degree. A firm foundation in the fundamental sciences and the engineering sciences is built during this period. The Engineering One program relies on the Faculty of Science for the basic introduction to science and mathematics topics. The first year is a credit-based, flexible entry program in which students compete for their discipline of choice starting in the second year. All process engineering students follows a mandatory program of study up to Term 6. In Terms 7 and 8 elective courses are available in two areas namely Minerals and Metals Processing; and Downstream Oil and Gas Processing.

Special emphasis on design is considered throughout the program starting from the early stage with a course in the first year to introduce the design process and capture student interest.

Equipment design is introduced in Term 5 and 6 and then plant design is carried out in Term 7 and 8, as two separate but related capstone courses. Design elements are included in most of the courses offered in the program. The practice of teamwork is promoted in the design components of the courses for strengthening teamwork skills.

Use of engineering software is another strong aspect of the program. A separate course, namely Process Simulation, is offered in Term 7 where students use simulation software (currently HYSYS) to simulate individual components as well as an entire plant. This course also provides students the background in simulation to perform details analysis in their plant design course. In addition to this, specialized software is regularly used (e.g. LoopPro (ENGI 7621), Matlab (ENGI 5621)).

The program has significant laboratory components as part of different courses (details in Table 3.4.7). The laboratory facilities house state of the art laboratory equipment to demonstrate separation processes, chemical reactions, materials processing as well as concepts of fundamental sciences. An advanced process control laboratory having the facilities to demonstrate advanced process control technologies is currently being commissioned.

3.4 CO-OPERATIVE EDUCATION

One of the main strengths of Memorial's engineering programs generally is the mandatory co-op component of the program. There are ten full-time professional engineers who act as Co-op Education Co-ordinators (CEC's). This is a tremendous resource and a significant part of the reason why the co-op program is so successful. Students, faculty and staff alike are very proud of the program and its connections to industry.

The Bachelor of Engineering Degree at Memorial is set up as a block-based, mandatory co-operative degree program, under which regular full time academic study alternates with terms during which students must complete a minimum of four and maximum of six full-time work terms (see pages 232-242 of the 2012-2013 University Calendar).

Although academic credits are not assigned for the practical work experience, successful completion of the work term requirements is prerequisite to graduation. The Registrar's Office in cooperation with the Undergraduate Studies Committee, and the Office of Cooperative Engineering Education and the Office of the Associate Dean (Undergraduate) undertake an audit of each student's academic record to ensure that work term requirements are met.

The details of the work term component of the co-operative degree program including the program objectives, requirements, procedures and expectations are outlined in the Engineering Student Co-op Handbook.

Successful progress through the program is dependent upon satisfactory completion of each term, be it academic term or work term, before moving on to the next term. Recent analysis of work term placements indicate that 95% of our students complete 5 or more work terms and

the remaining 5% complete 4 work terms. A minimum of four work terms is required for graduation.

The objectives of the work term component of the Co-operative Engineering Program are embodied in the following work term descriptions. The rate at which a student might achieve them depends on the prevailing economic conditions, variation in employment opportunities and requirements, and the student's capability. Although it is expected that each student will meet the established standards by the end of work term 6 it is recognized that each student's development rate over the six work terms will differ. The descriptions therefore serve to guide the student and employer toward achieving these objectives and to guide the faculty in monitoring and evaluating each student's progress.

001W Engineering Work Term 1

Work Term 1 represents, for most students, their first experience in an engineering or related work environment. Students are expected to learn, develop and practice the basic standards of behavior, discipline and performance normally found in a professional work environment. Students are also expected to learn the basics of technical writing and to become familiar with the various communications tools used in a technical work environment.

Two documents must be submitted for evaluation for the communications component for Work Term 1. Additional communication requirements such as technical reports or manuals may be requested by the employer. The two documents to be submitted to the Engineering Co-operative Education Office are the Personal Job Diary and the Work Term Journal or Short Technical Report or Portfolio. Detailed guidelines for the preparation of these documents are provided in the Co-operative Student Handbook.

002W Engineering Work Term 2

Work Term 2 requires students to have sufficient academic grounding and work experience to contribute in a positive manner to the engineering design and problem solving processes practiced in the work environment. Students are expected to show greater independence and responsibility in their assigned work functions than in Work Term 1. An ability to deal, under supervision, with complex work-related concepts and problems should also be demonstrated. Students can become better acquainted with their chosen discipline, and can observe and appreciate the attitudes, responsibilities, and ethics normally expected of engineers.

The communications component for Work Term 2 consists of a formal, descriptive technical report describing a technical process, project, procedure or investigation chosen from the student's work environment. Students are also expected to keep a job diary, which will not be submitted but must be available for review during monitoring.

003W Engineering Work Term 3

Work Term 3 requires greater participation in the student's selected engineering discipline. Students become more experienced and proficient with the appropriate design procedures

than in the preceding work terms. Students are expected to acquire improved speed and accuracy in their work and at the same time accept greater responsibility and be able to function with less direct supervision. Self-confidence and initiative as well as improved analytical skills are expected to develop at this stage in the student's engineering education

The communications component for Work Term 3 consists of a formal technical report on a topic related to a specific theme prescribed by the Faculty and the Co-operative Education Office. Examples of themes would be sustainable development and environmental stewardship. Ideally the report would relate to the student's work in the areas of process, project, procedure or investigation.

004W Engineering Work Term 4

Work Term 4 requires students to engage in various facets of engineering, such as design, analysis, project management, specifications, plans, formal proposals, tender documents, etc. Participation in their selected engineering discipline is expected. Students should continue to gain an appreciation of the use and importance of acquired analytical skills in engineering analysis as well as the application of specifications and codes. Students should have a level of responsibility commensurate with their academic background and experience.

The communications component for Work Term 4 consists of an oral presentation on a technical subject taken from the student's work environment and preferably related specifically to the student's work. The presentation should be of 10 minutes duration and will be given on campus in a formal setting after students have returned to class. A written summary is also required.

005 Engineering Work Term 5& 006W Engineering Work Term 6

Work Terms 5 and 6 require students to engage in various facets of engineering, such as design, analysis, project management, specifications, plans, formal proposals, tender documents, etc. Participation in their selected engineering discipline is expected. Students should continue to gain an appreciation of the use and importance of acquired analytical skills in engineering analysis as well as the application of specifications and codes. Students should have a level of responsibility commensurate with their academic background and experience.

3.5 ADMISSION STANDARDS

Applicants to the Faculty of Engineering and Applied Science fall into one of three categories:

- High School Applicants;
- Memorial University of Newfoundland Applicants (current MUN Students);
- Transfer Applicants.

High School Applicants and Transfer Applicants must first apply for admission to the University according to the criteria detailed on pages 60-67 in the 2012-2013 University Calendar.

High School Applicants

High school applicants admitted to the program who are admissible to the required Engineering One courses Mathematics 1000, Physics 1050 and Chemistry 1050 are expected to be able to complete the Engineering One requirements during their first two semesters at Memorial University. Students have three semesters to complete the first year requirements if required. Weaker students are encouraged to spread their course load out over three semesters. Entry is competitive and based on the expectation of student success. The average of all admission averages ranges between 85 – 90%.

High school applicants who are not admissible to these courses, but who are interested in pursuing an engineering degree, are encouraged to contact the Faculty and to discuss an appropriate first-year program with the Associate Dean (Undergraduate Studies).

Memorial University of Newfoundland Applicants (current MUN students)

To be eligible for consideration for admission to Engineering One, students who are attending or have previously attended this University must have a cumulative average of at least 60% or an average of at least 65% on their most recent 30 attempted credit hours and be admissible to (or have previously completed) the Engineering One courses Mathematics 1000, Physics 1050 and Chemistry 1050. Admission is competitive and only high academic performers are admitted through this route.

To be eligible for consideration for admission to Academic Term 3, students who are attending or have previously attended this University must meet the requirements stated in the Promotion Regulations, Promotion Status (Engineering One). Admission is competitive. Providing spaces are available and the student's promotion average is competitive, students compete equally for their choice of discipline.

Transfer Applicants

Applicants seeking admission through transfer from accredited post-secondary institutions must have achieved a minimum overall average of 60% to be considered for admission. Admission is competitive.

A student's placement within a program, and requirements needed to complete the program, will be determined on an individual basis at the time of admission. Transfer applicants must complete a majority of the credit hours in their program at Memorial University of Newfoundland. Students do not normally get advanced standing in the program due to the block-based structure of delivery.

The Faculty's Admissions Committee, in consultation with the Registrar's Office through the Office of the Associate Dean (Undergraduate Studies), adjudicates admissions of applicants to the engineering programs. The Committee's decisions are guided by the admission regulations and criteria described in the University Calendar. The likelihood of an applicant succeeding in the engineering program is the primary criterion used by the Admissions Committee to reach

decisions on applications for admission. All admissions are based on a competitive process for the available seats.

3.6 PROMOTION AND GRADUATION

The regulations for promotion are defined on pages 243 - 244 of the 2012-2013 University Calendar. In general, promotion from Engineering One is on a credit basis, whereas progress through the engineering program from Term 3 and beyond is on the basis of block promotion.

Promotion from Engineering One to Academic Term 3

An overall average of at least 65% on the following nine courses: Mathematics 1001, Mathematics 2050, Physics 1051, Chemistry 1050, English 1080 (or equivalent), Engineering 1010, Engineering 1020, Engineering 1030 and Engineering 1040, with a grade of at least 55% in each of these courses.

Students in Engineering One must complete the requirements for promotion to Academic Term 3 before the end of the academic year of admission, or they will be deemed to have withdrawn from the program.

Students are assigned to their discipline preferences based on their Engineering One promotion average. Students who are in the Faculty and achieve the minimum requirements are guaranteed a place in Term 3 but they are not guaranteed their choice of discipline.

Promotion beyond Engineering One

Clear Promotion - Academic Terms: A promotion average of at least 60% and a grade of at least 50% in each of the courses included in the calculation of the promotion average is required. The promotion average is calculated to be the overall average of the required courses completed in the semester (including technical electives) excluding complementary studies, focus stream electives and free elective courses.

Work Term: A grade of PAS (Pass) or PWD (Pass With Distinction) is required in order to be promoted from the work term. Work term grades are based on a performance component as well as a communications component.

Probationary Promotion (from Academic Term only)

Probationary promotion results when a student's promotion average is at least 60%, but she/he received less than 50% in any course(s) during that particular semester. The student will be able to continue to the subsequent work term, but must successfully pass a re-examination for the failed course(s) before he or she is promotable to the next academic term.

Promotion Denied

When a student does not meet the requirements for Clear Promotion or Probationary Promotion, he or she will be denied promotion and is required to withdraw from the Faculty.

A student with Promotion Denied status may apply for readmission after two semesters. An academic term may be repeated only once, and not more than two academic terms may be repeated in the entire program.

The student will be required to repeat all required courses in which the student obtained less than 60% in that term.

3.7 MONITORING STUDENT PROGRESS

Faculty Council delegates to the CUGS Executive the function of a "grades and promotions committee" on behalf of Faculty Council. The defined membership of CUGS Executive ensures broad representation, including student participation.

Discipline Marks and Promotion Meetings

Discipline "marks meetings" are scheduled as soon as possible after term grades are submitted in such a way that it is possible for all course instructors to attend. The Undergraduate Studies office provides an advisory set of guidelines (reviewed/maintained by the CUGS Executive) for the conduct of marks meetings to each Discipline Chair in advance of those meetings, together with the summary statistics for each of the past five years for all courses taken by students in that discipline in that semester.

Each discipline will examine the grade distributions for the compulsory and technical elective courses in its major(s), identify any anomalies, note any explanations for those anomalies, and make recommendations to avoid such anomalies in the future as appropriate. This information will be forwarded to the CUGS Executive. The discipline will make a recommendation on acceptance of grades which it will also forward to the CUGS Executive.

Each discipline will consider the marks for all students in its major(s), in the presence of all available instructors. The Chair should have a detailed marks breakdown from any instructor who is absent. The meeting verifies the list of students who earn clear promotion under Clause 6.3.1 and the list of students who earn probationary promotion under Clause 6.3.2. If students are close to the 60.0 average, the discipline should consider carefully if there is any reason to consider any revision to course grades which could affect the average to bring it in line with the promotion requirements.

For students with averages below 60% the discipline then recommends whichever of FRn (fail, repeat term n), FRW (fail recommended to withdraw) or FQW (fail, required to withdraw) is appropriate. It may decide that a marginal student should have an interview with the discipline chair prior to the next academic semester. The purpose of any such interview is to check that any ongoing problems that are interfering with the student's likelihood of success are being addressed. The discipline also needs to watch for cases falling under Clauses 6.4.4 – 6.4.7 (insufficient number of work terms to be promoted into the next academic term) and Clause 6.4.9 (no required course may be attempted more than twice).

The disciplines forward their promotion recommendations to the CUGS Executive.

CUGS Executive Marks and Promotion Meeting

A CUGS Executive ”promotion meeting” will be scheduled as soon as possible after the discipline marks meetings to consider the recommendations of the disciplines. Each discipline shall be represented at the meeting (preferably by the person who presided at that discipline meeting). A report of the promotion meeting will be made at the next full Faculty Council meeting including the mean promotion average for each major in each term.

The CUGS Executive will review any recommendations from the disciplines regarding identified grade anomalies and it may also request explanations for any anomalies that no discipline has identified. The CUGS Executive will then make recommendations to the Dean on acceptance of the grades as well as issues surrounding grade anomalies.

The CUGS Executive then confirms and approves the lists of students who earn clear promotion under Clause 6.3.1 and the lists of students who earn probationary promotion under Clause 6.3.2 for each major. It then reviews and decides on recommendations from the disciplines for the various categories of denial of promotion. All of the CUGS Executive decisions are taken with the delegated authority of Faculty Council and are in effect from the end of the promotion meeting. Decisions formerly handled by Executive Action will be handled by the CUGS Executive at a secondary promotion meeting.

The CUGS Executive reports to the next meeting (regular or special) of Faculty Council the numbers of students in each major in each term who are in each of the categories:

- Clear promotion (with promotion average>=60);
- Probationary promotion (with promotion average >=60);
- Clear promotion (despite promotion average <60); (not normally given)
- Probationary promotion (despite promotion average <60); (not normally given)
- Promotion denied (repeating a term);
- Promotion denied (recommended to withdraw);
- Promotion denied (required to withdraw);

The CUGS Executive also reports any late decisions made after the main promotion meeting.

Note: The Admissions Committee, acting on delegated authority from Faculty Council, makes promotion decisions from Engineering One and makes the discipline preference assignments.

Appeal of Regulations - Faculty Appeal Committee

Appeals against decisions of the Faculty Admissions Committee and appeals against promotion decisions of Faculty Council will be considered by the Faculty Appeal Committee.

1) An appeal against promotion decisions of Faculty Council will normally only be considered upon presentation of evidence which has not been placed before Faculty Council.
2) Any such appeal must be made within one month of the issue of the decision of the Admission Committee or within one month of the issue of results by the Registrar, as the case may be.
3) When a student has requested a re-read of an examination paper which may affect an appeal that must nevertheless be made within one month of the issue of the original results, and consideration of the appeal will be delayed until the result of the re-read is available.

Any student whose request for waiver of Faculty regulations has been denied has the right to appeal. For further information, refer to the Academic Calendar – University Regulations– General Academic Regulations (Undergraduate) – Appeal of Regulations.

3.8 DEGREE AUDITING

The Faculty uses a system of block promotion (i.e., students are promoted or failed on a semester by semester basis). This cumulative promotional procedure ensures that graduation requirements are successively built up as the student proceeds through the program so that graduation requirements are automatically met upon successful completion of Term 8. Additionally, the Registrar's Office undertakes a final audit of each student's academic record to ensure that all the graduation requirements are met. Students complete and submit a Complementary Studies Audit form which is approved through the office of the Associate Dean (UGS) and then forwarded to the Registrar's Office to verify the completeness of their complementary studies component.

3.9 RESPONSIBILITY FOR ENGINEERING CURRICULUM

The FEAS Faculty Council holds responsibility for maintaining the standards and high quality of education and curriculum to meet the accreditation requirements of CEAB (Canadian Engineering Accreditation Board). It consists of engineering faculty members and co-op coordinators. A representative of the Professional Engineers and Geoscientists of Newfoundland and Labrador (PEG-NL) serves on Faculty Council. There are five student delegates, including three undergraduate students on Faculty Council.

Curriculum related issues are initiated and proposed by the Discipline committee and submitted to the Faculty Committee on Undergraduate Studies (CUGS). CUGS then submits their recommendations to Faculty Council for consideration.

All curricular changes must be approved by Faculty Council. Following the approval of the Faculty Council, proposed curriculum changes are submitted to the Senate Committee on

Undergraduate Studies (SCUGS) for consideration and approval. After due consideration and approval at SCUGS, any proposed changes are submitted to the Senate for final approval. The Dean and two members of the Faculty of Engineering and Applied Science serve as Senators.

Apart from the seven courses in first year of the program (math, physics, chemistry and English), control of the curriculum is entirely within the Faculty, subject only to the approval of the University Senate. The Faculty is consulted and involved in discussions on any proposed changes in first year courses prior to the submission of the proposed changes to SCUGS.

Administrative decisions for the Faculty are made by the Dean in consultation with the Faculty Management Group (FMG). The FMG is comprised of the Dean, the three Associate Deans, the Discipline Chairs and the Manager of Finance and Administration.

3.10 RESPONSIVENESS TO EMPLOYERS

EASAC (Engineering and Applied Science Advisory Council) is an external advisory council that advises the Dean and Faculty Council and provides an independent voice on the direction of Faculty. It advises, guides, and facilitates FEAS to excel and lead in educating engineers; researching, developing and disseminating existing and new engineering know-how; and to enable the Faculty to achieve recognition as an engine in the economies of Newfoundland and Labrador, and Canada.

At least twelve industry and private sector representatives serve on the basis of four-year staggered terms as recommended by the Dean. Two recent graduates also serve, one male and one female, on the basis of four-year staggered terms as recommended by members of EASAC. In addition, there are several ex-officio members:

- Past Chair of the Council;
- Vice-President (Academic) and Provost;
- Dean of the Faculty;
- Associate Deans of the Faculty;
- Discipline Chairs;
- Director of Cooperative Education;
- President of C-CORE;
- Director General of IOT;
- President and CEO of Genesis.

The Council meets at least twice per year at the call of the Chair to consider matters brought before it by the Dean or other members of the Council. The Council is concerned with any

matters related to the interface of the Faculty with the industrial community and the private sector, including but not limited to:

- review of plans for new developments;
- exchange of scientific and engineering information;
- professional development of faculty members;
- professional development programs for industry;
- research and development activity;
- cooperative engineering education;
- participation of practicing engineers as teachers in University programs;
- transfer of research outcomes to industry (including product development and commercialization);
- evaluation of program content as it relates to the future demands of the profession;
- educational and market research related to recruitment and retention of undergraduate and graduate students and to evaluation of programs by former students;
- funding plans for excellence;
- employment opportunities for engineering graduates.

The Chair of the Council shall present to the Dean a written annual report of the activities and recommendations of the Council. A copy of the report will be sent to the President and the Faculty Council of Engineering and Applied Science.

The Faculty of Engineering and Applied Science has worked closely with DELTS to develop a new graduate attributes methodology for transitioning of our curriculum to new outcome-based programming, assessment, and accreditation of the undergraduate programs. These efforts are consistent with the objectives of Memorial's Teaching and Learning Framework, will be continued and expanded in 2013-14. Furthermore, the Faculty is engaging an external consultant and holding discussions with the College of North Atlantic to explore the possibility of developing bridging programs that would help engineering technology diploma holders to receive adequate preparation and gain advanced entry into the undergraduate program.

In response to the needs of industry, the Faculty has engaged an external consultant to assess the viability of launching a new Petroleum Engineering program, as part of the Faculty Growth Plan. The consulting study with AMEC will assess the viability (projected enrolments, long term needs), costs (labs, faculty) and requirements (courses) to launch a new program. Preliminary estimates indicate about 7 new faculty members and 21 new courses. There has been strong interest and support to offer this new program from the local oil industry, particularly Statoil and Suncor. Courses in a new program would include, but not limited to: upstream petroleum

production; reservoir modelling; subsea production systems; drilling; safety, risk and reliability; among others.

3.11 RECRUITMENT AND RETENTION

Attrition in the first year can be as high as 40-50% with respect to completing the first year in one year. Some of these students take an additional year and rejoin the program at the beginning of Term 3 but the attrition rate is still very high. Additionally, there is a further attrition of approximately 21% from Term 3 to the end of the program (most significant in Terms 3, 4 and 5). These rates are relatively high, particularly compared to other programs and universities. This is a significant challenge that needs to be addressed in the Faculty. A specific retention strategy is being planned and will be implemented over the next several years in order to bring retention rates in line with national averages.

In addition to retaining students, there is a need to place an emphasis on attracting a more diverse group of students including more female and first-nations applicants, as well as providing support for the international students in our programs. Additional resources focused on recruitment, retention and outreach activities will allow the Faculty to increase its proportion of women in engineering.

Although the university's proportion of women is about 60%, only about 20-29% (varying by year and program) of the total engineering students are women. While this is higher than the national average, the Faculty has identified this as a specific recruitment strategy. Adding faculty members and course focus streams like environmental engineering are anticipated to help increase the number of female applicants. Also, expanded outreach activities at the high schools will also be beneficial to attract more women to engineering.

Additional student spaces in FEAS will be beneficial to college graduates and incoming applicants to enter their preferred program of study. To meet the evolving needs of employers for skill development of employees, FEAS aims to work with colleges on bridging programs that would allow more college graduates to gain advanced standing when entering engineering undergraduate programs. Also, the availability of additional seats in FEAS would allow more students to study the discipline of their first choice, thereby improving student satisfaction and retention rates.

The Faculty is developing a better database capability to statistically analyze a range of student data to improve undergraduate student retention rates. A database developer was hired on a temporary basis to support this initiative. Also, the Faculty has worked closely with the student recruitment office to focus and expand our recruitment efforts, within the province and others (particularly Ontario and Nova Scotia), in order to achieve our enrolment growth targets. The position of the Student Liaison Officer and the Engineering One Help Centre Coordinator were recently made permanent in recognition of the long-term, on-going effort that is required to address the challenges of recruitment and retention. The Faculty has also launched several

outreach activities including summer camps focusing on engineering (i.e. Robotics / Junior Engineers, GirlQuest and Arctic Engineers). In order to facilitate this outreach, a camp coordinator has been hired on soft funding.

In recognition of the recruitment challenge in front of it and of the dynamics of moving to a departmental structure, the Faculty is developing a comprehensive Recruitment and Retention Plan which will be reviewed on an annual basis to ensure it is responsive to the needs of the Faculty. This will be generated and implemented in close collaboration with the other related units within the university.

3.12 PROGRAM OUTCOMES

A consistent approach to "graduate attributes" has been taken across all of the engineering programs within the Faculty. This approach has been advised by the work of other Canadian engineering schools and, particularly, the work of the NCDEAS sponsored Engineering Graduate Assessment Development project (EGAD). Memorial's work in this area has been presented at the Canadian Engineering Education Association (CEEA) conference and further dissemination and participation in CEEA is anticipated.

A curriculum map has been developed for all of the programs and the details are being developed. The Process Engineering program has progressed furthest in this mapping process and it will be used as an example in this report but all of the disciplines are moving along the same path. The curriculum maps provide an overview the various places where graduate attributes are addressed in the program, and the level to which these attributes are developed. Level one indicates that an attribute has been addressed at a basic level while level three indicates an advanced contribution to the development of the attribute in question. This map is intended to give a visual overview of the program and act as a tool for continuous improvement.

A more detailed, database informed curriculum map is being developed to link course-based learning outcomes to graduate attributes and assessments. This three-dimensional, searchable curriculum map will provide the user with information about what students are learning, how this contributes to their development of graduate attributes, and how that learning is being measured.

Graduate attributes are program outcomes. They represent what a student will know, what they will be capable of and the attitudes they will possess upon graduation. Program outcomes are a compilation of course-based outcomes; therefore, the graduate attributes are built upon the foundation of these course-based learning outcomes. Through the assessment of these course-based outcomes, graduate attributes are assessed.

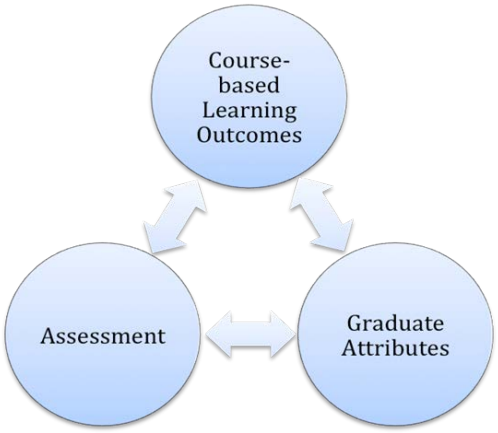

Figure 3.1: Schematic of learning outcomes

Learning outcomes have been developed for all courses in Process Engineering and they have been linked to the associated graduate attributes. How each learning outcome is assessed is being documented. The linkages between learning outcome, graduate attribute and assessment will allow for a complete, searchable curriculum map that documents the development of graduate attributes throughout the program. This system will also facilitate continuous improvement.

For example, ENGI 7102, The Engineering Profession, is a required course for all Process Engineering Students. It has a number of learning outcomes, including the following:

- document your own attempts to meet the profession's criteria for success, and critically evaluate the effectiveness of your efforts,
- evaluate your own career path and expectations in relation to the standards of professional conduct,
- communicate technical information in a clear, effective, and professional manner using oral, written, and graphic delivery methods.

These learning outcomes are linked to Graduate Attributes:

- communication skills,
- professionalism,
- life-long learning.

The learning outcomes are also linked to the assessment tool: ePortfolio artifact - autobiographical map (a visual representation of the path that led the student to their current state of development) and an action plan to achieve future professional goals.

This assessment tool is linked to associated rubrics, which communicate expectations to students and facilitate grading and feedback. It sets clear thresholds for successful completion of the course, and sets targets for student achievement.

The curriculum mapping and course-based learning outcomes are only the start of a long process to formalize the evaluation of the desired outcomes of the program. Additional steps include the following.

The Faculty is collaborating with the Distance Education, Learning and Teaching Support (DELTS) unit of the University to provide professional development and support for faculty with respect to the development of learning outcomes. A full-time, dedicated resource has been embedded in the Engineering Faculty and this support for teaching and learning will be continued.

The Faculty will continue to implement professional development to ensure that faculty are skilled in designing assessment tools that are relevant, authentic and adequately assessing learning objectives. This professional development is offered through a partnership with DELTS and the establishment of a Teaching and Learning Community.

Learning outcomes for the mandatory work terms have been developed and outlined in the same way as in the academic portions of the program. New approaches to assessment are being developed and will be introduced (e.g. oral examination, ePortfolios, cross-discipline debriefing sessions) to better assess and document identified learning outcomes.

The Faculty is working with DELTS to pilot an e-portfolio approach to managing a long-term overview of each student's progress in achieving the desired graduate attributes. By identifying clear rubrics through which progress will be evaluated, combined with periodic review and coaching, students will be responsible for demonstrating their own 'professionalization'.

The e-portfolio is introduced to students in ENGI 3101, The Engineering Workplace in Term 3. Students learn how to build a portfolio and use it to demonstrate their development of the required graduate attributes. Throughout the program and, in particular during work terms, students will add to the portfolio, and receive support and feedback on their artifacts and overall presentation. The portfolio will be revisited in ENGI 7102, The Engineering Profession, which is a capstone course that builds on concepts introduced in ENGI 3101, Engineering Practice.

The use of e-portfolios as an assessment tool will be encouraged throughout the program. Students will be guided through the process in a structured way, with clear rubrics outlining expectations. The e-portfolio will provide a verifiable record of learning across the full program, and give students an opportunity to use project work, work terms, design competitions, volunteer experiences and other curricular and co-curricular content to demonstrate development of the required graduate attributes. The e-portfolio approach will not require significant additional effort on the part of the student as it is simply a method of capturing existing examples of students' work, with some reflective observations. In addition, the Faculty plans to introduce exit interviews in conjunction with the final e-portfolio reviews.

The curriculum is reviewed and monitored regularly so that it is an ongoing, continuously improving system. Fundamental components of this continuous improvement include:

- Committee on Undergraduate Studies that meets monthly and identifies challenges and opportunities for improvement of the curriculum;
- Samples of students work and assessment criteria (answer keys, rubrics, etc.) are collected for each course every semester;
- Learning outcomes are reviewed every semester and updated as required;
- Focus groups are conducted with graduating students in their final semester to gather feedback on graduate attribute acquisition and assessment;
- Ongoing support for learning outcome development and assessment through continuing partnerships with Distance Education, Learning and Teaching Support unit,
- Encouraging and supporting teaching and learning study groups within disciplines.

In order to ensure continuous improvement, the Faculty is introducing a system of review and audit, including the review of graded student work, on an ongoing basis. This will ensure that the system of evaluating graduate attributes is sustained and that the program is responsive to feedback. This auditing process will include the Engineering and Applied Science Advisory Committee (EASAC – industry advisory group) to ensure an external view is incorporated.

Undergraduate and graduate students will continue to be engaged in co-curricular and extra-curricular activities such as: participation in national design conferences, events organized by student chapters of learned societies, organization of events by student societies, as well as the local chapter of Engineers Without Borders, Student LIFE Forum organized by students, and so on. The Faculty supports a number of such events every year through participation, faculty advising and funding support of student teams and activities.

3.13 ETHICS AND PROFESSIONALISM

Focused course materials on ethics and professionalism are included in each of the undergraduate programs. Learning is evaluated through a blended assessment approach involving graded student submissions and portfolio-based self-assessments. Learning objectives outline the expectations for students with respect to understanding these issues. The student work is reviewed to ensure that the learning objectives are being addressed, evaluated and successfully met.

Support for the instruction and assessment of learning outcomes concerning ethics and professionalism are provided through online collaborative tools including suggested learning activities, discussion topics, assessment tools and rubrics. Faculty can use these resources to support the delivery and assessment of these learning outcomes in courses throughout the program.

In addition to the core program elements, students are also asked to reflect on these principles in light of their own co-op work term experiences. This self-reflection is documented in their e-portfolio and reviewed at mid-program and final/exit interviews.

Professionalism is evaluated through a combination of approaches involving graded student submissions and self-assessment. Learning objectives outline the expectations for students with respect to understanding the roles and responsibilities of the professional engineer in society. Students reflect on the professionalism as part of their e-portfolio. This reflection is structured and guided by periodic constructive feedback.

Professionalism is regarded as the way in which an individual performs their roles and responsibilities (e.g., independence, judgment, etc.). Survey questions explore the employer's input on the 'professionalism' of the students during their co-op work terms. Expectations for professional behavior are established as a guideline for evaluation.

3.14 SELF-REFLECTION

The Faculty has a long-standing record of success with its cooperative undergraduate programs. The recent positive outcome of the CEAB accreditation visit provides external validation of the programs' strengths. The following sections briefly review the strengths, weaknesses, opportunities and threats relating to the undergraduate engineering programs.

Strengths:

- Full four year accreditation for all programs through to 2017.
- Students graduate with significant work experience with up to a year of that experience counting towards their required experience to become registered professional engineers.
- The cooperative education model and the low tuition fees make these the most affordable programs in Canada.
- Student demand is high within the province.
- Many labs have been renewed significant program revision has already taken place to update the programs.
- "New" faculty and staff are already starting to make an impact with their enthusiasm and new approaches as well as lowering the load on existing personnel.
- Centralized coordination of all programs is very efficient and effective.

Weaknesses:

- CEAB graduate attribute assessment and program continuous improvement are not yet fully developed and implemented.

- Relatively narrow and restricted curricula that don't provide flexibility for student choice. This in turn limits the number and diversity of students who might wish to apply.
- Insufficient instructional resources have resulted in a teaching deficit in the past, with many faculty teaching beyond the required levels.
- Many labs still require updating and expansion, particularly in light of expanding student numbers. Finding sufficient space is a challenge.
- Many classrooms are outdated and poorly outfitted. Much work is needed to make an engaging environment. This is true for many of the Carew Building common spaces as well.
- The existing organizational structure may not be well suited to handle the planned growth in numbers (thus the planned departmentalization).

Opportunities:

- A supportive government and senior administration have agreed to the growth plan as outlined including proposed budget support for eight years.
- Many other universities in Canada and elsewhere are struggling which presents an opportunity to hire very good candidates.
- The university has developed a Teaching and Learning Framework and is very supportive of initiatives around T & L.
- The push by CEAB towards focusing on graduate attributes provides an incentive to introduce curricular change and to integrate continuous improvement.
- The provincial economy is doing well and much of the growth is due to technology intensive industry activities (oil & gas, mining, energy, etc).
- There is significant industrial support for program areas such as Petroleum Engineering and this may bring the promise of additional funding.

Threats:

- The demographics of the primary and secondary school system mean that there will be less high school graduates each year until the year 2020.
- The university is facing an efficiency review and other units at MUN might not appreciate the proposed expansion during a time of retrenchment.
- The government may rescind its promised funding for later years of the expansion program.
- Many other universities are actively recruiting and are direct competition.

The Faculty's plans have been developed with these strengths, weaknesses, opportunities and threats in mind. On balance, the Faculty is very excited about the expansion and enhancement of the undergraduate programs and it feels it has rationale and achievable plans in place that take advantage of our strengths and mitigate the challenges that have been identified. Recruitment, admission and first year retention are being dealt with at the Faculty level, while enhanced programing and new initiatives are largely the domain of the Disciplines/ Departments.

4. RESEARCH THESIS-BASED GRADUATE PROGRAMS

4.1 OVERVIEW

Graduate programs in the Faculty of Engineering and Applied Science lead to the research thesis-based degrees of MEng (Master of Engineering) and PhD (Doctor of Philosophy). The MEng program normally takes two years to complete and students are required to complete at least five courses, a seminar course and a research thesis. The PhD program usually takes three to four years to complete and comprises two courses beyond the masters level, completion of comprehensive examinations and a significant research thesis.

4.2 HISTORY OF PROGRAMS

Memorial's MEng and PhD degree programs started at about the same time as the undergraduate programs in the late 1960s to early 1970s. The first two MEng graduates were in 1971. In the beginning, the requirements for the MEng program were: a) 6 graduate courses + research thesis, or b) 8 graduate courses plus an engineering project report. Ten years later in 1981, an Ocean Engineering Professional Masters program was added which required 10 graduate courses, a one semester project and a minimum 2 weeks of field experience. In 1983, the 6 course requirement was reduced to 4 plus a research thesis. In 1988, a new Masters program in VLSI design was added. This program requires 5 courses plus a research thesis. This is a joint offering between FEAS and the Department of Computer Science. In 1992, due to a lack of interest in non-thesis programs, the 8 courses plus project report and Ocean Engineering Professional program were terminated.

A major overhaul of the MEng degree was implemented in 1996. The MEng degree is now categorized by disciplines (Civil, Mechanical, Electrical and Computer, and Ocean and Naval Architectural Engineering). There was also a change in the number of courses from 4 to 5 of which 4 must be graduate courses and 1 can be either a graduate or senior undergraduate course. Furthermore, 1 of the graduate courses must be from a list of Faculty Core courses, 1 from a list of Discipline Core courses, and one other graduate course. The main purpose of having core courses was to increase student numbers in these courses so that they can be offered on a regular basis.

In 1999, a compulsory graduate seminar course was introduced for all new Master students, as well as industrial internship option, and a fast-track option of our top undergraduate students. In 2001, there was some streamlining of the core courses and a slight change in the core courses requirements was made for each discipline in 2003. In 2007, Computer Engineering and Oil and Gas Engineering were added to the list of Masters and PhD programs. There was also a change in the list of core courses required. In 2011, the number of required courses was reduced back to 4 from 5 and two of the 4 courses must be from the list of core courses.

The only PhD program available up to 1989 was in Ocean Engineering. The requirements for the PhD have remained largely unchanged until very recently. The requirements are two graduate courses beyond the Masters degree, comprehensive exams in 2 parts, a written thesis, and the final oral examination. Part 1 of the Comprehensive exam was the research proposal, and Part 2 was the general examination. In 1989, a PhD in Electrical Engineering was added with specialization in Applied Electromagnetics, Power Apparatus and Systems, and Signal Processing and Communications. In 1992, PhD in Civil, Mechanical, Electrical, and Ocean Engineering were added. Computer Engineering and Oil and Gas Engineering were added in 2007. In 2009, the order of the comprehensive exams was reversed. Part 1 is now the General exam, and Part 2 the research proposal. A further change was made in 2013 with only the former Part 1 as the Comprehensive Exam. The thesis proposal is no longer part of the comprehensive exam.

In 2013, a new graduate diploma in safety and risk engineering was introduced. This was the result of recognized strength in the area and also demands from industry. Courses completed in the graduate diploma program can be directly transferred to the MEng program.

The Faculty has seen programs added and terminated over the last 40 years. It is likely that in future new programs will be added and some terminated as well. Currently, all existing programs have healthy student enrolments.

4.3 PROGRAM ADMINISTRATION

I. ADMINSITRATIVE STRUCTURE

All graduate programs in the Faculty of Engineering and Applied Science are administered by the Office of the Associate Dean – Graduate Studies (ADGS). The ADGS office consists of the Associate Dean (GS) who is appointed on a 3-year term (currently Dr. Leonard Lye on his 2nd term), and four staff members. Three are permanent staff and one contractual staff. The permanent staff members are Ms. Moya Crocker (Academic Program Administrator), Ms. Colleen Mahoney (Academic Program Assistant), and Ms. Nicole Parisi (Secretary). The contractual position is the Graduate International Program officer who is Ms. Ying Zhang. She is filling in for Ms. Jinghua Nie who is on maternity leave. The ADGS office handles every single

graduate student's program from the application stage until graduation. These include funding, course registration, thesis submissions, comprehensive exams, oral exams, etc.

II. ADMISSIONS

To be considered for admission, an applicant shall have qualifications and/or engineering experience that is acceptable to the Dean of Graduate Studies and to the Faculty of Engineering and Applied Science. Admission to all graduate programs is limited and competitive. All applicants must meet the minimum qualifications. Decisions on admission, however, will also take into account such things as the applicant's rank in class, referees' assessments, general performance throughout the applicant's undergraduate academic program, availability of supervisors in the area of the applicant's interest, and the availability of funding for the student. In cases of demonstrated ability, a student enrolled in the MEng program may be allowed to transfer to the Ph.D. program without the completion of all the MEng Degree requirements. As well, in exceptional cases, direct entry to the Ph.D. program, after completion of a Bachelor's Degree in Engineering or a related area, is possible.

FEAS receives upwards of 1,000 applications per year to all our graduate programs. As such only the highly qualified with a good chance of obtaining funding will be offered admission. The deadline for applications for international students is November 1st for admission to the Fall semester of the following year. Normally applicants will be considered in January for admission to the following September. In special cases applicants may also be considered in April and August. All application files when complete will be reviewed by the Graduate Studies Admissions Committee for admissibility and the level of baseline funding support. The list of all admissible applicants will then be circulated to faculty members for consideration. Interested faculty members can then look through the files and make an offer. The offer would include the thesis topic, list of suggested courses, and financial package. The official offer of admission comes from the School of Graduate Studies after they have vetted the offer for compliance with their policy on funding and admission standards.

III. DEGREE REQUIREMENTS

The MEng program normally takes two years to complete and students are required to complete at least four graduate courses, a seminar course and a research thesis. The PhD program usually takes three to four years to complete and comprises two courses beyond the masters level, completion of the comprehensive examination, a research proposal, and a significant research thesis and oral defense of the thesis. The MEng thesis is examined by two examiners who maybe internal or external to the Faculty or MUN. The PhD thesis is examined by an external examiner and two internal examiners.

FEAS also offers an Industrial Internship Option to MEng students who may want to gain some industrial experience while working on their thesis. There is also a fast-track option available for MUN undergraduate students. Undergraduate students after completing their second last academic term (Term 7) can start graduate work for a semester instead of going on a work-term. They would then return to their undergraduate studies for the final term. After graduation in spring, they continue with their graduate studies. The fast-track option allows a student to complete their degree about a year earlier after graduation than those who follow the traditional route of starting the following fall after graduation.

IV. FINANCIAL ASSISTANCE

FEAS has a policy of providing a minimum level of funding to all our research–based graduate students. That means that we do not accept self-funded students unless they hold a fully funded government or company scholarship. The current minimum funding levels for MEng students is $15,000/year for two years, and for PhD students is $16,000/year for four years. Most funding levels range from the minimum to a high of $50,000 per year. The amount of funding comes from several sources. It can be a single source or a combination of sources such as 1) supervisor's grants or contracts, 2) SGS baseline funding, and 3) other funds.

SGS baseline funds are annual allocations given to the Faculty to provide funding for graduate students. The allocation is a function of last year's level and a projection of enrollment growth. Currently the FEAS holds the highest allocation of over $1 million at MUN. In FEAS, the amount of baseline funding to a MEng student is $5,500/year for a Level A student and $4,000 for Level B student. For a Level A PhD student, it is $8,000 per year, and for a level B student, it is $6,000 per year. Levels A and B are determined by the student's grades. Other funds could take many forms. It could be special funds for PhD students supervised by new tenure-track faculty, or it could be other awards or top-up funds. It is rare that the supervisor needs to pay for the whole funding package unless he or she decides to offer the student more than certain amounts. SGS has a policy that if it exceeds $27,500 for a MEng student or $35,000 for PhD student, then they are not eligible for SGS baseline funding. The funding levels and baseline levels from SGS are subject to change each year depending on what the university gets from the provincial government. SGS has certain guidelines on baseline funding levels and these have to be negotiated and approved by SGS before implementation in each academic unit. It is always a balance between making more offers at lower baseline funding levels or fewer offers at higher baseline funding levels. Also, one has to consider the number of offers made and the number of students that eventually shows up.

4.4 PROGRAMS

I. CIVIL ENGINEERING

The Faculty of Engineering and Applied Science at Memorial University offers graduate programs leading to master of engineering (MEng) and doctor of philosophy (PhD) degrees in civil engineering, as well as the related multidisciplinary fields of mechanics; structures and materials; and hydrotechnical and environmental engineering and applied science. Civil engineering graduate studies may be pursued in many areas, including: coastal; geotechnical; structural design and analysis; water resources; hydraulics; hydrology; and environmental engineering. The Faculty of Engineering and Applied Science offers extensive computing, laboratory and workshop facilities. Computers, printers, plotters and specialized software are available for the exclusive use of engineering students.

Laboratories for studying soils, bitumen, concrete, hydraulics, structures, materials and the environment facilitate student research. Students can also access specialized facilities including a strength and concrete laboratory and a structural laboratory with a one-metre-thick concrete floor for static and dynamic testing; a hydraulic laboratory with a 58-metre wave/towing tank; environmental laboratories; soil simulator; two wave/soil interaction tanks and a deep tank for acoustic work; an ice structures laboratory with cold rooms and specialized testing equipment; in-house facilities for model fabrication, custom welding and machining services; and a geotechnical centrifuge operated by C-CORE.

II. COMPUTER ENGINEERING

Students may pursue computer engineering graduate studies in a wide variety of areas including: digital and image processing; software design and verification; error-control codes; real-time discrete event systems; multimedia communications; image and video coding; cryptography; and digital systems. Memorial University is the largest university in Atlantic Canada. Memorial's Faculty of Engineering and Applied Science has many well-respected academic and research programs in several other disciplines of engineering including electrical engineering.

The faculty has extensive computer, laboratory and workshop facilities. Students have access to a wide variety of engineering software for tasks such as:

- mathematical analysis, such as MAPLE and MATLAB;
- electric circuit simulation, such as SPICE, PSPICE and electronics workbench;
- VLSI and FPGA design, such as Synopsys, Cadence and Xilinx;
- software design, such as Visual Paradigm and Microsoft development tools.

Special facilities include:

- Instrumentation Control and Automation (INCA) Centre;

- Computer Engineering Research Laboratories (made up of the Centre for Digital Hardware Applications Research, the Software Engineering Research Laboratory, the Multimedia Communications and Remote Sensing Laboratory, and the Computer-Aided Design Laboratory for Analog and Mixed Signal VLSI Systems and the Wireless Communications and Mobile Computing Research Centre - WCMCRC);
- Power Devices and Systems Laboratory.

In addition, research facilities from industrial and government collaborations are available.

III. ELECTRICAL ENGINEERING

Students may pursue electrical engineering graduate studies in a wide variety of areas including but not limited to: antennas; applied electromagnetics; broadband communications networks; industrial automation; robotics; electric machines; autonomous vehicles; power systems and electronics; wind and alternative energy; distributed power generation; intelligent control; controllers and sensors in harsh environments; and wireless communications.

Graduate students in electrical engineering have access to extensive computer, laboratory and workshop facilities, described above for computer engineering graduate students. This includes the engineering software tools, special facilities and laboratories which were listed above for computer engineering. Also, research facilities from industrial and government collaborations are available.

IV. MECHANICAL ENGINEERING

Students may pursue graduate studies in mechanical engineering in areas such as: computer-aided design (CAD); controls; corrosion; environmental engineering; fatigue and fracture mechanics; fluid dynamics; heat transfer; integrity assessment; materials; mechanical design; resource utilization; robotics; and structural dynamics. Students interested in biomedical engineering, such as biomechanics and occupational health, can pursue research through an interdisciplinary group of engineering and medical faculty.

Memorial University's engineering research facilities for mechanical engineering include automation and control, computer, fluids, heat transfer and structures laboratories. Specialized facilities include a low-speed wind tunnel, a scanning electron microscope, a multiphase flow loop, cold rooms, wave/tow tank, machine vision and x-ray imaging, and a mechatronics laboratory. We also have manufacturing technology and biomedical engineering centres. The laboratories are supported by on-site technical services, which include a large machine shop and numerically-controlled milling facilities.

Students have access to the acclaimed research centres associated with Memorial University. Adjacent to the university is the National Research Council (NRC) with its large ice tank, wave tank and sea-keeping basin. Also close by is the Centre for Cold Ocean Research Engineering (C-

CORE), which houses a large centrifuge for studying the behavior of loaded soils. A short drive from Memorial is the Marine Institute, which has a ship simulator and flume tank.

V. OCEAN AND NAVAL ARCHITECTURAL ENGINEERING

The ocean and naval architectural engineering (ONAE) graduate program at Memorial University is the only one of its kind in Canada. It is renowned for its unique approach, diverse research projects, exceptional faculty and top researchers. Graduate studies in ocean and naval architectural engineering can be pursued in areas such as: marine hydrodynamics; marine structures; underwater vehicles; Arctic engineering; ocean environmental engineering; offshore safety; and marine simulation.

Facilities available to students include a 60-meter towing/wave tank and a structures lab with cold rooms and highly-specialized testing equipment. Research in ocean engineering is complemented by several research groups on campus, providing ideal opportunities for field work and graduate research projects. The Faculty's Ocean Engineering Research Centre (OERC) is involved in research, development and consulting in most areas of ocean engineering including the offshore petroleum and shipping industries. Scale model experiments, numerical modeling, software development and structural testing are some of the activities within OERC.

Students have access to what is arguably one of the best oceans research facilities in the world all associated with Memorial University. Adjacent to the university is the National Research Council (NRC) with its large ice tank, wave tank and sea-keeping basin.

Also, close by is the Centre for Cold Ocean Research Engineering (C-CORE) which specializes in Arctic research. The Marine Institute, another unit of Memorial with programs in ocean related technology, has a ship simulator and flume tank. These facilities are all relatively modern and large scale and provide opportunities for students and faculty to engage in significant research activities.

Research funding in the ONAE group is very high relative to other units at the University (see Table 4.1). This reflects the high level of government and commercial interest in oceans research and in particular issues related to Arctic and northern ocean engineering.

2011-12 Memorial Fact Book

	Measures		Ratio
DEPT	Faculty	$ Research	$/Faculty Member
Arts	179	4,161,830	$ 23,250
Science	195	25,026,933	$ 128,343
Business	43	1,465,608	$ 34,084
Education	46	258,670	$ 5,623
Medicine	231	24,793,045	$ 107,329
ONAE	6	3,300,000	$ 550,000
Engineering	55	10,872,076	$ 197,674

Table 4.1: Research funding by units

The current ONAE group is very research–active and there is much opportunity for further growth. In addition, the ocean is a multi-disciplinary arena and Memorial University has identified the oceans and the Arctic as theme areas of broad interest. These research areas will also be of broad interest within the Faculty of Engineering and Applied Science. The ONAE group will seek to engage other disciplines in ocean and Arctic related research.

ONAE's goals for the graduate program for the coming 10 year period are summarized as follows.

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Graduate Courses	2	3	4	5	6	7	8	9	10	10	10
Research Funding	$3.3M	$3.6M	$4.1M	$4.6M	$5.1M	$5.6M	$6.1M	$6.6M	$7.1M	$7.6M	$8.1M
Graduate Students	50	55	60	65	70	75	80	85	90	92	92

Table 4.2: ONAE graduate program and research targets

Specific goals for the graduate program are listed as follows.

1) Develop a structured graduate program on ONAE that offers a minimum of ten graduate level courses per year based on 15 available and fully developed graduate courses in five specialties: Ocean Engineering, Ice Engineering, Structural Mechanics, Numerical Hydrodynamics, and Marine Simulation.
2) Increase the number of ONAE and interdisciplinary Ocean Engineering graduate students from the current level of approximately 50 students to approximately 120 students as the research activities grow.
3) Develop a series of CEE professional development courses for industrial graduates.

Complimentary to the graduate program, the ONAE goals for research activity are shown as follows.

1) Continue with AIF funded industrial partnership research projects at the current rate of approximately 2 projects in play with a cumulative value of approx. $1.5M/yr.
2) Better serve the HETC program provided by ABS by increasing the number and size of active projects.
3) Develop a UTC concept proposed by Rolls Royce with an initial research support level of approximately $1.8M/yr.
4) Continue to seek a CERC in Arctic Operations in coming rounds.
5) Work with the local offshore and ocean technology industries to provide additional research funding at the level of approximately 0.8M/yr.
6) Engage other disciplines within Engineering to address broader ocean technology research under the auspices of a re-vitalized OERC. This would include, for example Civil for offshore structures, Electrical for ocean sensors, communications and heavy

electrical marine engineering, Computer engineering for simulation of ocean and ice problems and Mechanical for marine engineering, subsea engineering and ocean systems such as autonomous systems and renewable energy.

7) Develop research support links with the National Shipbuilding program.
8) Increase national and international collaboration.

VI. OIL AND GAS ENGINEERING

The Faculty of Engineering and Applied Science offers graduate programs leading to master of engineering (MEng) and doctor of philosophy (PhD) degrees in oil and gas engineering, including related fields of: offshore oil and gas operations; safety, risk and environmental management; reservoir engineering; drilling engineering; offshore structures; natural gas engineering, with a focus on unconventional developments; asset integrity management; subsea systems; and control and instrumentation.

The oil and gas engineering graduate program at Memorial is a unique program that focuses on offshore oil and gas operation in harsh climatic conditions. Our program is geared towards providing solutions to upcoming challenges to produce oil and gas in more remote and harsh environments, such as the Arctic and deep water. Our program emphasizes safety and risk management of oil and gas operations through core courses on safety and risk and offshore environmental management.

The program is a multi-disciplinary program taught by professors who have specialized in electrical engineering, reservoir engineering, drilling engineering, environment engineering, safety and risk engineering and process engineering. Graduate programs in oil and gas engineering are of an inter-disciplinary nature and therefore include a combination of existing and new specialized courses.

The faculty has large, well-equipped facilities and a dedicated technical support staff. Students can access 4,500 square metres of laboratories. All research is supported by a comprehensive computer-aided engineering centre. Facilities available to students include the following: drilling laboratory; geomechanics laboratory: process engineering laboratories (environment, health and safety, hydrometallurgy and modeling and simulation); and fluids and microfluids laboratories with several process and reservoir simulating and modeling software. The Faculty also houses a 60-metre towing/wave tank and a structures laboratory with cold rooms and specialized testing equipment.

Research in oil and gas engineering is supported by oil and gas industries and also by national and provincial-national research grants. Faculty members in oil and gas engineering have active collaboration with industry and their research is directed towards solving real life problems.

4.5 GRADUATE PROGRAM TRENDS

This section presents some historical and current statistics of the FEAS graduate programs. A breakdown by major and degree type are also shown in some cases.

Figure 4.1a shows the fall semester enrollment numbers for the last 20 years. As can be seen, there has been a very dramatic increase in graduate enrollment in the graduate programs. Step increases can be seen whenever a new program was introduced. There was a jump in 1996 after the introduction of the course-based environmental engineering and applied science program. Then jumps occurred in 2004 and 2005 after the introduction of the MASCE and MESEM programs. Another jump occurred in 2010 after the introduction of the MOGE and MEM programs. Since then there has been a rapid increase in numbers especially in the oil and gas area.

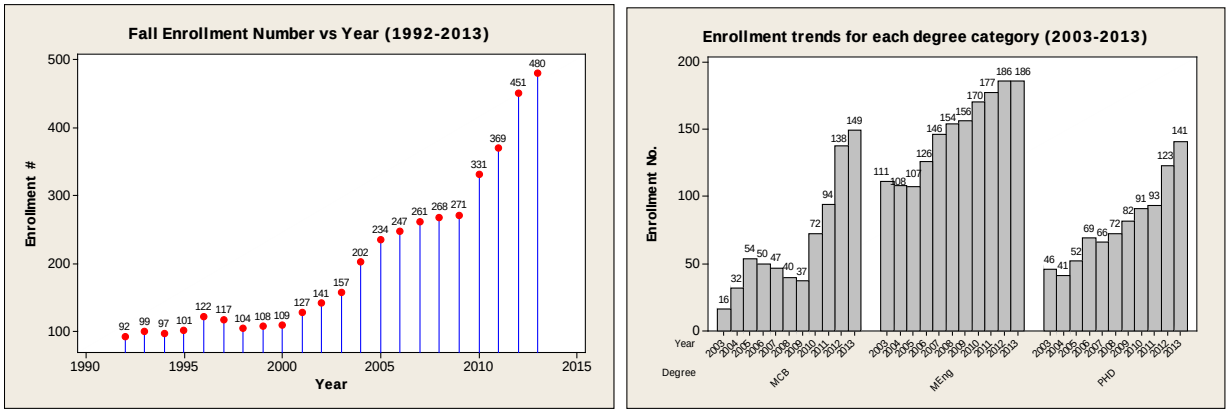

Figure 4.1: Fall enrollment: a) from 1992 to 2013; and b) by degree category

Figure 4.ab shows the enrollment trends for the last 10 years for both course-based degrees and research-based degrees. It can be clearly seen that all categories are on the rise. The new graduate diploma program has been excluded in that graph since it was started only this year.

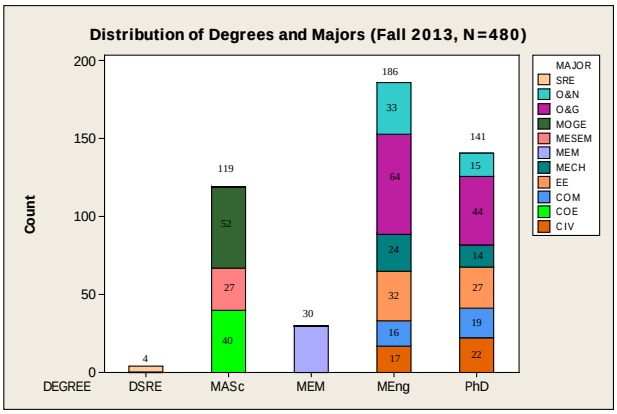

Figure 4.2: Distribution of graduate students in programs

Figure 4.2a shows the distribution of students in all the 17 graduate programs for the Fall 2013 enrollment. It shows 149 or 31.04% are in course-based masters programs, 186 or 38.75% in thesis-based masters programs, 141 or 29.38% in PhD programs and the remainder in the new graduate diploma in safety and risk engineering program. More than one-third of graduate students are in oil and gas related areas (MOGE, MEng, PhD).

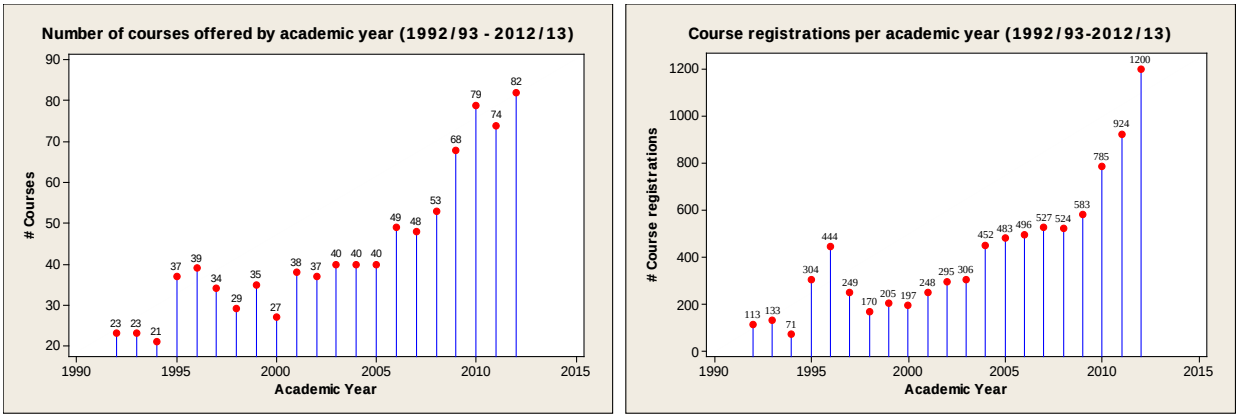

Figure 4.3: Number of a) courses offered and b) students registered in courses since 1992

Figures 4.3a and b show the historical numbers of graduate courses offered and taught each year, and the number of students registered in courses each year since 1992, respectively.

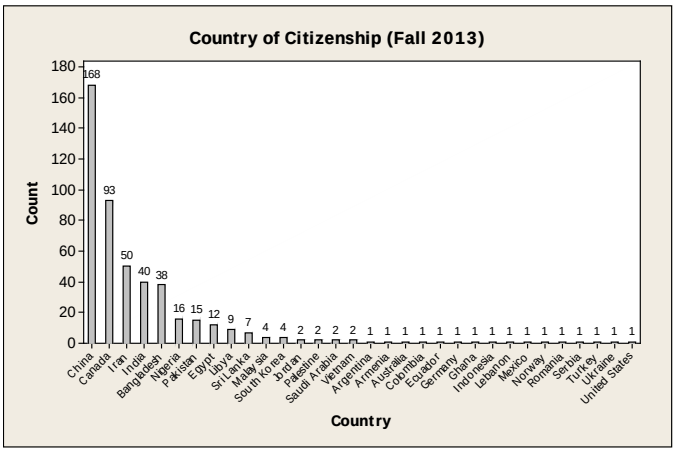

Figure 4.4: Country of citizenship of graduate students

Figure 4.4 shows the country of citizenship of the graduate students enrolled in fall 2013. It can be seen that the five countries with the largest numbers are from China (35.0%), Canada (19.4%), Iran (10.4%), India (8.3%) and Bangladesh (7.9%). A total of 31 countries are represented. However, most of the students from China are in the course-based masters programs.

About 15% of all graduate students are part-time students. The largest proportion is in the Master of Engineering Management program of which about 43% are part-timers. At the other extreme is the MASc course-based masters programs where only 1 out of 119 is a part-time student and that student is Canadian student.

Overall for Fall 2013, about 26% of graduate students in engineering are female. This is the highest proportion of female graduate engineering students in the history of FEAS.

As of the Spring 2013 convocation, a total of 1210 students have graduated. It is interesting to note that it took about 15 years to graduate the first 100 students. We reached the 1,000th student milestone during the Spring 2011 convocation. During the last few years, we graduate more than a hundred every two years. It is very likely that we will hit the 2,000th mark by 2020.

As of the Spring 2013 convocation, 162 PhD degrees have been conferred since 1971. With the current PhD enrollment of 141 and with the increase in faculty members in future, the number of PhDs will continue to increase.

A projection of future to 2020 was made in June 2012 using data up to Spring 2012. It was projected that for Fall 2013, the total enrollment is going to be 440 and for Fall 2014 is going to be 480. However, the actual enrollment numbers far exceeded the projected numbers for these two years. The actual enrollment numbers for Fall 2012 and 2013 were 451 and 480, respectively. A revised projection is given in Table 4.3. It is very likely that these projects would need to be revised every one or two years.

	Current (2013)	2014	2016	2018	2020
Faculty Complement[1]:	68	75	85	95	100
12 (MEng+PhD):	327	350	400	450	500
4 Course-based (Masters[2]):	149	140	125	125	125
1 Course-based (PGD[3]):	4	10	15	20	25
Total:	480	500	540	595	650

Table 4.3: Graduate Enrollment Projections to 2020

Notes/Assumptions:

[1] Increase in Faculty complement taking into account lag time for hiring and ramping up. Also not all will have 5 students.

[2] Based on cap of 100 new intakes with about 40% overlap of previous year. Some programs take a little longer. A gradual decrease in demand from China in some programs is likely in the future.

[3] PGD = Graduate Diploma in Safety and Risk Engineering. 2013 is the first intake.

4.6 RECRUITMENT

Promotion of graduate programs in general at MUN is handled by the School of Graduate Studies. These are done through the MUN website, recruitment fairs, and a new microsite for prospective students. There is a rotating presence on www.mun.ca (banner and spotlight) and monthly information sessions tailored to demographics, e.g. Part-time, visiting undergraduates/ESL students, email blasts to 3rd and 4th year undergraduate students within MUN, and through social media profile such as Facebook, Twitter, and RenRen. FEAS also attends together with the School of Graduate Studies the annual China PhD Fair in Beijing to recruit China's top prospective PhD students. Now that MUN has signed the MOU with the China Scholarship Council who normally funds these PhD students, we hope to see more of them coming to MUN in future. Within FEAS, we also promote our Fast track option to Term 7 students every year. Personal connections of faculty members also play a large role in the recruitment of students. MUN also has MOUs signed with two of Chinas top petroleum universities: China University of Petroleum-Beijing, and China University of Petroleum- East China. These universities on an annual basis send students here as visiting students during their senior year. So far almost all of them apply to MUN to continue their graduate studies.

Future recruitment efforts will focus on countries such as United Kingdom where fees have increased dramatically, Turkey, Korea, and some Latin American countries. These countries have been identified as fertile recruiting grounds especially for graduate education. We plan to attend some recruitment fairs in these countries in the next few years.

4.7 SELF-REFLECTION

Graduate enrollment numbers have been steadily on the rise since 2001. The most dramatic increases occurred starting in 2010 after the introduction of the course-based oil and gas and engineering management programs. Now that FEAS was asked to double in size with government funding, the enrollment will see even higher numbers in future. The projected number in 2020 is 650 students. Rapid growth will bring along several challenges. This section will discuss some of the challenges and how we might mitigate them.

Office spaces for graduate students: All research-based full-time graduate students are entitled to an office space. Based on the Fall 2013 enrollment numbers, 274 or 57% of engineering graduate students need an office space. However, we have only about 220 available at present. However, the opening of the new Suncor building within the next month, 108 new spaces would be available of which at least 75% will be available for graduate students. That will bring the total available office spaces to about 300. This will be sufficient for the next two years at most. New spaces would need to be developed to accommodate the projected growth numbers.

Class sizes and increased number of courses: Class sizes on average have increased rapidly over the last few years. In fact many graduate courses have larger class sizes than some undergraduate courses. Small seminar rooms that were adequate in the past cannot be used

for many of the graduate courses nowadays. Scheduling of courses is also getting more difficult because of the increased in the number of courses and students. More and larger classrooms will be needed to accommodate the increasing numbers.

Teaching assistantships: We can no longer promise teaching assistantships to all graduate students. In fact some graduate students may never get a TA position because of the large numbers wanting a TA and there are only limited numbers of courses that require TAs. Currently demand for TA positions far exceeds the availability of TA positions especially for process engineering courses. This is partly due to the fewer number of process engineering courses and the large number of graduate students in this area. The situation may ease somewhat when the petroleum engineering program is introduced.

Funding of graduate students: Currently all research-based graduate students receive a funding package with their admission offer. The funding package normally comprises of a combination of baseline funding from SGS, supervisor's contribution, and other top-up funds. TAs are not included as they are not guaranteed. The minimum level of funding for a masters and PhD student are $15,000 and $16,000 per annum, respectively. These amounts have not changed for many years. If we want to be more competitive, we need to increase these levels. The baseline funding amounts from SGS is tied to our projected growth in the number of research-based masters and PhD students. It is also dependent on what funding they receive from the university. A cut from this source would mean a higher contribution from the supervisor is required thus limiting the number of students they can support. So far baseline funding from SGS has been fairly stable and we can only hope that this will remain so in the next few years.

Associate Dean's Office Staffing: With rapid growth there is also rapid increase in workload in the Associate Dean's office in dealing with the large number of students. Currently, the Associate Dean is supported by 4 staff members. The office plans to add an intermediate clerk stenographer in 2015 to help with increased the workload.

5. COURSE-BASED GRADUATE PROGRAMS

5.1 OVERVIEW

The Faculty of Engineering and Applied Science (FEAS) currently has four premium-fee course-based Masters programs. The first program was a Master of Applied Science in Computer Engineering or MASCE in short. A contract was signed with Can-Zhong International of Vancouver to recruit students from China for the program. The program's first intake of 25 students was in July 2004. The program is now in its 10th year and a total of 151 students have enrolled in that program and 94 have graduated. The Masters in Environmental Systems Engineering and Management or MESEM program was subsequently developed and the first intake of 11 students was in 2005. So far 90 students have enrolled in the program and 60 have

graduated. Another two new programs were developed subsequently. These were the Masters in Oil and Gas Engineering or MOGE, and the Masters of Engineering Management or MEM. Both programs had their first intake in 2009. The MOGE program started with 8 students and so far 75 students have enrolled in the program and 44 have graduated. This program has students coming from a wide variety of countries. The MEM program is jointly offered by the FEAS and the Faculty of Business Administration (FBA). Students have to take several courses from the MBA program in addition to engineering courses. The first cohort had 3 students and so far 47 students have enrolled in the program and 17 have graduated. Many of the MEM students are domestic students. Most of the domestic students are taking the program on a part-time basis. In total, 363 students have enrolled in the course-based programs since 2004. The overall attrition rate across all 4 programs is about 11%. Many of the graduated students have continued on to the research-based Masters or PhD programs at MUN and elsewhere. Many are successfully employed in Canada and internationally, while others have returned home for employment. To help deliver the programs, a total of 11 faculty members were hired during the last 10 years. Five faculty members were hired for the MASCE program over the past 10 years, two in MESEM, three in MOGE, and one in MEM. Many of these hires have now been converted to tenure track positions. In addition, in 2009 an international program officer was also hired to help with recruitment and administration. Two additional classrooms and student office spaces were created to accommodate these students together with additional lockers and lab facilities. While the bulk of the students are still mainly from China, we have expanded our recruitment efforts to a wider market now. We have signed new recruiting agents from India and the Middle East and we plan to sign on more agents from other countries.

The premium fee programs fit well with MUN's strategic plan. They have provided a stable and wider choice of courses for all graduate students and also provided a prospective group of students for the research-based Masters and PhD programs. Capstone research projects done by students in these programs are also directly relevant to the community and/or industry. The revenues from the programs have provided a means to hire well-qualified faculty members, and to upgrade labs, graduate student offices, and classrooms. In addition, the revenues have provided a supplementary source of funding for research students in the areas of course-based programs. On a wider context, these course-based programs not only provide a source of income within the faculty, but also to other units on campus, such as ESL, FBA and VPA for wider distribution across campus. They have a positive economic and cultural impact for the province in terms of student diversity, housing, food, transportation, entertainment and services, etc. Lastly, they provide a source of specialized HQP needed by Canadian companies and they enhance the reputation of MUN as these programs are promoted world-wide. The outlook for these programs is good especially now that we have diversified our recruiting strategy. The students are generally very satisfied with the programs and the quality of some of the students has been outstanding.

5.2 ADMINISTRATIVE STRUCTURE

Associate Dean (Graduate Studies)

All graduate programs in the Faculty of Engineering and Applied Science are administered by the Office of the Associate Dean – Graduate Studies (ADGS). The four premium fee programs however have a Board of Studies (BOS) since students in these programs do not have an individual supervisor unlike the research-based programs. The ADGS office assists in processing the applications and liaising with the School of Graduate Studies regarding final offers or rejection of admission. The official offer of admission letter is from the School of Graduate Studies.

Board of Studies

Each program is administered by a Board of Studies (BOS) consisting of four or five faculty members. The BOS members assist with recruitment, interviews of potential applicants, review of application files, and recommendations of admissibility. The admissibility of each applicant is decided by the BOS. The BOS will also recommend additional courses to be taken in cases where a student is missing some background knowledge. The BOS is assisted by the International Officer who normally would provide all the details for each applicant such as transcripts, letters of recommendation, technical test scores, interview results, and any additional information required for the BOS to make a decision. BOS members are appointed by the Dean for a 3-year term generally. The Chair of the BOS gets a ½ teaching credit per annum for their role. BOS members for each of the programs are listed below:

- MASCE: Dr. Cheng Li (Chair), Dr. Octavia Dobre, Dr. Lihong Zhang, and Dr. Howard Heys
- MESEM: Dr. Bing Chen (Chair), Dr. Helen Zhang, Dr. Faisal Khan*, and Dr. Kelly Hawboldt
- MOGE: Dr. Faisal Khan* (Chair), Dr. Lesley James, Dr. Kelly Hawboldt, Dr. Thormod Johanssen
- MEM: Dr. Amy Hsiao (Chair), Prof. Andy Fisher, Dr. Lesley James, Prof. Peggy Coady (FBA), and Dr. Tom Cooper (FBA)

* Dr. Faisal Khan is currently on sabbatical leave, and Dr. Lesley James is acting on his behalf.

Once the decision has been made to recommend admission of an applicant, the program of study for the student will be assigned by the respective chair of the BOS and then transmitted to the Associate Dean (Graduate Studies) office in the FEAS for approval and further processing.

The BOS system of administrating the premium fee programs has generally worked well over the years since the collective experience of the members has helped in making admission decisions. A minor challenge is making the decisions in a timely fashion as it is often not easy to get the busy faculty members and the international officer together for a meeting. Despite the many years of experience there are still cases where the admitted student did not perform as well as expected. There are still many factors in student performance that the BOS cannot control once the student starts his or her program.

International Officer

The International Officer (IO) works closely with the Associate Dean (Graduate Studies) and the Manager of Finance and Administration in the FEAS. The IO provides leadership in the development, promotion and coordination of the international aspects of the Faculty's graduate programs. The IO participates in managing program development, program internships and ensures quality service and systems in the daily delivery of information and advice to students, prospective students, faculty and staff. The IO coordinates admissions and also manages the orientation of the premium fee programs. In addition, the IO assists in researching the needs of foreign countries and developing proposals for new programs; promoting the Faculty's graduate programs to prospective international students; coordinating the development of promotional material and assisting in the maintenance of the FEAS graduate programs website and databases; developing best practices for student recruitment, retention and career counseling and working collaboratively with other university departments on implementation; assisting with program analysis and academic support to the Boards of Studies (BOS), Graduate Studies Committee and Faculty Council. The IO may also act as the delegate of the Associate Dean to internal and external committees. The IO participates in the annual recruitment and interview of students in China for the premium fee programs. The IO is the first point of contact for all the premium fee students before and after they arrive on campus. The IO also provides assistance with housing, course selection, fee payments, and general advice on settling in St. John's. The IO also keeps track of the progress of all the course-based students during their program and sometimes after graduation. The current IO is Ms. Jinghua Nie who was hired in 2009. She is currently on maternity leave. Her maternity replacement for this year is Ms. Ying Zhang who started in June 2013.

5.3 RECRUITMENT AND ADMISSIONS

6.3.1 Recruitment Process

Students are recruited to the premium fee programs in several ways depending on where the students are from. For countries such as China, the Faculty of Engineering and Applied Science uses a recruitment agency. With a population of more than 1.3 billion in China and more than 1 billion in India, it is impractical for Memorial to do all recruitment on its own. Like other universities, we use a recruitment agency and the agency assists us in China and India. Our recruiting agent Can-Zhong International has an exclusive contract to recruit students from China for these four programs. More recently, we have signed a few more agents from India and the Middle East. The agents are responsible for marketing the programs and for the initial screening of applicants. Marketing of the programs in China is done through various media, information sessions, educational fairs, and through sub-agents. For China, representatives from FEAS will normally visit Beijing, Shanghai, or Guangzhou twice a year to interview students and to train agency staff members on our policies and requirements. An agent's manual has been prepared for this purpose in both Chinese and English. The recruiting team will also

normally visit universities to promote the programs. Typically, on a visit, the team would interview up to a hundred potential applicants for the four premium fee programs. Only those deemed to be academically qualified are encouraged to apply. Admission decisions are not made at this stage. The use of a recruitment agency assists in achieving our recruitment goal of attracting quality students who meet our high standards. The recruitment and admission processes are rigorously controlled by Memorial's School of Graduate Studies and BOS for each program. Students from abroad can apply directly to Memorial or through an agency. If they are not pre-screened by the agency, Memorial verifies the authenticity of their transcripts and other documentation.

Recruiting in countries other than China is less organized as we do not visit those countries to interview students because the applicant pool is still quite small. We do receive many applications directly from students by the online application process available on the SGS website. For countries where we do have agents, these agents do not have an exclusive contract. We have only recently started to use agents outside of China. Hence the numbers recruited by these agents are still quite small.

For the MEM program, the Chair of the BOS, Dr. Amy Hsiao, takes an active role in the recruitment of domestic students. She conducts information sessions in the Faculty and also advertises the program in local and regional trade magazines. The program is also promoted at conferences. Domestic student recruitment is thus done a little differently for the MEM program.

6.3.2 Admission Requirements and ESL

The general admission requirements for the premium fee programs are set out in the current calendar. More details for each program are given in Section 4. The general requirements are similar to any other graduate program in engineering with the exception of a personal interview with a MUN representative and the English requirement for the MEM program is higher. The requirements are:

- Second-class bachelor's degree in engineering or a relevant area from a recognized university.
- TOEFL score of at least 80 on internet-based test for MASCE, MESEM and MOGE programs or TOEFL score of at least 90 on internet-based test for MEM program; a minimum overall score of 6.5 on IELTS; or other demonstrations of English proficiency as described in the University Calendar (www.mun.ca/regoff/calendar/).
- Successful interview with a Memorial University representative.

6.3.3 ESL Requirements

In addition to an acceptable background in engineering, all applicants must show competency in English. Below are the various demonstrations of English proficiency proof required for admission to graduate studies at Memorial University:

a) Successful completion of a baccalaureate degree from a recognized University where English is the language of instruction and from which transfer of credit may be allowed by Memorial University of Newfoundland.
b) Successful completion of a post-graduate degree program at a recognized University where English is the language of instruction and from which transfer of credit may be allowed by Memorial University of Newfoundland.
c) Submission of official results of the Test of English as a Foreign Language (TOEFL) with a paper-based score of 550 (or higher) / computer-based score of 213 (or higher) or Internet-based with a score of 80 (or higher) and the Test of Written English (TWE) with a score of 4 (or higher) for MASCE, MESEM and MOGE programs. The TOEFL requirement for MEM program is a minimum of 90 on internet-based test.
d) Submission of the official results of the Michigan Test of English Proficiency with a score of 85% (or higher).
e) Submission of the official results of the English Language Testing Service (ELTS) Test with an average band score of 6.5 or higher.
f) Submission of official results of the Carleton Academic English Language (CAEL) Assessment with a minimum score of between 50 and 60 in each of four bands, with at least two band scores of 60.
g) Submission of official results of the Canadian Test of English for Scholars and Trainees (CanTEST) with a Band Level 4.5 in the listening comprehension and reading comprehension sub-tests and a score of 4 in writing.

Note: If a student's undergraduate study is instructed in English, he/she needs to submit a statement from the university regarding the language of instruction. The statement can be demonstrated in a letter or on transcript.

6.3.4 Personal Interview and Tests

In addition to meeting the academic admissions requirements, most applicants are required to attend an interview with either faculty members from the BOS, IO, or the Associate Dean – Graduate Studies (ADGS). The interviews are conducted either in person, by telephone, or via Skype. The interviews with the prospective student are meant to provide additional information to help the BOS make better informed decisions. Typical interview questions include: what is their motivation in applying for the particular program, what are their favorite subjects and can they briefly explain what the subject is about, what are their hobbies, who will be supporting their studies, what are their plans for the future, what they did during their internship during their undergraduate studies, who helped them with the application, etc. The purpose of the interview is also to gauge English competency, provide a check on the authenticity of their transcripts, provide a quick test to see if they have basic knowledge of some core areas, and to gauge their motivation. Each interview normally lasts between 15 to 20 minutes. Practically all applicants who apply through our authorized agent in China will be interviewed during our two recruitment trips in the Fall and in the Spring. Applicants from other countries are generally not interviewed unless requested by the BOS.

In addition to the personal interview, applicants who apply through our authorized agent in China are also given a technical test in the area of the program. This is a one-hour test to gauge basic knowledge in the field of interest. For example, potential applicants to the computer engineering program will be tested on some basic programming skills, digital logic, circuits, etc. The test results provide additional information to the BOS to help them with their recommendation. If the student performed poorly in the test, they are generally not recommended for admission regardless of their academic performance.

For students who have not received an acceptable standardized English test score (TOEFL or IELTS) yet or have yet to take the standardized tests, they have to take the CANTEST during the visit of the recruiting team. The CANTEST is a replacement of TOEFL or IELTS to gauge English competency. This is administered and graded by Janet Benger, Director of MUN's ESL after the visit. The CANTEST is deemed acceptable by SGS in place of TOEFL or IELTS.

6.3.5 Additional ESL training

All admitted students to the premium fee programs whose language of instruction at the undergraduate level is not English must complete additional English training upon their arrival in St. John's. For those given full admission, that is, those who have met the English requirement for admission prior to arrival, they will attend an 8-week professional English course in July prior to starting their graduate studies at MUN. For those given a conditional offer, that is, those who have not met the language requirements prior to arrival, would complete the 12-week ESL training program prior to starting the graduate programs. The 8-week course has no additional fees as it is part of the total program fee. The details of the two courses are given below.

Students whose undergraduate study was not instructed in English will be required to attend an 8-week professional English course prior to taking any graduate courses. The contents of the course are selected from the textbooks in the student's area of study. This course is meant to enhance the students' communication skills and technical vocabulary. It is offered during the Summer Session (July to August) each year. There is no additional charge to students for this course.

Only students who have met the English requirement for admission will be allowed to attend this course. They will register as graduate students while attending this course. They are required to pass this course with a minimum mark of 65%. After successful completion of this course, students can continue their graduate study in the Fall semester (September) and start taking the prescribed graduate courses for their particular program.

The Intensive English Program at Memorial University of Newfoundland is a multi-skill program for students preparing for full-time university studies conducted in English, or who wish to improve their English communication skills for business or professional purposes. The program is designed for students from the low-intermediate to advanced levels.

Students may apply for provisional admission to Memorial at the same time as they apply for this program. Successful completion of the Intensive English Program together with an acceptable score on the test of English language proficiency given at the end of the program may allow students to finalize their admission to a university program.

The 22 to 25 hours per week program includes 13.5 to 15 hours of classes in academic reading, writing, and listening, and eight to ten hours of speaking and listening including presentation skills, special interest seminars on culture, literature, or business, pronunciation or conversation tutorials, and practice in our language lab.

To obtain an ESL admission, applicants should indicate on the application that they wish to attend the 12-week ESL early May. Then, if the applicants are eligible for a conditional offer, an ESL admission will be issued along with the conditional offer. The cost of the 12-week ESL program is $3,500 Canadian Dollars (subject to change).

5.4 PROGRAMS

Currently, there are four premium fee course-based programs in the FEAS. The first program which is the Masters of Applied Science in Computer Engineering (MASCE) accepted its first students in 2004. This was followed by the Master of Applied Science in Environmental Systems Engineering and Management (MESEM) in 2005, and then the Master of Applied Science in Oil and Gas Engineering (MOGE) and the Master of Engineering Management (MEM) in 2009. The details of each program are given below. FEAS is also examining the viability of launching other new programs, streams and/or options, for example, a design focused stream in existing programs that specializes in innovative design engineering called a Design MEng.

I. COMPUTER ENGINEERING

This course-based graduate program prepares its graduates for further post-graduate study or for careers as computer engineers in sectors such as telecommunications, information technology, software development, and digital hardware design. The degree will provide participants with a balanced background in computer hardware and software and an in-depth knowledge of important applications areas, such as software development, hardware design, telecommunication systems, computer networks, and parallel computing.

Graduate students have access to extensive computer, laboratory, and workshop facilities. A large network of personal computers provides access to the Computer Engineering Research Laboratory's computing cluster, the Centre for Computer Aided Engineering and other university computing resources. Students have access to VLSI, System on Chip, and FPGA design tools from Synopsys, Cadence, and Xilinx, and Altera; programming tools for C++ and Java, software design tools, such as Visual Paradigm, and analysis tools such as MAPLE and MATLAB.

Applicants shall have at least a second class engineering degree in Computer Engineering, Computer Science or Electrical Engineering. Preferably, they have a background in many of the following areas: object-oriented programming, data structures, digital logic, computer organization, circuits and electronics, systems and signals, communications, discrete mathematics and probability and statistics. Students with excellent grades but missing one or two background courses may be assigned additional courses for the graduate program. This may extend the period of study for individual students.

Examples of possible backgrounds are:

- Computer Engineering
- Electrical Engineering
- Software Engineering
- Networking Engineering
- Information and Computer Science
- Information Engineering
- Telecommunication and Network Engineering
- Computer Science and Technology
- Communication Engineering
- Information Security
- Electrical and Information Engineering
- Electronic Science and Technology
- Information Technology
- Computer Information Technology
- Computer Science

Duration of the program: 18 months including an 8-week professional English course for students whose undergraduate study was not instructed in English; 16 months without the 8-week professional English course.

Degree requirement: The total credit requirement to complete this program is 36 credit hours. Students are normally required to complete 10 graduate courses (three credit hours per course) plus one course project (six credit hours).

Seven Core Courses (three credit hours each)

- ENGI 9859 Computer Engineering Fundamentals
- ENGI 9861 High Performance Computer Architecture
- ENGI 9865 Advanced Digital Systems
- ENGI 9867 Advanced Computing Concepts for Engineering
- ENGI 9871 Information Theory and Coding
- ENGI 9874 Software Design and Specifications
- ENGI 9876 Advanced Data Networks

One Project Course (six credit hours)

- ENGI 980A/B Computer Engineering Project

Three Elective Courses: (three credit hours each)

- ENGI 9821 Digital Signal Processing
- ENGI 9822 Nonlinear Image Processing & Analysis
- ENGI 9868 ASIC Design
- ENGI 9869 Advanced Concurrent Programming
- ENGI 9872 Digital Communications
- ENGI 9875 Embedded and Real-Time Systems Design
- ENGI 9877 Computer and Communications Security
- ENGI 9878 Wireless and Mobile Communications
- ENGI 9879 Formal Specification and Development
- ENGI 9880/83 Special Topics in Computer Engineering
- ENGI 9888/91 Special Topics in Communications Engineering
- CS 6752 Applications of Computer Graphics
- CS 6756 Digital Image Processing
- PHYS 6102 Optics and Photonics

For a student who has missing prerequisite background knowledge in either hardware or software engineering is normally required to take additional courses to fill knowledge gaps in the missing areas. These courses are normally undergraduate courses such as Engi 3861 Digital Logic, Engi 3891 Advanced Programming, and Engi 6861 Computer Architecture. There are no additional charges for these courses. These courses will form part of their graduate program and the students are required to obtain a minimum grade of 65%.

II. ENVIRONMENTAL SYSTEMS ENGINEERING AND MANAGEMENT

Environmental engineering has become an increasingly important discipline due to complexity and multi-disciplinary nature of the environmental issues dealing with human health and ecosystem protection. To find cost-effective engineering solutions to these complex issues, it is important to acquire broad-based education and professional training in inter-disciplinary fields of physical, chemical and biological principles, resource management and mitigation measures besides in-depth knowledge in environmental engineering. This program will cover a wide range of related topics, such as environmental law and management; human health and ecological risk assessment; remediation technology; treatment processes of drinking water and wastewater; contaminant transport and environmental modeling; environmental sampling; and pollution-control engineering. To apply the concepts learned in the classroom and laboratory environments, students will work in teams on an engineering project for two terms. In order to

acquire broad-based knowledge in the field, students are encouraged to take courses from other disciplines in the university. The program can be completed on a full- or part-time basis.

The environmental engineering laboratory in the Faculty of Engineering and Applied Science has state-of-the-art equipment for air, water, and soil analyses. Besides this facility, the university offers excellent centralized facilities in chemical and biological analyses. The master of applied science in oil and gas engineering, master of engineering management program, and the undergraduate program in process engineering offer courses related to the environmental engineering and management discipline.

Applicants shall normally hold a minimum second class Bachelor's Degree in engineering, preferably in civil, environment, chemical, processing or petroleum engineering; or in a related discipline from a university of recognized standing. Preferably, they have background in areas such as fluid mechanics, chemistry, statistics, water resources management, and pollution control. Students with excellent grades but missing one or two background courses may be assigned additional courses for the graduate program. This may extend the period of study for individual students.

Examples of possible backgrounds are:

- Environmental Engineering
- Environmental Science
- Civil Engineering
- Process Engineering
- Petroleum Engineering
- Mechanical Engineering
- Biotechnology
- Bioscience
- Polymer Materials and Engineering
- Mining
- Geomatics Engineering
- Chemistry/Applied Chemistry

Duration of the program: 14 months including an 8-week professional English course for students whose undergraduate study was not instructed in English; 12 months without the 8-week professional English course.

Degree requirement: The total credit requirement to complete this program is 30 credit hours. Students are normally required to complete eight graduate courses (three credit hours per course) plus one course project (six credit hours).

Group A - Environmental engineering project (six credit hours):

- ENGI 960A/B Environmental engineering project course (six credit hours).

Group B - Five core courses (three credit hours each):

- ENGI 9601 Environmental pollution and mitigation
- ENGI 9609 Environmental risk assessment
- ENGI 9626 Environmental management system
- ENGI 9627 Environmental systems engineering
- ENGI 9628 Environmental laboratory

Group C - Three courses from the following list (three credit hours each):

- ENGI 9603 Environmental sampling and pollutant analysis
- ENGI 9605 Water and wastewater treatment
- ENGI 9621 Soil remediation engineering
- ENGI 9622 Environmental statistics
- ENGI 9624 Air pollution
- ENGI 9625 Environmental impacts of offshore oil and gas operations
- ENGI 9629 Environmental policy and regulations
- ENGI 9630 Pollution prevention
- ENGI 9610-9615 Special studies topics
- ENVS 6001 Earth and ocean sciences
- ENVS 6002 Environmental chemistry and toxicology
- ENVS 6003 Applied ecology
- GEOG 6250 Conservation of natural resources

Students from certain environmental background may have to take additional courses to fill their knowledge gap. Students who are missing water related courses are normally required to take the undergraduate Engi 6713 Hydraulics or Engi 6961 Fluid Mechanics course. Those with strong environmental engineering backgrounds but missing the sciences may be required to take Envs 6000 Environmental Science, or Engi 6651 Sustainable Engineering in Processing Industries. There are no additional charges for these courses. These additional courses will form part of the program and the students must obtain a minimum of 65%.

III. OIL AND GAS ENGINEERING

The oil and gas industry is complex and requires expertise in various areas and technical disciplines. To meet this demand, the program will provide the latest technical knowledge on upstream, production and downstream aspects of oil and gas engineering. The program will also address serious issues faced by the oil and gas industries, such as sustainable development, environmental protection, risk, reliability and safety. In addition, the program will cover drilling engineering, phase behaviour of petroleum fluid, production engineering, compact process equipment design, offshore environmental operations and natural gas engineering. Many of the courses taught in the program will be supported by field study and laboratory demonstrations.

Applicants typically hold a minimum second class Bachelor's Degree in engineering preferably in mechanical, chemical/process, civil, environmental, mining/mineral or petroleum engineering, or in a related discipline from a university of recognized standing. Preferably, they have a background in areas such as Fluid dynamics, Heat Transfer, Thermodynamics, Mass Transfer, Engineering mathematics, and Process related engineering courses. Students with excellent grades but missing one or two background courses may be assigned additional courses for the graduate program. This may extend the period of study for individual students.

Examples of possible backgrounds are:

- Petroleum Engineering
- Environmental Engineering
- Civil Engineering
- Mechanical Engineering
- Chemical Engineering
- Process Engineering
- Mining/Mineral Engineering
- Petroleum Production Engineering
- Petroleum Chemistry
- Metallurgical Science and Engineering
- Thermal Energy and Dynamic Engineering
- Oil & Gas Storage and Transportation Engineering
- Materials Science and Engineering (polymers)
- Chemical Engineering and Technology
- Resource Exploration Engineering
- Geological Engineering
- Geophysics

Duration of the program: 14 months including an 8-week professional English course for students whose undergraduate study was not instructed in English; 12 months without the 8-week English course.

Degree requirement: The total credit requirement to complete this program is 30 credit hours. Students are normally required to complete 8 graduate courses (3 credit hours per course) plus one course project (six credit hours).

Group A – ENGI910A – OGE Project Course (zero credit hours)

- ENGI910B – continuation of OGE project course (six credit hours)

Group B – Five core courses (three credit hours each)

- ENGI 9110 Advanced Petroleum Production Engineering
- ENGI 9113 Phase Behaviour of Petroleum Reservoir Fluids
- ENGI 9114 Advanced Reservoir Engineering

- ENGI 9118 Advanced Drilling Engineering
- ENGI 9121 Advanced Safety, Risk and Reliability Modeling

Group C – Three courses from the following list (three credit hours each)

- ENGI 9002 Ocean Engineering Structures
- ENGI 9015 Ocean Engineering Hydrodynamics
- ENGI 9111 Well Testing
- ENGI 9112 Multiphase Flow
- ENGI 9116 Reliability Engineering
- ENGI 9119 Compact Process Equipment Design
- ENGI 9120 Advanced Natural Gas Engineering
- ENGI 9117 Offshore Petroleum Geology and Technology
- ENGI 9420 Engineering Analysis
- ENGI 9609 Environmental Risk Assessment
- ENGI 9624 Air Pollution
- ENGI 9625 Offshore Environmental Operations
- ENGI 9901 Fundamentals of Fluid Dynamics
- ENGI 9902 Advanced Transport Phenomena
- ENGI 9989 Special Topics – Corrosion Principles, Prevention and Control

Students who are academically strong but are missing background knowledge in certain areas are required to take additional courses to improve their background knowledge before taking more advanced courses in oil and gas engineering. Some of these undergraduate courses that they may be required to take include: Engi 6961 Fluid Mechanics II, Engi 3901 Thermodynamics I, Engi 6901 Heat Transfer, Engi 3600 Introduction to Process Engineering, Engi 6322 Thermal Sciences, Engi 6651 Sustainable Engineering in Processing Industries, or Engi 6602 Offshore Petroleum and Technology. Normally not more than 3 undergraduate courses will be required. There are no additional charges for these courses. These courses will form part of their graduate program and the students are required to obtain a minimum grade of 65%.

IV. MASTER OF ENGINEERING MANAGEMENT

The primary goal of the program is to enable engineering graduates to gain advanced knowledge in their field of engineering and formal training in business, such that they may enhance their participation in their firm's development as part of the current knowledge economy. This course-based masters program will combine education in management with technical training in the student's field of interest. The program draws on graduate courses in the faculties of engineering and business.

The core courses address important engineering management topics such as statistical modeling, organizational behavior, marketing, and accounting applied to decision-making in the engineering sector. Apart from core and elective courses in business and engineering, the program consists of an engineering management project. Issues discussed in courses and projects are geared to be of interest for engineering graduates associated with large companies, small and medium enterprises, and start-up organizations.

Candidates shall normally have obtained a baccalaureate degree, with a minimum 'B' standing, in an engineering discipline from a university recognized by the School of Graduate Studies. Preference will be given to students who have work experience in management or have completed courses in accounting, finance, management, human resources, etc.

* Please note that the English requirement for this program is **IELTS 6.5** or **TOEFL ibt 90**.

Examples of possible backgrounds are:

- Electrical Engineering
- Civil Engineering
- Computer Engineering
- Ocean and Naval Architecture
- Mechanical Engineering
- Environmental Engineering
- Mechanical Engineering
- Environmental Engineering
- Petroleum Engineering
- Electrical and Information Engineering
- Electrical Engineering & Automation
- Industrial Engineering
- Engineering Management
- System Analysis and Programming
- Electrical & Communication Engineering

Duration of the program: 18 months including an 8-week professional English course for students whose undergraduate study was not instructed in English; 16 months without the 8-week professional English course.

Degree requirement: The total credit requirement to complete this program is 36 credit hours. Students are normally required to complete 10 graduate courses (three credit hours per course) plus one course project (six credit hours).

Courses include:

- Engineering Management Topics
- Advanced Modeling and Quality Management
- Marketing

- Accounting for Management
- Organizations: Behaviour and Structure
- Three electives from Engineering
- Two electives from Business
- Master of Engineering Management Project (six credit hours)

The program consists of five courses in the Faculty of Engineering and Applied Science, five courses in the Faculty of Business Administration, and a six-credit project. Currently there are no additional prerequisite courses required for students in the MEM program.

Unlike the other course-based programs, the MEM program is built on existing courses (with only 2 MEM-specific new courses) and does not prescribe undergraduate courses as part of the admitted student's program of study. Engineering Management is part of the FEAS Strategic Plan, as a response to local industry interest, including an increased component in the undergraduate curriculum and potentially an additional faculty member to be hired in the future.

V. SAFETY AND RISK ENGINEERING

Safety and Risk concerns are of paramount importance in a wide variety of complex engineering activities such as offshore operations, petroleum refining, and mineral processing. Today, there is a wide range of techniques available to assess safety, risk and reliability, both in relation to design as well as day-to-day operations. The use of these techniques is now an integral part of safety related regulations of hazardous facilities and operations.

The Graduate Diploma in Safety and Risk Engineering is designed to give a thorough understanding of these techniques and their application to a variety of real-world problems. The program is the only one of its kind in Canada. It aims to provide students with a good grounding in safety and risk engineering in both a qualitative and quantitative manner, and to develop the skills to apply this understanding. The program will also introduce students to recent developments in analytical techniques, e.g. computer modeling of risk, reliability and safety problems, dynamic risk analysis, etc.

The program is intended, though not limited, to working professionals to advance their understanding and skill related to safety and risk engineering. The knowledge acquired through the program will enhance the skills of engineers in the process industries, oil and gas service and operating companies, mineral processing, engineering consultants, and also government services. This graduate diploma builds around the knowledge and understanding of accident modeling, process and offshore safety issues. It also covers engineering and human factors associated with the safety and risk assessment. There is no thesis requirement for the graduate diploma.

The following topics will be covered in detail in different courses of the diploma program: Accident modeling; Process safety; Electrostatic hazards and their prevention; Safety

instrumented system; Offshore safety; Fire and explosion engineering; Emergency situation assessment and management; Human factor assessment; Reliability assessment; Structural safety and integrity assessment; Quantitative risk assessment and management; Probabilistic risk modeling and its application in safety and structure design; Environment risk assessment; Risk-based asset integrity assessment and management; Risk-based safety measure design.

5.5 TRANSFERABILITY AMONG PROGRAMS

It would be very rare for a student to transfer from one premium fee program to another although it is technically possible. Since all students have engineering backgrounds, it is feasible for a MEM student with the right background to transfer to the MESEM, MOGE, or MASCE program or vice versa if they have some management experience. It is more likely for a premium fee student to transfer to the research-based MEng program after their arrival. This has happened on several occasions. There was also one case where a MEng student transferred to the MEM program. However, once the special fee is paid, it is not refundable. Students transferring to the MEng program after paying the special fee would then have to forfeit the fees.

5.6 PROGRAM FEES

The four premium fee programs were proposed at different times: MASCE in 2004, MESEM in 2005, and finally MEM and MOGE in 2009. The program fees for both MASCE and MESEM when these programs were proposed were in US dollars and the latter two programs were in Canadian dollars of different amounts. The tuition fees were all approved by the Board of Regents at the time of the proposal. The original premium tuition fees are given in the Table 5.1. These fees were later harmonized in 2010.

Program	Canadian Tuition	International Tuition
MASCE (Computer)	$26,000 USD	$26, 000 USD
MESEM (Environmental)	$20,000 USD	$20, 000 USD
MOGE (Oil and Gas)	$19,398 CAD	$20,718 CAD
MEM (Engineering Management)	$16,000 CAD	$22,000 CAD

Table 5.1: Tuition fees for MASCE, MESEM, MOGE, and MEM (prior to harmonization)

As can be seen from Table 5.1, each program has a different fee resulting in several difficulties as follows:

- The MASCE and MESEM programs have tuition based on USD which causes revenue and planning problems due to the fluctuating CAD-USD exchange rate.
- The MASCE and MESEM programs have a single fixed tuition rate for all students regardless of nationality.
- The MOGE program has tuition in CAD but has a fixed special fee and Canadian students enrolled in the program are charged for ESL which they do not utilize.

In view of the above issues with the fees, harmonization of the fees was proposed in 2010. The justification for the harmonization was that the MEM program was the last premium fee program to be approved, and its tuition fee plan was approved by the Board of Regents in 2009. As per this fee plan, all students pay the Masters Plan A[1] tuition which is higher for international students due to the differential fee.

Students pay different special fees based on whether or not they take the English courses. As a result, the tuition schedule for MEM addresses the three major issues with other program fees listed above, and is the best fee model to expand student enrollment among Canadian and international students. The proposal to the Board of Regents in 2010 was to harmonize the tuition for the MASCE, MESEM, and MOGE on the pattern of the MEM program. The MESEM and MOGE programs have 3 academic semesters after the English course which is the same as the MEM program (see note after Table 5.3). Hence all three programs should have the same fees as follows:

Plan A (pay over 6 semesters)	Regular Tuition Fee (Plan A)	Premium Tuition Fee (also called Special Fee)	Total (in Canadian $)
Fee per semester for domestic students	$733 x 6 = $4,398	$11, 602	$16,000
Fee per semester for international students	$953 x 6 = $5,718	$16,282	$22,000

Table 5.2: Harmonized fees for MESEM, MOGE, and MEM programs

The MASCE program has 4 post-English course semesters compared to the 3 academic semesters of the other premium fee programs, therefore the special fee is scaled proportionately. The harmonized fee for the MASCE program is shown in Table 5.3.

Plan A (pay over 6 semesters)	Regular Tuition Fee (Plan A)	Premium Tuition Fee (also called Special Fee)	Total (in Canadian $)
Fee per semester for domestic students	$733 x 6 = $4,398	$15, 302	$19,700
Fee per semester for international students	$953 x 6 = $5,718	$20,282	$26,000

Table 5.3: Harmonized fee for MASCE program

[1]Plan A semester fee schedule and associated regulations, such as continuance fees and refund, are outlined in the University Calendar.

Note: It must be pointed out that the MEM is actually a 36 credit hour program or requires 4 semesters, post-English course, and not 3. Hence the MEM and MASCE program should have had the same fee structure.

Students offered admission into any of the four programs will be required to pay a non-refundable $2,000 deposit to confirm their seat in the program. This deposit is credited towards the Premium Tuition Fee (also called Special Fee) for the program as tabulated above. In addition to the payment of the tuition fee by semester under Plan A, the Special Fee (less the $2000 non-refundable deposit), referred to as the Remaining Special Fee (RSF), will be paid by the students in two installments as follows: at the beginning of semester 1 the student will be charged 60% of the RSF; and at the end of semester 2 the student will be charged the remainder of the fees. The Special Fee, once paid, is not refundable. The deposit of $2,000 is in general non-refundable. However, if the student can show proof of visa rejection by a Canadian Embassy, the deposit fee is refundable. Currently there is no refund policy for the Premium Tuition (Special) Fees regardless at what point the student is in the program. The harmonized fees were implemented starting May 2010.

5.7 INDUSTRIAL INTERNSHIP OPTION

In 2009, an industrial internship option was added to the premium fee programs. It was viewed that the addition of this option would help provide students with some work experience and enhance their employability, as well as make the programs more attractive. The internship option was modelled after the existing MEng internship option which does not require supervision or monitoring beyond what can be provided by the BOS. The internships will not be guaranteed prior to the student's entry into the program. It is an option but has fairly strict criteria. The calendar description is given below.

The Faculty of Engineering and Applied Science encourages students to undertake internships in industry. These internships will allow students to enhance the application of their knowledge and skills by working within industry or by completing a research project defined by industry.

Students registered in the masters program may, with the permission of their Board of Studies, the Dean of the Faculty of Engineering and Applied Science, and the Dean of Graduate Studies, select the Industrial Internship Option. Students registered for the option must satisfy the degree regulations for the masters program. In addition, students in the Industrial Internship Option:

- Shall normally complete at least 18 credit hours of the courses required for their program with an average of 75% or higher prior to the internship; the remaining required courses may be taken on campus or by distance.
- Shall normally spend at least two continuous semesters on campus on a full-time basis as a graduate student at this university.
- Shall submit a concise progress report to their Board of Studies, no later than the end of each semester while on an internship.
- Shall not opt out once the internship starts.

Attending job search workshops offered through the experiential learning and career development center is highly recommended to students who wish to undertake an internship. Ideally, students can start an internship after they have completed all the courses in the graduate program.

To further enhance the education of the premium fee masters students, the Faculty of Engineering and Applied Science has been collaborating with the Gardiner Center at Memorial University in the delivery of professional development program for our students. The program has been designed to develop the skills of the students in areas of Effective Communications, Quantitative Methods and several streamed topics based on the program to which they apply. Three topics included in the professional development courses are: Essential Communication Skills for Professional Success; Stand and Deliver: Effective Presentation Skills; and Technical Report Writing. The desired outcome for all students participating is a more finely developed skill-set in business communications. So far 213 students have taken the courses. These courses are offered over several weekends. Students who attend and complete the courses get a completion certificate from the Gardiner Centre. There are no additional fees for students to attend these courses.

5.8 ENROLMENT AND RETENTION

As of Spring 2013, a total of 363 students have enrolled in the four premium fee course based programs. Table 5.4 shows the total enrollment over the last 10 years, the number graduated, the number currently registered in the programs, number terminated, and others who have withdrawn or transferred to other programs.

Program	Enrollment from start	Graduated	In-Program	Terminated	Others[1]
MASCE	151	94	33	20	4
MESEM	90	60	24	2	4
MOGE	75	44	26	4	1
MEM	47	17	25	2	3
Total	**363**	**215**	**108**	**28**	**12**

[1]Others: withdrawn on their own accord or transferred to MEng programs.

Table 5.4: Overall Summary of Enrollment, Graduation, Registrations and Attrition (Spring 2013)

From Table 5.4, the MASCE program has the most terminations. While this seems disproportionately high compared to the other programs, it is believed that this is not unusual for a computer engineering program, given that the BOS aims to maintain high standards and technical content of coursework. It should be noted that Memorial's undergraduate program in computer engineering also has the highest failure rate among all of our undergraduate engineering programs.

The historical enrollment trends for the four programs are given in Table 5. It can be seen that there was a distinct drop in the enrollment during the 2009/2010 period. However, since a dedicated International Officer was hired in 2009, the enrollment numbers have increased. There is more proactive recruitment now and also as the programs become more well-known throughout the world, enrollment numbers should continue to increase.

Program/Year	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13
MASCE	25	18	12	15	10	7	10	30	24
MESEM		11	10	7	11	10	4	13	24
MOGE						8	19	22	26
MEM						3	16	13	15

Table 5.5: Historical enrollment trends

Practically all students in the MASCE program are from China except one or two from India. The most diverse student body is in the MOGE program. The MEM program has the most domestic students (19) but almost all are part-timers. For the programs to be financially viable, it is necessary to have at least 20 students per program.

Careers after the premium fee programs are quite varied. In general they can be classified into three groups: 1) those who continued on to the research Masters or PhD programs at MUN and elsewhere, 2) those who found employment in Canada, and 3) those who have returned home for employment or switch fields. Table 6 shows some sample data of careers after graduation from the premium fee program. The data are not entirely accurate as some graduate students do not tell us what is their current status.

Category	MASCE	MESEM	MOGE	MEM	Total
MEng	11	13	11	0	35
PhD	8	10	2	0	20
Working in Canada	53	22	11	5	91
Unknown*	22	15	20	12	69

*Unknown = returned home or did not report current status.

Table 5.6: Post-graduation careers (numbers are approximate)

Once they return home, unless they keep in touch, it may be difficult to find out their current status. We also note that some of the premium-fee students were outstanding and were admitted directly to PhD programs at Memorial or other universities.

5.9 FINANCIAL DETAILS

Revenues

The revenues are naturally the premium fees collected from each enrolled student. As described in section 5b, the total program fees consist of two parts: Plan A semester fees paid over 6 semesters, and the special fee part paid over 2 semesters. The current fees for an international and domestic student are as follows:

International students:

- MASCE : $26,000 ($20,282 + $5,718)
- MESEM/MOGE/MEM: $22,000 ($16,282 + $5,718)

Domestic students:

- MASCE: $19,700 ($15,302 + $4398)
- MESEM/MOGE/MEM: $16,000 ($11,602 + $4,398)

The underlined amount is the premium fee portion. The FEAS keeps only the premium fee portion of the fees. The Plan A fees go to the university. This is a significant reduction in the revenues of FEAS after post-harmonization of the fees. Before the harmonization of the fees,

FEAS kept all of the fees, e.g. $26,000 USD and $20,000 USD for MASCE and MESEM, respectively.

Expenses

Expenses can be classified into two main types. Regular expenses are those that occur every semester, per student, or annually. Irregular expenses are those that are as needed and do not occur on a regular basis.

There is 10% of premium fees that go to the Provost's Office. For example, $2,028/student (MASCE) and $1,628/student (MESEM/MOGE/MEM) are collected for international students. These amounts are taken before expenses.

Balance of revenues (90% of special fees) goes to pay:

1. Salaries + Benefits (largest expense that increases each year)
    - Professors (approximately 1.5 positions per program)
    - International Officer + ½ of Academic Program Administrator's salary
    - Extra teaching + sessional instructors for premium fee courses
    - Teaching assistants for premium fee courses
2. Recruiting agent fees
    - $2,000 per student (plus HST if it is a Canadian based company)
3. Language and professional development
    - 8-week English course ($1,800 per student)
    - Communication + professional development training (Gardiner Centre) – about $550 per student
4. Materials and Supplies
    - Course related material and field trips
    - Capstone project presentations
    - Postage and courier services
5. Research student support
    - Research support for students in the four cohort areas - $2,000 top up
    - Research in other areas - $1,000 top up
    - Research student travel support ($250/student)
6. Recruitment
    - Bi-annual student recruitment travel to China by Faculty and IO
    - Other recruitment fairs, registration and travel
    - Recruitment material (brochures, flyers, etc)
    - Meetings with agents
7. Scholarships
    - Entrance scholarships ($3,000 for MASCE, $2,000 for others)
    - In-program scholarships ($2,000 for 1st, and $1,500 for 2nd)
8. Revenue sharing with FBA

- $500/course per MEM student enrolled in MBA courses (as of Spring 2013)

9. Other expenses
   - Computer upgrades and renovations
   - Classroom renovations
   - Graduate office space renovations
   - Furniture
   - Computers in home rooms

More than 10 faculty members were hired for the premium fee program over the years. All of them were hired as assistant professors on a three-year contract with the exception of the MEM program. A tenure-track associate professor was hired and continues to be paid from the MEM program revenues. Over the years, some of them went into tenure track positions when these positions became available. However, some who went into tenure track positions continue to be paid by the premium fee programs. Most of them are still teaching in the programs. The list of faculty members and their current status are given below.

MASCE:

- Dr. Octavia Dobre - converted to tenure track, now tenured Associate Professor
- Dr. Lihong Zhang – converted to tenure track, now tenured Associate Professor
- Dr. Fang Wang – 3-year contract expired, not renewed
- Dr. Andrew Vardy (1/2) - converted to tenure track with Computer Science, now tenured Associate Professor with Computer Science, renewed with FEAS for another year at ½ time
- Dr. Mohammed Sheheta – currently Assistant Professor with a 3-year contract

MESEM:

- Dr. Bing Chen – converted to tenure track, now tenured Associate Professor
- Dr. Helen Zhang – Assistant Professor with 3-year contract, converted to tenure track Assistant Professor when contract ended but continues to be paid by premium fee program

MEM:

- Dr. Amy Hsiao – hired as tenure track Associate Professor, now tenured Associate Professor but paid through premium fee program

MOGE:

- Dr. Abdul Illyas - Assistant Professor with 3-year contract expired, not renewed
- Dr. Lesley James – hired as Assistant Professor with 3-year contract but converted to tenure track Assistant Professor after a few months, now Chevron Chair
- Dr. Azizur Rahman – new Assistant Professor with 3-year contract to start November 1st, 2013

There are plans to hire another faculty member to teach in the MASCE program in the near future as there is still a shortage of faculty teaching in that program. Currently, the program is relying on sessional instructors or overload teaching of other faculty members.

From the above list of expenditures, the largest expenses are in salaries of professors and staff, and in research student support. The salaries of two faculty members, one in MEM and one in MESEM who are in tenure track positions are still coming from these programs. This situation is unlikely to change in the near future and this expense is only going to increase each year. Research student support was implemented about two years ago when there was surplus revenue. However the recent and planned hiring of new faculty members for the premium fee programs will eliminate the surplus. Hence graduate research support seems to be the only avenue to reduce expenses. FEAS plans to reduce the amount of research support to the four cohort areas by half and to eliminate the support of the non-cohort areas starting in Spring 2014. Another way to increase revenues to cover expenses is to increase the enrollment for these programs. Recruitment efforts have to be stepped up to reach the full capacity of these programs which is 25 per program. As can be seen in Table 5, this number has not been reached on a consistent basis. Programs of particular concerns are the MESEM and MEM programs. Detailed annual revenues and expenses by program over the years will be made available during the site visit of the reviewers.

5.10 BENEFITS OF PROGRAMS

The value of the premium fee programs are often questioned within the faculty especially by disciplines not involved with any of the premium fee programs. They are often viewed as an additional strain on the faculty and taking away resources from research programs and the delivery of core undergraduate teaching requirements (core faculty involved in premium tuition courses). Some faculty members strongly object to these programs. However, on a broad objective basis, considering all pros and cons, there is a significant value of these programs as follows.

1. Aligns well with MUN's strategic frameworks on teaching, research and external engagement (collectively referred to as Capstone)

- Expand program innovation and development
- Increase graduate student enrolment
- Enhance student recruitment and financial support
- Focus on expanded program delivery in areas of high industry needs
- Expand research collaboration and partnerships
- Increase student diversity and internationalization
- Build infrastructure for graduate programs
- Participate in the international community
- Increase revenue and funding sources

2. Adds diversity of programs to our graduate offerings

3. Provides a stable set of graduate courses for all graduate students

4. Provides a strong prospective pool for subsequent research-based Masters and PhD students

5. Provides more breadth and diversity of graduate level education

6. Provides a means of hiring additional well-qualified faculty

7. Enhance reputation of MUN by promoting programs worldwide

8. Provides a modest source of income to the Faculty for office, classroom, and laboratory upgrades

9. Capstone research projects done by students are directly relevant to the community and/or industry

10. Provides a supplementary source of funding for research students in the area of course-based programs

11. Provides job opportunities within the faculty, ESL, and other units

12. Positive economic and cultural impact for the province: rental housing, food, transportation, entertainment and services, etc. See Siddiq et al (2010)

13. Source of HQP for Canadian companies – new hires and upgrading of professional skills

14. Educational capacity contribution to the country

15. Provides generous scholarships to local students to offset cost of programs

Professional masters or cost-recovery programs are offered in numerous top Canadian, US, UK, and Australian universities. Many or most of these universities are calling for an increase of professional masters programs e.g., CGS (2006) and Pennsylvania State University (2008).

"*By 2017, we plan to more than double our graduate student population. We aim to have 8,000 graduate students – 5,000 in research programs and 3,000 in professional and course-based masters programs. That's a big, bold leap forward from the 4,300 graduate students now at Waterloo! " – University of Waterloo.*

5.11 SELF-REFLECTION

Over the past decade, several significant changes have been made within the premium fee programs that have and will have serious implications for the future viability of the programs. There are also issues that have arisen over the years that are largely beyond our control or not foreseen when some of these programs were launched. Below are some of these changes and issues.

Fee harmonization: The most significant change was the harmonization of the fees in 2009. The rationale for harmonization was discussed in Section 5b. However, this has caused a significant

reduction in revenues to the FEAS. Less than 80% of the fee now comes to FEAS. Then 10% of this goes to the Provost's Office. Hence only about 70% of the total revenue can be used for operating expenditures. A recent review by the Budget Advisory Team (BAT) recommended that 10% to the Provost would remain for existing programs but would increase if there are changes made to the programs. This means that if the fees are increased, then a higher portion of revenues will go the Provost's office, defeating the purpose of a fee increase from the perspective of FEAS. As a result, FEAS is increasingly unable to raise the revenues it needs to offset the rising costs of program delivery.

Increasing salaries: The salaries of faculty and staff increase each year because of step increases, collective bargaining or promotion. In addition, over the last decade, starting salaries of new hires have increased substantially. However, the premium fees have not increased since they were first proposed. This makes it very difficult to hire additional faculty members to teach in these programs without a significant reduction in other budgets. Increasing the fees is a possible solution, but aside from above point (a), there has been a recent controversy in the media about how significantly more expensive these premium fee programs are at MUN. Increasing fees may not be a viable solution at this time.

Faculty support: Since the start of the premium fee programs, there has been controversy in the FEAS regarding the support of these programs. Hence any discussions about these programs can be quite contentious. Some faculty members are not supportive of these programs, because in their opinion, they are viewed as inferior (for example, graduate courses at a lower technical level than research based programs) and they take away resources that should be otherwise focused on core undergraduate and research based program delivery. There has also been a call to show graduate course descriptions in the academic calendar for the benefit of both students and faculty members.

Quality of courses: The issue of the quality of some of the premium fee graduate courses has been brought up by some faculty members. Some believe that the technical content of some courses is too low and hence not appropriate as graduate level courses. This may adversely impact the level of education of research-based MEng and PhD students who are also taking these courses.

Not part of strategic plan: While FEAS plans to grow its graduate student enrollment from the current 400 to about 625 by 2020, increasing the premium fee cohorts is not part of the planned expansion. The maximum of 25 per program will remain. This is not a major issue for now as this number has not been reached consistently by some of the programs yet. For these programs to be viable, at least 20 students per program are required on a consistent basis especially with the increasing expenses each year.

Payments to FBA: When the MEM program was proposed, although it was done in collaboration with the Faculty of Business Administration (FBA), there was no revenue sharing arrangement as part of the proposal despite the fact that students in the MEM program take half their courses from the MBA program. This oversight was recently corrected and the FEAS

has agreed to pay $500 per MEM student per course enrolled in the FBA. However, this will have a significant adverse impact on the financial bottom-line viability of the MEM program for FEAS.

Reduced fees of Canadian students: With the harmonization of fees, it was recognized that Canadian students should pay less tuition than international students. However, this will impact the revenues especially for the MEM program since there are quite a number of Canadian students in the MEM program. While it is very encouraging to see more Canadian students in the MEM program, they do pay $5,000 less than international students.

Need for additional faculty: Currently there are only 1½ faculty members in the MASCE program that is financed by the premium fee program. Even with a full teaching load devoted to the MASCE courses, there are still many courses that are left without an instructor. There is also a project course that requires supervisors to help supervise individual projects. Some faculty members have been doing this by overload teaching i.e. teaching beyond their normal load, but building up more unfunded teaching credits. Through both projects and courses, core faculty members have been pulled from their core duties in other areas towards the premium fee programs, in other words taking away resources from other core areas of the Faculty to deliver the premium fee programs. The only way out is to hire additional faculty members to teach in the program. As discussed earlier, it may be necessary to hire faculty at the lecturer level rather than the regular Assistant Professor level. The lecturer level costs less and has a higher teaching load. However, this has never been done in FEAS before. This route is currently being explored.

Recruiting agents: There are plans to sign up more recruiting agents for the premium fee programs. Currently we have an agent for China (Can-Zhong International) who has a signed exclusive contract. We also have a signed contract with Canam from India and have started working with two additional agents for the Indian region, and one for the Middle East. However the contracts for the latter three have not been signed yet. Before we can sign up more agents, better clarity is needed on international recruitment and contract administration approvals.

Error in fee structure: As pointed out in Section 5b, the MEM and MASCE programs should have the same fee structure as both require 36 credit hours or 4-post English course semesters to complete. This error may be difficult to fix at this stage. Furthermore, as mentioned above in Section 9a, any changes in fees would also mean an increase in the Provost's portion.

Teaching credits for project supervision: Currently there is no clear mechanism for the awarding of teaching credits to Faculty members from other units who supervise the projects in the premium fee programs. The MASCE program uses faculty from the Department of Computer Science to assist with project supervision but teaching credits or payments do not seem to be transferable between different academic units. The MEM program faces a similar situation. There are also some inconsistencies the in awarding of teaching credits for project supervision among the four programs. Any changes would have cost implications.

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6. FACULTY ACTIVITIES

6.1 BALANCE OF FACULTY ACTIVITIES

The normal teaching load in the Faculty of Engineering and Applied Science is four courses (including graduate courses) in two of three semesters in any academic year. Ideally, faculty members are assigned three undergraduate and one graduate course per academic year. Associate Deans, Discipline Chairs, the Director of Ocean Engineering Research Centre, the Director of Industrial Outreach and Research Chairs carry a reduced teaching load.

Under Article 3 of the Collective Agreement it is possible to vary the teaching workload in individual cases. Faculty members in the first two years of a tenure-track appointment are assigned three courses in an academic year.

Faculty members have a duty to engage in scholarly activity which includes conducting research or other scholarly activities and disseminating such work in a means appropriate to the discipline. Faculty members who do not fulfill the duty to engage in scholarly activity may be assigned additional teaching duties up to a total of six courses in an academic year.

In 2003, the Faculty of Engineering established course equivalencies as required by Clause 3.16b of the Collective Agreement. These equivalencies provide teaching credit for non-lecture formats of teaching, including laboratory responsibilities, senior undergraduate project supervision and graduate student supervision.

Fundamentally, continued teaching competence and professional growth depend on a continual updating of knowledge through engineering research and study - usually evidenced by scholarly output in some form - or by involvement in professional engineering activity such as research contracts, consulting, or industrial leave.

Members of the Faculty are evaluated for tenure and promotions primarily on the basis of teaching performance and professional and research activity. Among other things, the criteria for promotion stress the importance of professional growth.

Memorial has implemented a mandatory course evaluation questionnaire (CEQ) process which provides student feedback on teaching performance to instructors. The CEQ results are also made available to the Faculty administration. When the CEQ results indicate a potential concern about teaching effectiveness, the Associate Dean and Discipline Chairs follow-up with instructors to provide assistance and support that will lead to an improvement in teaching performance.

Sabbatical leaves and non-teaching semesters may be spent at other universities, research institutes as well as in industry, under appropriate conditions. This opportunity is frequently taken by faculty members. A standard professional development allowance of $1600 per year is now in place and this provides very flexible support for ongoing professional development.

6.2 RESEARCH

The Faculty of Engineering and Applied Science is involved in a wide range of exciting fundamental and applied research. Our research programs reflect the needs of our unique location where industries such as oil and gas, and information technology are rapidly growing. Engineering research funding totaled close to $17.5 million in 2012, increasing six fold since 2002. There is strong support for this research from industry and from various funding initiatives, NSERC, ACOA/AIF, CRC and CFI. There are currently five externally funded research chairs in the Faculty and several more are under development. There are many opportunities for students, both undergraduate and graduate, to become involved in ongoing research in the Faculty of Engineering and Applied Science. Research activities are also supported by post-doctoral fellows, research engineers and work-term students.

Ocean engineering research has historically been an area of strength in the Faculty, and more recently we have strengthened our research in oil and gas engineering, environmental engineering, digital systems research, energy systems research, autonomous vehicles, instrumentation and control, thermo-fluids, structural engineering and process engineering. Research is currently supported by over 450 graduate students across all disciplines.

While our Faculty is very active in journal publications, patents and international conference publications, recently we have provided particular support to our graduate students who have launched start-up companies in order to commercialize the results of their research activities. Notable start-ups include Virtual Marine Technology, Extreme Ocean Innovation and Verafin. Additionally, our research and development expertise and unique research facilities are available to the external community through our Industrial Outreach Group (IOG).

6.3 RESEARCH FACILIITIES

Whether designing safer and more efficient ships or calculating the human health risks to industrial wastes, experts within the Faculty of Engineering and Applied Science utilize state of the art equipment for all their research activities. Faculty members collaborate with communities, industry and all levels of government. This section provides a brief overview of research facilities in FEAS.

Civil Engineering Research Facilities

The Strength Laboratory is equipped with the necessary equipment and test facilities to carry out a wide range of tests on a variety of structures. Starting from fracture toughness and flexural modulus tests on small-sized concrete beams, a variety of other tests have been carried out in the laboratory. Fatigue tests have been carried out on 0.9 m diameter tubular T-joints applying a dynamic load of 1.3 MN at 0.2 to 5 Hz. Seismic testing has been carried out on 2.0m x 2.0 m x 0.20 m thick concrete slabs. Frictional holding strength tests have been carried out on offshore rubber clamps. Static and dynamic tests have been carried out on 40 ft long

transmission tower poles and connections. Fatigue tests have been carried out on 50 ft. long transmission tower cables.

The Environmental Engineering Laboratory is a state-of-the-art facility with equipment available for water analysis in the laboratory. This includes total organic (TOC) analyzer, ultraviolet (UV) spectroscopy system, portable gas chromatograph (GC) with flame ionization detector (FID) and electron capture detector (ECD), and equipment for biochemical oxygen demand (BOD, solid, turbidity, alkalinity and nitrogen determination. Portable kits for water quality analysis, noise measurements, and indoor air quality measurements are also available in the lab. The laboratory is also equipped with sample preparation including extraction and digestion facilities. For air quality analysis, the Environmental Engineering Laboratory has monitors and samplers to monitor sulfur dioxide in the ambient air and to collect samples on filter media using high volume samplers for total suspended particulate matter (TSP) and dichotomous inhalable particulate matters. Portable meteorological station with data logging facilities is also available in the lab.

Electrical and Computer Engineering Research Facilities

Research activities are principally focused in the following research areas:

- Centre of Digital Hardware Applications Research (CDHAR): Quality-of-service in packet switching, packet switch fabric design, error control codes, communications security, hardware specification language tools;
- Software Engineering Lab (SwEL): Reliable software, real-time software specifications, software verification, pedagogical tools for software;
- Multimedia Communications Lab (MCL): Signal and image processing, wireless communications;
- Instrumentation, Control, and Automation (including C-CORE Intelligent Systems Group and the INCA Lab): Safety-critical automation, multi-agent panning and control, autonomous control and telerobotics telemedicine applications, control in harsh environments, intelligent control;
- Energy Systems Lab: Distributed energy systems, wind energy, motors and drives, digital relaying, power system security, power electronics.
- Remote sensing and HF radar in ocean technology applications.

Mechanical Engineering Research Facilities

Major equipment in the Fluids Laboratory includes a wave tank (52m long towing carriage capable of 5.0m/s maximum speed), wind tunnel (4' height x 3' width with 6 axis dynamometer), deep water tank (12' x 12' x 13' max water depth with access to 1t overhead crane), open water flume (32' long x 17" wide x 22" deep), portable flume (7' long x 6" wide x 12" deep), riverbed flume (16' long x 16" wide x 8" deep with a sand bottom), multiphase flow

loop (petroleum reservoir simulator), open boat used for open water propeller testing, and a trim tank (12' x 3' x 1'- 8" deep).

Materials Characterization Research Laboratory contains an X-ray Diffraction (XRD)-(Rigaku D/MAX 2200VPC); Scanning Electron Microscope (SEM)-(Cambridge Stereoscan 200 SEM); Chemical Analysis Detector on SEM which performs Energy Dispersive Spectroscopy (EDS)-(Oxford Link 6139 EDS); Digital Imaging on SEM and Optical Microscopes by Image Analysis System (IAS)-(Image Analysis Software with Digital Storage); Metallograph-(Reichert); various Optical Microscopes and Cameras-(Zeitz Metallovert, Wild Makroskop M420, Olympus, adaptors for Digital Imaging).

The Corrosion Research Laboratory has facilities which include a Potentiostat/Galvanostat-(Princeton Applied Research Company-PARC 283); Electrochemical Probes and Data Aquisition Software (Labview); Metallurgy and Tribology Research Laboratory; Heat Treatment equipment; Mechanical Testing; Non-Destructive Testing (NDT).

Other metallography and heat transfer facilities include casting and annealing heat treatments (Tube and Pot Furnaces-Lindberg; Box Furnace-Thermolyne; and High Temperature Furnace-Burrell); Tension and Compression Testers (Instron , Instron 1123, Instron 8874 (10,000N axial 100N-m rotational), MTS 312.21 (200,000N axial 80N-m rotational), MTS-Instron 8801 and MTS 312.21 System; Impact Tester-(Avery); Rockwell Harness Tester-(Wilson); Micro-hardness Tester-(Micromet); Hydaulic Press-(Vega); Motion Analysis-(Peak Six Camera Real-Time and VCR).

The Thermal Fluids Laboratory contains a number of facilities for conducting experimental studies in fluid dynamics and heat transfer. In addition to those listed below, the ocean and naval architectural engineering discipline also maintains a 58 m tow tank with wave generation capabilities and a deep water test tank. The civil engineering discipline also maintains a water flume of approximately 2' cross-section. Facilities for conducting research in electronics cooling, process flow and heat transfer, and heat exchanger modeling include a 36" Low Speed Wind Tunnel (open circuit wind tunnel with a 3' x 3' test section) and 12" Low Speed Variable Orientation Wind Tunnel (multi-purpose wind tunnel designed for mixed and forced convection testing for horizontal, vertical and inclined geometries).

Ocean and Naval Architectural Engineering Research Facilities

The Fluids and Hydraulics Laboratory in Memorial University's Faculty of Engineering and Applied Science is a unique facility dedicated to fluid related teaching and research activities. Specialized equipment and infrastructure facilitate hands-on laboratories for ONAE’s undergraduate and graduate programs while at the same time provide opportunities for research and outreach. One of the specialized pieces of equipment is the tow tank facility. It is 170 feet long, 14 feet wide and 8 feet deep, can generate low frequency 3-foot peak to peak regular and irregular wave profiles that include up to 1.2 Hz multiple spectrum secondary waves and also boasts a carriage facility for towing models. This ensemble provides a unique

setting to study the hydrodynamic effects of vessels, moorings, wharves, vortex induced vibrations and other related marine structures and interactions.

The MERLIN lab (Marine Environmental Research Laboratory for Intelligent Vehicles) is a multi-disciplinary facility that is involved with the use of autonomous underwater vehicles (AUVs) for research in the marine environment. Another component of the lab is a particle image velocimetry (PIV) system. AUVs can provide a means to do a wide array of research in the oceans and in hazardous underwater environments that cannot be done by other means. These vehicles are ideal for extensive ocean environmental monitoring, scientific survey and resource exploration work in the Atlantic and under the ice of the Canadian Arctic where extensive areas of the seabed that are normally inaccessible or cannot be obtained with the same precision due to the nature of ship based sampling.

Process Engineering Research Facilities

The Process Safety Lab focuses on activities or events involving accidental release of chemicals and industrial wastes, and deals with the prevention of catastrophic and dangerous occurrences that have a negative impact on human safety, health, environment and the overall viability of an enterprise. It includes activities such as accident forecasting, impact assessment, quantification of risk to industry, human health, environment and business, and development of strategies for prevention and control of such occurrences. All these activities require precise information about chemicals, their behavior under different operating conditions, process upsets, and design parameters. Many of this information may be derived through experimentation. This lab provides basic infrastructure facilities for investigating chemical behavior in different operating conditions (especially in offshore operating conditions), process upsets leading to accidents, and setting up of design parameters for safety measures.

The Advanced Drilling Laboratory conducts research on the development of advanced drilling technology. It is undertaking experimental and numerical investigations of vibration-assisted rotary drilling (VARD) leading to the development of a prototype drilling tool. The research emphasizes on four aspects: 1) fundamental penetration mechanisms and optimization; 2) influence of bit vibration and percussion on penetration rate (ROP) and bit wear; 3) design and develop Vibration Assisted Rotary Drilling (VARD) tools; and 4) proof-of-concept field trials of VARD tools. The research aims to improve drilling ROP and extend bit runs, enhance utilization of lower capacity drilling rigs and indirect applications to mitigate drilling vibrations.

Other process engineering facilities include research laboratories for enhanced oil recovery, unit operations, reaction engineering, bioprocesses, process control, hydrometallurgy and corrosion engineering.

6.4 RESEARCH CHAIRS

Currently there are five research chairs in the Faculty of Engineering and Applied Science (funded through Chevron, Husky Energy, Vale, Wood Group and CRC), as well as three additional chairs in progress (Statoil and CARD – Centre for Arctic Resource Development).

Chevron Chair in Petroleum Engineering

In 2011, Dr. Lesley James was appointed as the inaugural Chevron Chair in Petroleum Engineering. In late 2010, Chevron Canada Limited, the Research & Development Corporation of Newfoundland and Labrador (RDC) and Memorial University announced a five-year, $1-million dollar partnership to create a chair that would strengthen the capacity for petroleum engineering research in the Faculty of Engineering and Applied Sciences. Chevron's contribution of $500,000 is being utilized to establish the chair position. RDC is also investing $500,000 in partnership with Chevron to increase research and development in petroleum engineering given its importance to the future of Newfoundland and Labrador's offshore petroleum industry. Its funding comes from its Collaborative R&D Program.

Dr. James holds a PhD in chemical engineering and has worked as a management consultant. Her research, which is largely focused on enhanced oil recovery (EOR), aims to improve the percentage of oil recovered from petroleum reservoirs. As the Chevron Chair in Petroleum Engineering, Dr. James will research ways to maximize the recovery of oil from offshore Newfoundland and Labrador fields based on an understanding of their fluid-fluid and rock-fluid interactions. Dr. James is also excited by the opportunity this work provides to bring locally relevant, real-world data and industry challenges into the classroom and teaching laboratory.

The Chevron Chair in Petroleum Engineering represents a new focus on upstream oil and gas research at Memorial University. Dr. James is leading this effort through a world-class program of applied research. It is also a further illustration of how Memorial, in partnership with industry and the RDC, is addressing the needs of and helping to build future prosperity for our province.

Husky Energy Chair in Oil and Gas Research

Dr. Brian Veitch, a professor of ocean and naval architectural engineering is the Husky Energy Chair in Oil and Gas Research. The $2.5-million endowment for the Husky Energy Chair in Oil and Gas Research was initiated in 2003 by Husky Energy. The current focus of the chair is to undertake an innovative research program in offshore oil and gas research, with particular emphasis on offshore engineering for harsh ocean and Arctic environments.

Dr. Brian Veitch grew up in St. John’s and graduated with a bachelor of engineering degree, followed by a master of engineering degree from Memorial University. He completed further graduate studies at Helsinki University of Technology, where he focused on naval architecture and ocean engineering. Dr. Veitch returned to Canada in 1996 to work with the National Research Council. In 1998, he was appointed to the Terra Nova Project Junior Research Chair at Memorial University, where he developed an applied research program on ocean environmental risk engineering. In parallel, he initiated an inter-disciplinary research program

on offshore and maritime safety with the goal of improving the safety of life at sea. His work has garnered a number of awards, including the President's Award for Outstanding Research at Memorial University and Transport Canada's Marine Safety Award. He also helped launch several technology companies with his graduate students.

In addition to his teaching responsibilities, Dr. Veitch has held several administrative roles in the Faculty of Engineering and Applied Science, and currently serves on the Board of Directors of the Research and Development Corporation of Newfoundland and Labrador.

Vale Research Chair in Process Risk and Safety Engineering

In 2010, Dr. Faisal Khan, a professor of process engineering in Memorial's Faculty of Engineering and Applied Science, was appointed as the Vale Research Chair in Process Risk and Safety Engineering. The chair is supported by Vale, the Research & Development Corporation of Newfoundland and Labrador (RDC) and the Atlantic Canada Opportunities Agency (ACOA).

Associated with Memorial's Faculty of Engineering and Applied Science, the chair will expand and support the faculty's safety and risk engineering program. The research chair will strengthen the ongoing research, teaching and training initiative in this important area. It will also provide opportunities for students and professionals to acquire knowledge and skill in the area of safety and risk engineering, which is much desired in industry and other professional institutions.

The Vale Research Chair in Process Risk and Safety Engineering will support Memorial's long-term vision to establish a cluster of scientists and engineers focused on supporting the minerals and oil and gas industries in the province and Vale's goal to reduce and ultimately eliminate the incidence of disabling injuries and production loss at all operations and projects.

In addition to the above, the chair will develop highly trained personnel to create expertise and knowledge in the important area of safety and risk engineering, particularly in process systems relevant to mineral extraction and oil and gas processing. It will generate new data and develop advanced methodologies and models for risk assessment and design of safety measure for processing facilities. It will also develop expert tools for fault diagnosis and accident prevention in processing facilities, develop advanced systems for risk-based integrity management and loss prevention in harsh and remote operating conditions as well as develop novel methods for inherently safer process design and operations.

With a significant research record in the area of risk assessment and an international reputation in his area of expertise, Dr. Khan brings more than 15 years of experience to his position. He is also sought after by several companies from around the world to provide support and expert advice on safety and risk assessment. His research interests include safety and risk engineering, environmental risk modeling, life cycle analysis, computer aided process plant design and inherent safety.

Wood Group Chair in Arctic and Harsh Environments Engineering

In 2009, Dr. Shawn Kenny, an associate professor in Memorial's Faculty of Engineering and Applied Science, was appointed as the Wood Group Chair in Arctic and Harsh Environments Engineering. The Wood Group Chair, one of the largest research chair contributions at Memorial, is sponsored by international energy services company, John Wood Group PLC. As chair, Dr. Kenny is developing cutting edge technology for use in the Arctic and cold regions for the oil and gas industry.

Dr. Kenny is leading a team to explore how geohazards in Arctic and northern cold environments, such as permafrost and ice gouging, influence pipeline structural behavior and integrity. Pipelines provide an efficient and cost-effective way to transport hydrocarbons over long distances. For offshore pipelines, a significant issue is bottom-scouring icebergs off Labrador and Newfoundland, where the pipeline will need to be buried in trenches on the seabed. Shawn and his team are building numerical models to simulate and thus predict how icebergs will interact with the seabed. These models will be calibrated through physical testing and compared with field data. Once their accuracy is confirmed, these engineering models can be applied to solve a broader class of problems.

Dr. Kenny's technical areas of expertise include Arctic and offshore environmental loads, onshore and offshore pipeline engineering, computational mechanics, finite element methods, structural stability, post-buckling, limit states design, risk analysis, structural dynamics and impact engineering.

He is a member of the American Society of Mechanical Engineers, the Canadian Geotechnical Society, the Canadian Society for Civil Engineering, Professional Engineers and Geoscientists of Newfoundland and Labrador, Professional Institute of Pipeline Engineers and Society of Petroleum Engineers. Dr. Kenny is also Chair of Offshore Pipelines Subcommittee of Canadian Standards Association Z662 Oil and Gas Pipeline Systems and a member of the Canadian Advisory Committee for ISO TC 67/SC 2 Pipeline Transportation Systems.

Canada Research Chair in Ocean Technology

In 2009, Dr. Ralf Bachmayer, an associate professor in Memorial's Faculty of Engineering and Applied Science, was appointed as the Canada Research Chair in Ocean Technology and received the Petro-Canada Young Innovator Award. Dr. Bachmayer's research involves using autonomous underwater vehicles to push the boundaries of oceanographic research and exploration, in particular for under-ice applications.

Dr. Bachmayer is spearheading research on autonomous underwater gliders, a type of underwater vehicle that 'glides' through the water column, using a change in ballast to ascend and descend and wings to develop forward motion not unlike a soaring plane in the air. Because of their ultra-low power design and gentle motions, gliders can soar through the oceans for weeks or months at a time collecting invaluable data along their way.

Dr. Bachmayer received his engineering degree in electrical engineering from the Technische Universität Karlsruhe, Karlsruhe, Germany. He then worked as a visiting researcher at the Deep Submergence Laboratory of the Woods Hole Oceanographic Institution in Woods Hole, Massachusetts. After he received his MSc and PhD degrees in mechanical engineering from the John Hopkins University, Baltimore, Maryland, he joined the Dynamical Control Systems Laboratory at Princeton University as an associate researcher. Then, he joined the National Research Council of Canada Institute for Ocean Technology in St. John's as an associate research officer where he worked until his appointment at Memorial University came into effect.

6.5 SERVICE AND EXTERNAL ENGAGEMENT

Faculty members contribute to service and external engagement in the form of committees within the Faculty and also University; outreach events to high schools and the general public; service to professional societies such as journal / grant reviews; among others. Committees within the Faculty include the Undergraduate Studies Committee, Graduate Studies Committee, Research Advisory Committee, Search Committees, Promotion and Tenure Committee, representatives to other Faculty Councils.

The Faculty also engages with the local community in a number of ways. Through our Speaking of Engineering Public Lecture series, we educate general audiences on topics of broad interest - with an engineering focus. The F.W. Angel Lecture is named for the late F.W. Angel and the firms with which he was associated. This public lecture brings in an esteemed guest speaker to highlights engineering-related topics. Our Summer Camp Program is for ages nine to 17. Participants learn what it's like to be an engineer through robotics and Arctic engineering programs.

7. ADMINISTRATIVE SUPPORT AND INFRASTRUCTURE

7.1 ADMINISTRATIVE AND TECHNICAL SUPPORT STAFF

Administrative and technical staff members provide key support functions in the Faculty for delivery of our academic programs and research activities. The staff support positions are summarized as follows:

- Office of Associate Dean, Undergraduate Studies: secretary, academic program administrator, academic program assistant, intermediate clerk stenographer (2), student liaison officer, laboratory instructor;
- Office of Associate Dean, Graduate Studies: secretary, academic program administrator, academic program assistant, international student officer;
- Office of Associate Dean, Research: secretary, research development officer;

- General Office: administrative staff specialist (4), intermediate clerk stenographer (2), senior clerk, intermediate clerk;
- Offices of Industrial Outreach and Ocean Engineering Research Centre; administrative staff specialist;
- Office of Manager of Finance and Administration: intermediate secretary, communications officer, database developer;
- Office of Manager of Engineering Computing Services: programmer consultant (4);
- Officer of Manager of Laboratories: laboratory technologists (12)

Additional staff members will be needed to support the Faculty's expanded capacity. As the Faculty grows, modifications to the administrative structure and increased staff support are envisioned. This includes a projected addition of administrative staff members, to support the department heads, growth of student recruitment activities and graduate students. The 24 projected new staff positions include additional lab technologists, IT staff, accounting, recruitment and other administrative staff.

7.2 LIBRARY

Memorial University of Newfoundland libraries include:

- Queen Elizabeth II Library, St. John's campus: main library for the university;
- Health Sciences Library, St. John's campus: serving the Health Sciences Centre and the Newfoundland and Labrador medical community;
- Dr. C.R. Barrett Library, St. John's Ridge Road campus: serving the Fisheries and Marine institute and College of the North Atlantic Engineering Technology Centre;
- Ferriss Hodgett Library, Grenfell campus: serving the University's programs in Corner Brook;
- Two small branches on the St. John's campus and one at Memorial's Harlow Campus in the United Kingdom.

The Memorial University Libraries hold a collection equivalent to 3.6 million physical volumes. This collection serves as the major information resource for the University as well as the province. All services of the library system may be used by all students, faculty and staff, as well as the community at large.

Library collections which directly support the teaching and research of the Faculty of Engineering and Applied Science are located in the Queen Elizabeth II Library. The Dr. C.R. Barrett Library also holds engineering and marine related materials that support engineering and applied sciences study and research.

The NRC Information Centre, St. John's [Canada Institute for Scientific and Technical Information] is located on the St. John's campus; it can be used for research by engineering faculty and students. Other local special libraries, including those of the Canada-Newfoundland Offshore Petroleum Board, the Newfoundland and Labrador Department of Labour, and the provincial Department of the Environment, may provide research support for engineering students.

The Memorial University Libraries have developed an extensive web site providing descriptions and access links for services, facilities, and collections <http://www.library.mun.ca/> that are available through the Libraries.

Facilities and Services

The Queen Elizabeth II Library, which opened for service in January 1982, comprises 200,000 square feet of floor space on five levels and provides seating for more than 2,000 researchers - individual study carrels, tables for group work, individual and group study rooms, and a Learning Commons.

The Queen Elizabeth II Library is located approximately five minutes from the S.J. Carew (Engineering) Building; the route between the buildings is fully enclosed and accessible.

Library Collections

The Queen Elizabeth II Library contains more than 1.5 million books, periodical volumes and government documents in paper, and more than 2 million books, government documents and periodicals available online or in micro format. Its collections serve as the major information resource for the University, as well as the province.

The Library's Collections Division, in concert with faculty, acquires materials to support the University curriculum directly, and to provide scholars with a well-rounded research collection. Two librarians from the Collections Division have been responsible for managing the Engineering collections.

Engineering Collections

Books

The book collection for engineering and applied science includes monographs, handbooks, textbooks, conference proceedings, etc. They are catalogued and shelved according to Library of Congress classes. Linkable Uniform Resource Locators [URLs] for online resources are included in any record describing an e-resource. The Engineering collection has grown in recent years, mainly through purchases or subscriptions for online e-texts. Some gift volumes have been added. Older, little used books have been sent to an offsite storage facility; these materials can be requested and will be retrieved within two days. The e-text collection for Engineering and Applied Sciences comprises more than 150,000 titles.

Other collections in the Queen Elizabeth II Library book stack and reference areas support the programs offered by the Faculty of Engineering and Applied Science, e.g. mathematics, physics,

earth science, computer science, geography and business. Engineering materials also can be found in the government documents, microform, media and map collections.

The Centre for Newfoundland Studies holds reports concerning Newfoundland and Labrador engineering projects and companies, theses from all faculties of the Memorial University of Newfoundland, and technical reports from Newfoundland and Labrador government agencies.

Book ordering for materials to support the programs of the Faculty of Engineering and Applied Science is managed by collections librarians who specialize in engineering / technology information resources. Faculty members serving as engineering library liaison representatives provide subject advice and coordinate suggestions for purchase.

Journals

At present, the Memorial University Libraries provide access to more than 5,300 online journals which directly support the study and research programs of FEAS.

Individual subscriptions for most Engineering and Applied Science journals have been cancelled; online journals are received through large subscription packages paid by separate funding, e.g. Elsevier ScienceDirect, Springer/Kluwer, Taylor & Francis, Wiley/Blackwell. ACM, ACS, ASCE, ASME, IEEE, IET, IWA, Royal Society.

The Queen Elizabeth II Library receives only 39 current print periodical subscriptions for Engineering and Applied Sciences. However, it continues to house tens of thousands of print back-volumes of engineering journals that have not yet been digitized.

Other serial collections in the Queen Elizabeth II Library will be of interest (e.g. physics, mathematics, earth science, computer science, geography and business).

The Reference collection maintains serial subscriptions to important Engineering indexes, abstracts, handbooks and encyclopedias, either in print or online.

Grey Literature

The Queen Elizabeth II Library holds a depository collection of Canadian government documents, together with an extensive collection of materials from other Canadian provinces, the United States and other nations, and international organizations.

Many full-text engineering documents which are available on the World Wide Web have been catalogued and made accessible through the Memorial University Libraries' online catalogue. Information Services librarians are adept at finding these reports on the web, even when they are hidden in difficult to navigate institutional repositories or databases.

Thousands of online engineering standards are available in e-resource collections held by the Memorial University Libraries, e.g. IEEE standards through IEEE Xplore, CSA through the CCOHS academic support program, ASTM through the MyASTMsubscription, API through the IHS standards expert collection. The QEII Library holds hundreds of current print standards in the Reference collection, as well. Other standards are RUSH added as needed.

Many patents are freely available online now; the Memorial University Libraries have prepared a navigation guide for finding and accessing patent literature. We have online full-text access to a major collection of U.S. and international patents through the Libraries' subscription to the LexisNexis Academic database.

Theses from institutions worldwide are now available full-text over the Internet. Thousands are freely available online in Institutional and National e-resource repositories. Engineering theses and dissertations completed at the Memorial University of Newfoundland are available online in the Libraries' Digital Archives Initiative repository. The ProQuest Dissertations & Theses databases, which are included in the Article Search listings, may be searched to locate hundreds of thousands of Masters and Ph.D. theses worldwide; in addition, full-text PDF copies of most North American theses from 1997 to the present can be downloaded.

Reference Materials

Reference materials for Engineering and Applied Science includes general and subject specific abstracts and indexes, dictionaries, encyclopedias, handbooks, standards, etc. in various print and electronic formats. New Reference materials are purchased using Library funds allocated to Reference. Sometimes funds allocated to Engineering for monograph purchases may be used to purchase highly specialized Engineering reference materials. Subscriptions to Engineering Reference serials are maintained using Library funds allocated Reference for subscriptions. The Memorial University Libraries opt for online access to Reference materials whenever feasible.

The Memorial University Libraries provide access to Engineering abstracts and indexes. These are used by researchers to identify information resources on a chosen topic in journal articles, conference papers, technical reports, book chapters, etc. Online databases which are available to support research in Faculty of Engineering and Applied Science include Applied Science & Technology Index, Engineering research database, Engineering Village: Compendex, Marine Technology Abstracts, SciFinder Scholar, Scopus, Web of Science, Marine Technology Abstracts, Petroleum Abstracts, and more.

The Memorial University Libraries maintain subscriptions / standing orders for several online, keyword-searchable engineering collections which supply full-text access to specialized handbooks, dictionaries, encyclopedias, and more. These include AccessEngineering, ASCE Digital Library, ASM Handbooks, ASME Digital Library, Books24x7, IEEE Xplore, IGI Global, Knovel, OnePetro, SpringerLink, Water Intelligence Online, and more.

In addition to the online encyclopedias that are included in the packages mentioned above, the Memorial University Libraries have acquired access to some major engineering online encyclopedias, including EOLSS-online: Encyclopedia of Life Support Systems [a collection of 20 science, engineering & environmental encyclopedias], Kirk-Othmer encyclopedia of chemical technology, McGraw Hill Encyclopedia of Science and Technology, and others.

Major engineering print handbooks, dictionaries and encyclopedias continue to be housed in the Reference collection in the Queen Elizabeth II Library as well.

Books (electronic)

In addition to physical collections above, the MUN Libraries provide access to substantial electronic book collections from a number of publishers including: AccessEngineering, ASME Digital Library, Books24x7, Knovel, SpringerLink , Water Intelligence Online.

Journals

The Memorial University Libraries subscribe to large journal packages from several publishers including: American Society of Mechanical Engineers, Elsevier, Nature, Oxford, Springer, Taylor & Francis and Wiley.

Indexes

The library provides access to a number of article indexes including Applied Science and Technology Index, [ASTI], Engineering Research Database, Engineering Village: Compendex, SciFinder Scholar, Scopus, and Web of Science. The Memorial University Libraries purchased back-files for ASTI, Compendex and Web of Science giving coverage back to 1884.

Funding for e-books, journals, e-journals, and indexes comes from separate allocations that are shared by all subject areas. In recent years, funding has remained constant and the Canadian dollar has been strong against other currencies; thus, no cancellation projects have been required in the past five years.

7.3 COMPUTING FACILITIES

Computing is an integral part of the teaching and research programs in the Faculty of Engineering and Applied Science. Student computing is supported by two primary sources: Engineering Computing Services (ECS) within the Faculty and the Department of Computing and Communications (available to all university students). All faculty members can connect via Ethernet cables to ECS services, university computing services and the world-wide-web through PC's or workstations in their offices.

In 2009, the former Centre for Computer Aided Engineering (C-CAE) was renamed Engineering Computing Services in recognition of its larger support and service role and encompassed C-CAE to provide more services for the faculty and students. These new services include the introduction of new computing techniques like clustering, virtualization, and cloud computing.

There are five staff members of the ECS, including help desk support, two programmer / consultants, one programmer/analyst, one Graphics Artist/Web Designer and a system manger. ECS regularly employs co-op engineering students from the computer or electrical engineering disciplines. A brief description of these computing facilities follows.

Hardware

ECS provides a network of Linux and Microsoft Windows base server computers serving both files and applications to many Personal computers. The capability of stand-alone desk-top

computers to do independent engineering computations and the power of the central processors for large simulations and analysis have been integrated using a local area network which connects the laboratories, lecture rooms, faculty and administrative offices in the S.J. Carew Building with the ECS's servers.

ECS's Data Centre is driven by 2 HP DL380 G6 Enterprise Class servers running VMware's ESXi 4.1 Virtualization Platform, as well as 4 dedicated physical servers, providing a flexible and powerful platform to power the demanding services required to deliver Faculty of Engineering's programs and support researchers. ECS provides computing facilities to the students in their respective senior design labs as well as the labs dedicated to the particular disciplines. In total there are about 420 computers, several image scanners, an HP plotter (HP750c, 36 inch wide plotter) and about 20 HP LaserJet printers that are available on the ECS and Labnet network providing service to all facets of the Faculty.

The Department of Computing and Communications is another source for computer resources, and is the central facility that provides general computer support for all academic departments and administrative services in the university.

Software

ECS offers software packages which can be categorized by the two main operating systems which are currently being used in the Faculty: Window based and Linux based. The majority of the Windows software from the Centre is installed on all the computers available to the students. Access is granted via license daemons in the cases where there isn't a full site license, or access is restricted by licensing agreements.

8. COST EFFECTIVENESS

8.1 PROGRAM COSTS

The 2013-14 budget submission to the Office of the Vice-President (Academic) and Provost outlined the program costs of the Faculty of Engineering and Applied Science. The budget submission included completed elements of the strategic plan, as well as the previously developed 8-year Faculty Growth Plan. It is based on Years 1-2 (funding secured) and 3-8 (anticipated) from the Province in support of the engineering expansion strategic initiative.

The Faculty of Engineering and Applied Science offers six undergraduate programs, namely, Civil, Computer, Electrical, Mechanical, Ocean and Naval Architectural and Process Engineering. Each of these programs take four years for completion once a student has completed the requirements of Engineering One. The combined total years for completion of a Bachelor of Engineering degree typically takes five years.

The double cohort of students in the modified undergraduate engineering programs is in the final year of their programs in 2012-13. This also includes the first cohort of students in the new Process Engineering program. The first class of process engineering students graduated in April

2013. In January, 2013, an accreditation visit by CEAB (Canadian Engineering Accreditation Board) was successfully completed for this new program. All of the Faculty's six undergraduate programs have been successfully accredited until June 30, 2017.

Equipment was acquired to support selected teaching laboratories that were identified in the past accreditation report as not adequate. Lack of adequate teaching capacity was cited as a concern in all five programs that were considered for accreditation in 2011 (Process Engineering program was not reviewed at this time as it didn't have its first graduates until April 2013) . Filling current existing faculty vacancies as well as recruiting new faculty members to increase the number of base positions as per the Faculty Growth Plan have been among the top priorities over the past year.

Students begin their Engineering studies with Engineering One. It is comprised of the following list of courses: Mathematics 1001, Mathematics 2050, Physics 1051, Chemistry 1050, English 1080 (or equivalent), Engineering 1010, Engineering 1020, Engineering 1030 and Engineering 1040. The Faculty is responsible for the offering of the four first year engineering courses and any associated costs, such as materials and supplies for each of the courses. Other expenses include a Help One centre that provides support to first year students in Engineering to transition from high school to the academically challenging engineering program.

The Help One Centre was created and opened in 2008-09. It was staffed with a full-time laboratory instructor and part-time undergraduate and graduate student assistants are hired each semester to help those students that come to the centre for help with their course work. The Centre was equipped with furniture and multimediate equipment for group work/ presentations and 16 computers. The following chart provides a summary of the total costs associated with Engineering One and the running of a Help Centre from 2008 - 2013.

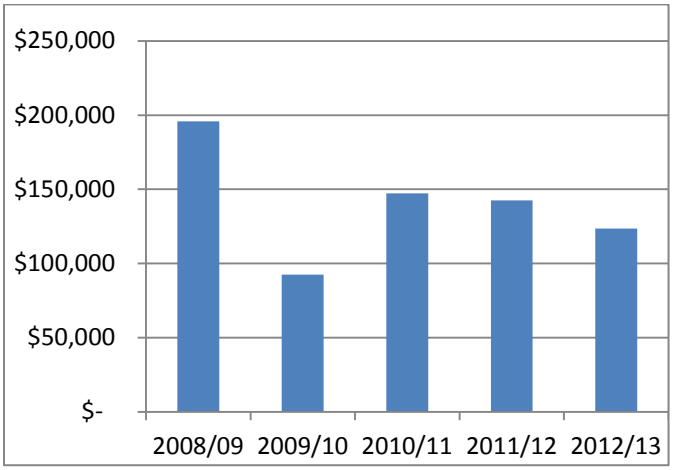


Figure 8.1: Engineering One and Help Centre

As mentioned above as once a student completes Engineering One and is successful in meeting the requirements he or she is eligible to enter into a particular discipline of their choice depending upon availability. The following charts provide a summary of the costs associated

with the running of each of the six programs. These costs include materials, supplies, field trips for students, printing, photocopying, travel for the Discipline Chairs to attend Heads meetings and equipment renewal purchases. etc.

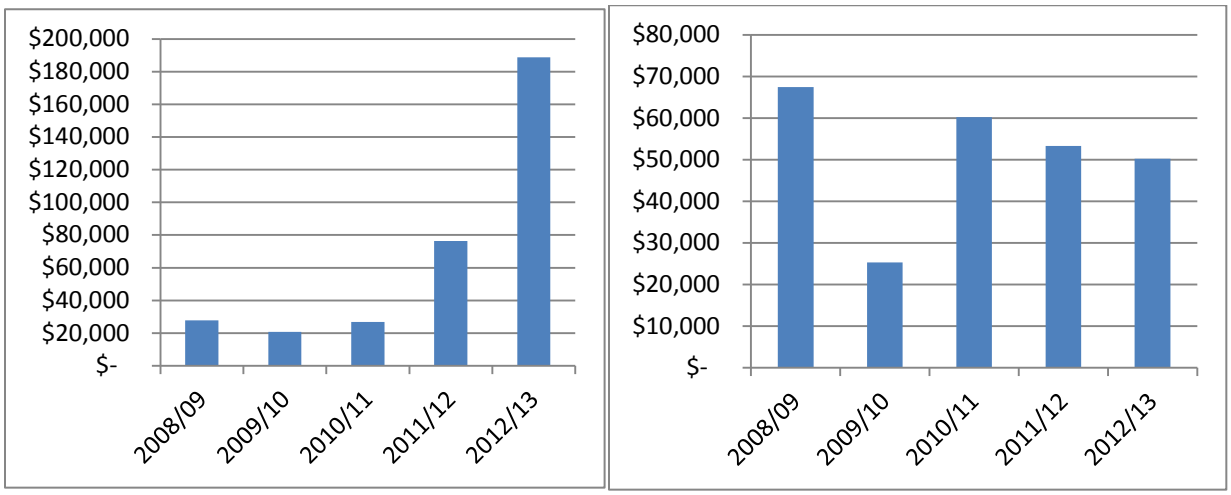


Figure 8:2 (a) Civil Engineering and (b) Electrical and Computer Engineering

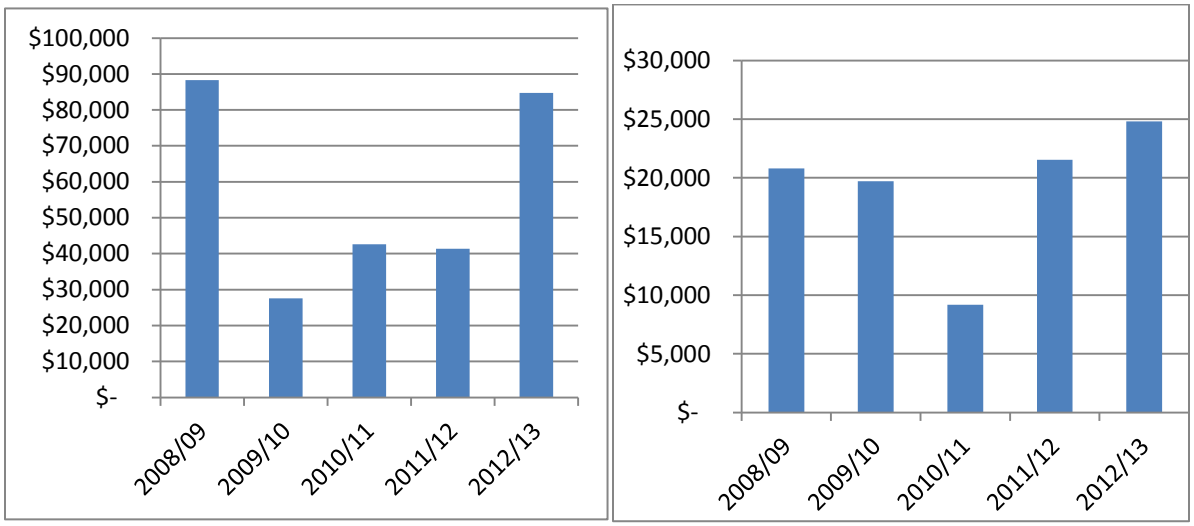


Figure 8.3 (a) Mechanical Engineering and (b) Ocean and Naval Architectural Engineering

Note that Process Engineering program is the Faculty's newest program. Major renovations and equipment purchases were necessary in order to offer such a program. The chart below reflects the costs associated with beginning such program.

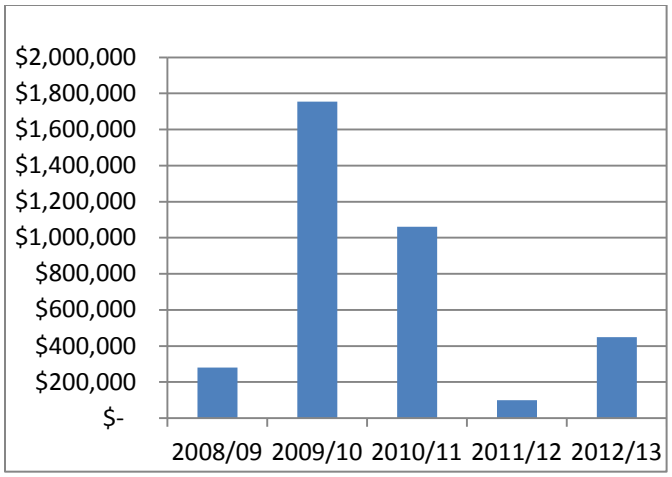


Figure 8.4: Process Engineering

The expenses associated with extra teaching or per course appointments for each these programs is maintained in a central account and not at this current time decentralized to the disciplines. The chart below summaries the costs from 2008 - 2013.

The expenses associated with teaching assistantships for each these programs along with Engineering One is also maintained in a central account and not at this current time decentralized to the disciplines. The chart below summaries these costs along with teaching assistants assigned to graduate courses from 2008 - 2013.

In addition, to the above costs the Faculty began tracking separately in 2009 the costs associated with running an efficient Undergraduate Studies Office and Graduate Studies Office. These costs are typically: office equipment/furniture, overtime costs of staff, materials/supplies, printing, photocopying, travel for the Associate Dean and hosting, etc.

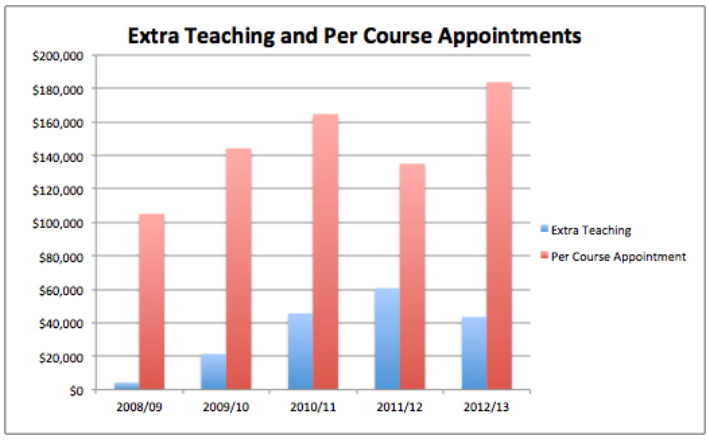


Figure 8.5: Extra Teaching and Per Course Appointments

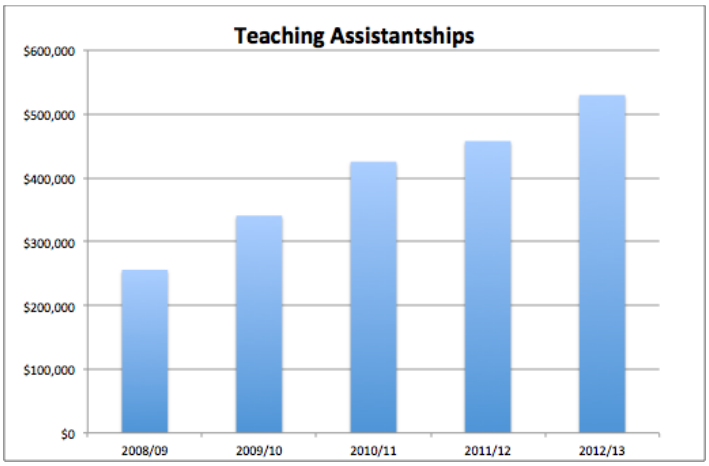


Figure 8.6: Teaching Assistantships

The research activity in the Faculty has also grown significantly and it is expected to continue growing in 2013-14. Some selected highlights of major successes over the past year include a $15M Hibernia grant for enhanced oil recovery (Dr. Lesley James) and Husky Energy Research Chair (Dr. Brian Veitch), appointment of Dr. Rocky Taylor as the first of two CARD Chairs in November 2013 and the first of two Statoil Chairs for the Faculty in March 2014. The Faculty will continue to work with the Office of the Vice President Research to identify mechanisms to improve the Faculty's success rates in the NSERC Discovery Grant program and others. Additional research chairs (Statoil, CARD) will be appointed in 2013-142014-15. The newly appointed research chairs will also submit proposals to NSERC under the Industrial Research Chair program to effectively leverage the industry funds.

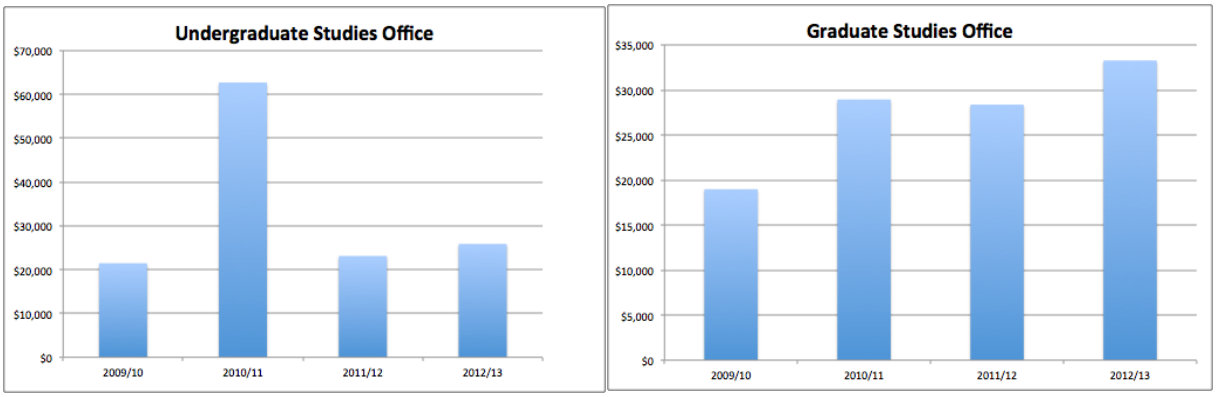


Figure 8.7: (a) Undergraduate and (b) Graduate Studies Office

8.2 REVENUE GENERATION AND FUNDRAISING

The Faculty of Engineering and Applied Science has a number of initiatives for revenue generation, including the following initiatives:

- MASc programs in i) Computer Engineering, ii) Environmental Systems Engineering and Management, iii) Oil and Gas Engineering, and iv) Engineering Management. Detailed description of these course based programs described in more detail in Section 5 of this report. Revenues vary from year to year in these programs because they are dependent upon student enrollment. See revenue and expense summary of these programs for the period of 2004 – 2013 in section 13.5 of this report;
- Industrial Outreach – Faculty's connection between industry and the academic community –revenues vary from year to year;
- OERC Wave Tank Rental – revenues vary from year to year;
- GirlQuest Program – support to increase awareness of engineering and science among young girls in the province; With the generous support received from Hebron and HMDC, the Faculty revived the GirlQuest program in 2012 to increase awareness of engineering and science among young girls in the province. This generous support enabled us to offer the program again during the Summer 2013.
- ArcticENGINEER - Geared specifically for high school students who are excelling in science courses. Sponsored by RDC.
- Robotics and Junior Engineers Camp - Specially designed for students ages 9-12, this camp is a great way to recruit future engineers. Cost recovery through registration fees.
- Reunion 2013 – The Dean hosted the classes of 1978, 1983, 1988, 1993 and 2003 on the evening of October 18th to a wine and cheese event. This event is meant to build relationships with alumni in the hopes of giving back to the Faculty. The planning for Reunion 2014 has already begun. The Faculty plans on celebrating the classes of 1979, 1984, 1989, 1994, 1999 and 2004.
- Additional initiatives pursued by the Dean, in cooperation with Alumni Affairs, with alumni and corporate donors, in order to pursue the fundraising priorities of the Faculty.

The Engineering One Help Centre has provided support to first year students in Engineering to transition from high school to the academically challenging engineering program. A donor (Fred Cahill) has generously supported this initiative financially, as well as a lecture series, and the Dean is pursuing further opportunities with this alumnus, among others, to support more fundraising initiatives. The Dean has been engaged in discussions with potential donors in support of the following initiatives starting in 2012-13: promotion of engineering programs in the high schools to further increase the proportion of women and rural applicants to engineering; design chair in engineering; classroom and lab naming opportunities; equipment / furniture renewal and upgrading in classrooms and labs.

The Faculty has identified a number of fundraising priorities as follows.

<u>Funding Priority 1: Environment for teaching, learning and research</u>

The SJ Carew Building and the majority of its teaching labs were built or acquired in the early 1970s. Building, laboratory and equipment maintenance have not been sufficiently funded over the decades, resulting in challenges and damage that have been patched temporarily over the years without longer term sustainability. Funding for upgrades of deteriorating infrastructure and equipment is needed, as well as additional space and facilities to accommodate the projected expansion of our Faculty growth plan.

The Canadian Engineering Accreditation Board (CEAB) has noted that outdated equipment, labs in disrepair, and damaged infrastructure are not adequately providing the level of desired education for our students. Our top funding priority is to improve the quantity and quality of space that our students deserve, both in our current environment, and to accommodate our future growth of doubling the Faculty by 2020.

- Naming opportunities in support of existing and new laboratories and classrooms to renovate and expand our physical space, equipment and infrastructure. For example classrooms are outdated and a donor would have a naming opportunity to a classroom by replacing and purchasing new furniture (i.e., outdated damaged desks).
- Major gift with a naming opportunity for renovations of a larger wing of the building, where maintenance has been particularly lacking over the past few decades. For example, re-purpose the multi-story mechanics equipment room on the back of the building (by moving air handlers onto roof space) to create a vibrant “student commons” for a student interaction and project environment.
- Classroom and laboratory renovations in support of the Faculty growth plan to support higher student enrolments. This includes design labs for each of the disciplines and anticipated larger rooms with the projected growth in students.
- Collaborative funding of shelled-in space of new building(s) for additional engineering space in the new Core Science Facility.
- The Faculty has engaged in discussions and planning with Stantec on the Faculty of Engineering and Applied Science Facility Program in order that the Faculty may acquire sufficient space and resources for its planned growth.

<u>Funding Priority 2: Special initiatives for student success</u>

The Faculty aims to provide an outstanding learning environment for students. Professors strive to deliver the highest quality of education and training of students with the skills needed by industry. In order to provide this positive student experience, it requires upgrading / new lab equipment and providing the latest commercial software in classrooms and laboratories. The following list below includes, but is not limited to, the funding priorities of the Faculty to enhance our teaching and learning environment for student success.

- Student bursaries, scholarships, research assistantships and other support (for example, laptop to students admitted) to attract and retain the best and brightest undergraduate and graduate students.
- Endowment for selected initiatives that foster student success, such as a student writing centre with staff support to improve written communication skills.
- Funding for a teaching focused chair, for example through the NSERC Design Chair program, for innovation in teaching, learning and curriculum development.
- Student incubator or centre that drives student commercialization efforts and fosters student entrepreneurship in linking student project teams with business students.
- Endowment for student teams and clubs, in order to provide support for larger and more teams, with better financial support to enhance their international competitiveness.

9. FUTURE DIRECTIONS

9.1 OVERVIEW

Support of the Faculty's growth will require additional resources, in terms of faculty and staff positions, budget, space and other facilities and equipment for labs, classrooms and offices. In order to achieve the Faculty's growth objectives, expansion of each of these resources is envisioned. Table 10.1 summarizes the key elements of expansion to realize this future growth of FEAS.

	2012	2020
Number of graduates (undergraduate programs)	155	250
First-year intake (undergraduate programs)	300	425
Total undergraduate enrolment	1,100	1,600
Total graduate student enrolment	360	625
Faculty complement	61	101
Support staff	38	62
Annual operating budget	$11.4M	$20.6M

Table 10.1: Projected increase of Faculty's resources from 2012 to 2020

Amidst this growth, teaching and learning will remain core pillars that uphold the highest quality of education and student experience for engineering students at Memorial University. Co-operative education will be core to all existing and future programs / options. A steady increase in undergraduate enrolments is projected. Table 4.1 shows the projected increases in

student graduates, first-year intake and enrolments. It also shows the corresponding needs for increased faculty, staff and co-op coordinators to support this growth of student enrolment.

The significant student growth will require enhanced efforts on recruitment, retention and exploring new initiatives, particularly a college bridging initiative. The projected increase in student enrolments can largely be met by students from Newfoundland and Labrador, through improvements of retention and success rates of students in its existing programs. The Faculty strives to have student diversity, particularly including more female, first-nations and international students. Also, it aims to broaden its student pathways, such as a college bridging program to allow advanced standing for students with college diplomas. Collaborations will be sought with the Marine Institute and College of the North Atlantic for these initiatives. These new and expanded initiatives will require increases in staff support.

To accommodate the projected increase in engineering student enrolments, additional resources may also be required in other academic units, such as the Division of Co-operative Education, School of Graduate Studies, as well as departments that teach courses to engineering students. About one new co-op coordinator in the Division of Co-operative Education, plus associated operating expenses and space, is anticipated per each increment of 130 student placements per year. Also, in the School of Graduate Studies, proportionally higher fellowship funding and support staff is needed for approximately 260 graduate students that are projected to be added by 2020, as well as support staff for recruitment, admissions, scholarships and other student support services. Larger engineering student enrolment would also impact the Faculty of Science, requiring additional resources for more (and/or larger) lab sections and additional lab instructors. Furthermore, each engineering student takes one course in English and a few courses in humanities, so higher engineering student enrolments would impact the budget needs of the Faculty of Arts. Growth of FEAS would also indirectly impact other administrative departments at the university, namely the Registrar's Office, Financial Services, Office of Research, Faculty Relations, Human Resources, Student Affairs and Services, and International Student Advisor's Office.

9.2 FACULTY HIRING PLAN

As6df In order to achieve the Faculty objectives of growth in enrolment and research activities, additional human and physical resources are needed to increase the faculty complement. New faculty members are needed in strategically positioned areas identified in the program unit reports (Section 5), including tenure-track / tenured appointments and research chairs. For the new faculty to be hired, there would be additional expenses for professional development costs, relocation, startup funds and teaching assistantships. A summary of the faculty complement as of December 2012 is shown in the following Table. 10.2.

Discipline	Faculty (2012)	Undergraduate courses	Graduate courses	Teaching tasks that can be assigned	Remissions
Civil	13	38	23	46.5	5.5
ECE	19.5 (+1)	54	22	67.5	10.5
Mechanical	12 (+2)	35	13	42.5	5.5
ONAE	8	19	4	23	9
Process	9	28	12	34.5	5.5
TOTAL	61.5(+3)	174	74	214	36

Table 10.2: Number of faculty, courses and remissions by discipline (as of December 2012)

To establish the new hiring areas within specific disciplines, numerous factors and data were analyzed (including, but not limited to):

- how positions fit within the strategic priority areas of the University and Province;
- consultations through Faculty and Discipline strategic planning processes;
- number of courses, students and student / faculty ratios;
- projected undergraduate and graduate student enrolments;
- sustainability of programs (eliminating teaching credit debts and deficits);
- faculty complement relative to other comparable engineering programs in Canada;
- other factors identified in the Discipline strategic plans.

Over the past several years, teaching credit deficits have occurred by teaching credit equivalencies that have led to an excess of owed course releases to faculty members. The teaching credit debt and budgetary structural deficit are planned to be eliminated within three years, through new faculty hiring, course consolidation, credit payout options for past and future courses and sessional instructors for course release of core faculty members.

The key principles adopted in the hiring plan are listed as follows:

- major strategic growth in ocean technology;
- strengthen each program and discipline in its strategic areas;
- sustainability of all programs by eliminating teaching credit debts within three years.

Based on these principles, the following 5-year hiring plan has been identified and presented in Table 10.3. This includes the hiring of an additional 28 faculty members by 2017-18.

	Year 1 (2013)	Year 2 (2014)	Year 3 (2015)	Year 4 (2016)	Year 5 (2017)	Total faculty (2017)	Projected graduates (2020)
Civil	2	1		1		17	50
ECE	1	1	1		1	24.5	60
Mechanical	2	1	1		1	19	75
ONAE	1	2	1	1	1	14	35
Process	1	1		1		12	30
Multi-Disciplinary			2	2	2	6	
TOTAL	7	6	5	5	5	92.5	250

Table 10.3: Faculty complement for the 5-hear hiring plan (including research chair positions)

The hiring areas of these positions are listed as follows:

- Civil Engineering – infrastructure management; geotechnical; environmental; design in ocean and harsh environments;
- Electrical and Computer Engineering – sustainable energy and power systems; sensors, control and instrumentation; remote sensing and communications; software, computing and simulation;
- Mechanical Engineering – materials science; fluid machinery (marine applications); mechatronics; petroleum production and operations; renewable energy;
- Ocean and Naval Architectural Engineering – naval architecture; Arctic and marine operations; ocean systems simulation; ship and offshore structural engineering;
- Process Engineering – system and process design; green engineering and bioproducts; improved oil production; mineral processing; transport processes.

In addition, new positions with a multi-disciplinary focus are also planned, i.e., petroleum, engineering management, complementary studies (ethics, impacts of technology on society, engineering workplace) and biomedical engineering.

9.3 STAFF HIRING PLAN

Additional staff members will also be needed to support the Faculty's expanded capacity. As the Faculty grows, modifications to the administrative structure and increased staff support are envisioned. This includes a projected addition of administrative staff members, to support the department heads, growth of student recruitment activities and graduate students. The 24

projected new staff positions include additional lab technologists, IT staff, accounting, recruitment and other administrative staff.

Three new staff positions per year are planned to be added, totaling 24 new positions by 2020. The following three principles are significant considerations in the staff hiring plan.

- The Faculty is moving towards a modified organizational structure which devolves administrative responsibilities to Department Heads.
- Administrative and technical staff / faculty ratios should better reflect local and national averages.
- A movement is recommended away from temporary contractual to permanent positions in order to improve staff morale, stability and commitment to the Faculty.

Firstly, due to the major future growth of the Faculty, there is a need to modify its organizational structure. There are a number of advantages of establishing Department Heads, including leadership development, better subject matter expertise, more direct interaction in teaching and research activities, and closer understanding of the needs of the specific discipline. Devolving more administrative responsibility to the Department Heads will require them to have more administrative assistance and support.

Secondly, according to a 2011 Survey, prepared by Engineers Canada for the National Council of Deans of Engineering and Applied Sciences (NCDEAS), the ratio of staff positions to tenure-track / tenured faculty in FEAS, 0.64, is significantly under-resourced relative to the Canadian average, 1.0. Under the proposed 8-year growth plan until 2020, the Faculty would add 5 professors per year, totaling 101 by 2020, as well as 3 new staff members added per year, totaling 38.8 + 24 = 62.8. This yields a total FTE (full time equivalent) staff / tenure stream ratio of about 0.62 by 2020. This growth in non-academic staff hiring still leaves a ratio below the Canadian average. In order to bring the technical staff / tenure stream ratio closer to the Canadian average by 2020, research funding growth and other innovative sources of revenue generation will be pursued to hire more support staff and research laboratory technologists.

Thirdly, a significant number of administrative staff positions are currently (base) unfunded (unfunded through base budget allocation to the Faculty). These are temporary positions with contracts that expire in 2014 or 2015. Base operating funds have been used to pay “(base) unfunded” faculty and staff positions, leading to a structural deficit of (base) unfunded positions in the Faculty. The positions have served an important role in the Faculty, thus should be extended and made permanent. To improve the stability of these positions, selected temporary contractual positions would be advertised through open search processes and base funded to become permanent positions.

Additional lab technologists and IT support staff in ECS (Engineering Computing Services) will be needed in the growth plan. The increased number of faculty, staff and students working in labs and classrooms located across campus will require support services such as critical software break and fix situations. The growth means more computers and software to maintain. The

variety of software used is large, technical and highly complex. Also, virus management is a significant challenge within the Faculty, as one infected machine potentially jeopardizes the entire network. Currently, on a weekly basis, it is not unusual to address several computers that have been quarantined due to virus attack. As a result, such computers are required to be formatted and fully reinstalled. This is a time consuming process that occurs regularly despite our best virus preventative measures. Also, there is a growing need for an advanced web development specialist to accommodate the growing social media, communication forums, websites, blog sites, and tools to enhance document sharing using Intranet sites. As a result, several new IT support staff members will be required as part of the Faculty growth plan.

9.4 PHYSICAL SPACE AND INFRASTRUCTURE

The planned faculty, staff, student and research growth will require additional space, namely offices, classrooms and laboratories. As part of the consultation processes with external consultants for the new science and engineering building, user groups engaged with the external consultant to determine the space requirements of Engineering in order to achieve our growth objectives. Based on the work of the Resource Planning Group Inc. and our own assessment of space requirements, approximately 104,000 ft^2 (net) of additional space will be needed to support the planned FEAS engineering expansion.

It is estimated that the Faculty will require about an additional 73,000 ft^2 (net) in the new building, in addition to other identified areas of additional net space in the current Computer Science space in the SJ Carew Building (16,000 ft^2), Suncor Energy Offshore R&D Centre (11,000 ft^2) and the reallocation of the Office of Collaboration and Partnership space, Bruneau Centre, which is adjacent to the existing Process Engineering space (4,000 ft^2), all expressed in net ft^2. The functional space requirements of Engineering in the new building are identified based on the following assumptions of related space allocations to the Faculty

<u>Short-term Space Plan</u>

- Approximately 11,000 ft^2 of new space will become available in the Fall 2013 in the new Suncor Energy Offshore R&D Centre.
- OCP space and IIC labs on the Bruneau Centre for Research and Innovation (Bruneau Centre) 1st floor would be vacated to accommodate the growth of Process Engineering.
- Space in Earth Sciences would be vacated as part of a re-organization when units go off-campus to the Battery Hotel.
- Additional research / teaching lab space would be added in the interim until the new building is completed, near / beside the SJ Carew Building.

A number of other initiatives will be pursued in the short-term to make better utilization of existing space within the SJ Carew Building. This includes re-allocation of existing labs to other

purposes. Other options include, but are not limited to, an expansion of the SJ Carew Building, potentially with an additional floor, expansion of labs, or other access for facilities.

Medium-Term Space Plan

- CS space in the Engineering building to be vacated when the new building is completed.
- Offices, labs, classrooms and support areas integrated together on about 3-4 floors in an engineering wing of the new building.
- Approximately 30,000 ft^2 net finished space and 43,000 ft^2 net shelled-in contiguous engineering space together in the new building.

The new multi-storey "engineering wing" of the new building would have about 73,000 ft^2 net, including finished and shelled-in space. This space would be contiguous and closely integrated together, including design project studio labs, classrooms, teaching / research labs and offices. One of the high-bay lab Disciplines (Mechanical, Civil or ONAE) would move from the SJ Carew Building into the new building, as well as Process Engineering labs, in order to permit lab growth of the other two remaining high-bay lab Disciplines in the SJ Carew Building.

Suncor Energy and RDC have provided funds for the expansion of the SJ Carew Engineering building. The Suncor Energy Offshore R&D Centre is expected to be completed by September 2013. This expansion includes new office space for research chairs, research engineers and graduate students who are engaged in major research projects related to offshore energy. A few other renovation projects have been completed or currently underway in 2013-14, including a concrete testing lab, graduate student and post-doctoral office space and computing service centre renovations. Shortage of teaching and research lab space to accommodate our engineering expansion is an urgent major challenge. Identification of suitable space for laboratories is high priority to be resolved as soon as possible.

In addition to physical space, growth in the capacity of IT infrastructure will also be required as part of the Faculty growth plan. This includes new resources of hardware, software, as well as new presentation and multimedia technology in classrooms. Increases in the budget will be needed for expansion of the Faculty's server/network infrastructure, storage space and server hardware. The Faculty will work collaboratively with DELTS to discuss options for better utilization of technology in engineering classrooms, including the necessary hardware and software resources to improve the learning experience for students.

As part of the growth plan, there will be an increase in the number of co-op work term placements due to the projected growth in undergraduate student enrolment. On average, for every additional 126 work term placements, one co-op coordinator should be added. Additional space will be required for an expanded Engineering Co-op Education Office, as well as further administrative staff support and operational expenses.

10. OVERALL SELF-REFLECTION

This section briefly summarizes an overall self-reflection of the Faculty's main strengths, challenges, opportunities and threats (SCOT).

Strengths

- High quality of faculty, staff and students
- Reputation of excellence, education, research
- Co-op programs for experiential learning
- Partnerships with industry collaborators

Challenges

- Budgetary: base funding, debt of teaching credits
- Space: teaching and research labs, offices
- Organizational structure amidst rapid growth
- Hiring in strategic areas of specialization

Opportunities

- Faculty growth plan to double by 2020
- Vibrant industry for engagement and collaboration
- New core sciences facility and other additional space for engineering expansion
- Transition to graduate outcomes curriculum

Threats

- Student quality and admission standards amidst rapid growth, demographics
- Space: multiple locations around campus
- Equipment, infrastructure maintenance
- Budgetary: university and province

11. ACKNOWEDGEMENTS

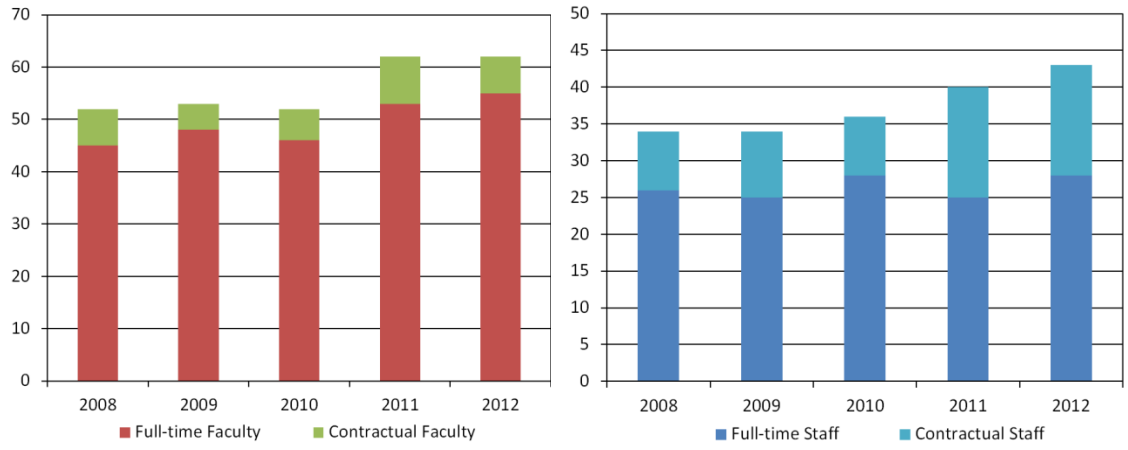
The input and significant contributions of faculty, staff, students and external stakeholders, either through written input, participation at meetings, or otherwise, is gratefully acknowledged. Special thanks to the Faculty Management Group, including Associate Deans (Andy Fisher, Leonard Lye, Yuri Muzychka), Senior Administrative Officer (Barb Elliott) and Discipline Chairs (Amgad Hussein, Dennis Peters, Nick Krouglicof, Steve Butt and Bruce Colbourne).

12. REFERENCES

1) Vision 2020, Strategic Plan of the Faculty of Engineering and Applied Science, Memorial University, July 3, 2013.
2) Proposal for the Creation of Departments, Faculty of Engineering and Applied Science, Memorial University, July 3, 2013
3) Council of Graduate Schools (2006): Professional Masters Education: A CGS Guide to Establishing Programs. CGS, Washington, D.C.
4) MUN (2007-2012): Five Pillars, Memorial University Strategic Plan. http://www.mun.ca/humanres/foremployees/StrategicReport5Pillars.pdf
5) Siddiq, F., Baroni, J., Lye, J., and Nethercote, W.C. E. (2010): The Economic Impact of Post-secondary International Students in Atlantic Canada: An Expenditure Analysis. Dalhousie University, School of Public Administration, for Council of Atlantic Ministers and Training.
6) Task Force on Professional Masters Degree (2008): Strategic Report for Professional Masters Degrees at Penn State. The Graduate School, Pennsylvania State University.

13. APPENDIX – SUPPLEMENTARY MATERIALS

13.1 FACULTY AND STAFF DATA



(a) (b)

Table 12.1: Number of full-time and contractual (a) faculty and (b) staff

13.2 UNDERGRADUATE STUDIES DATA

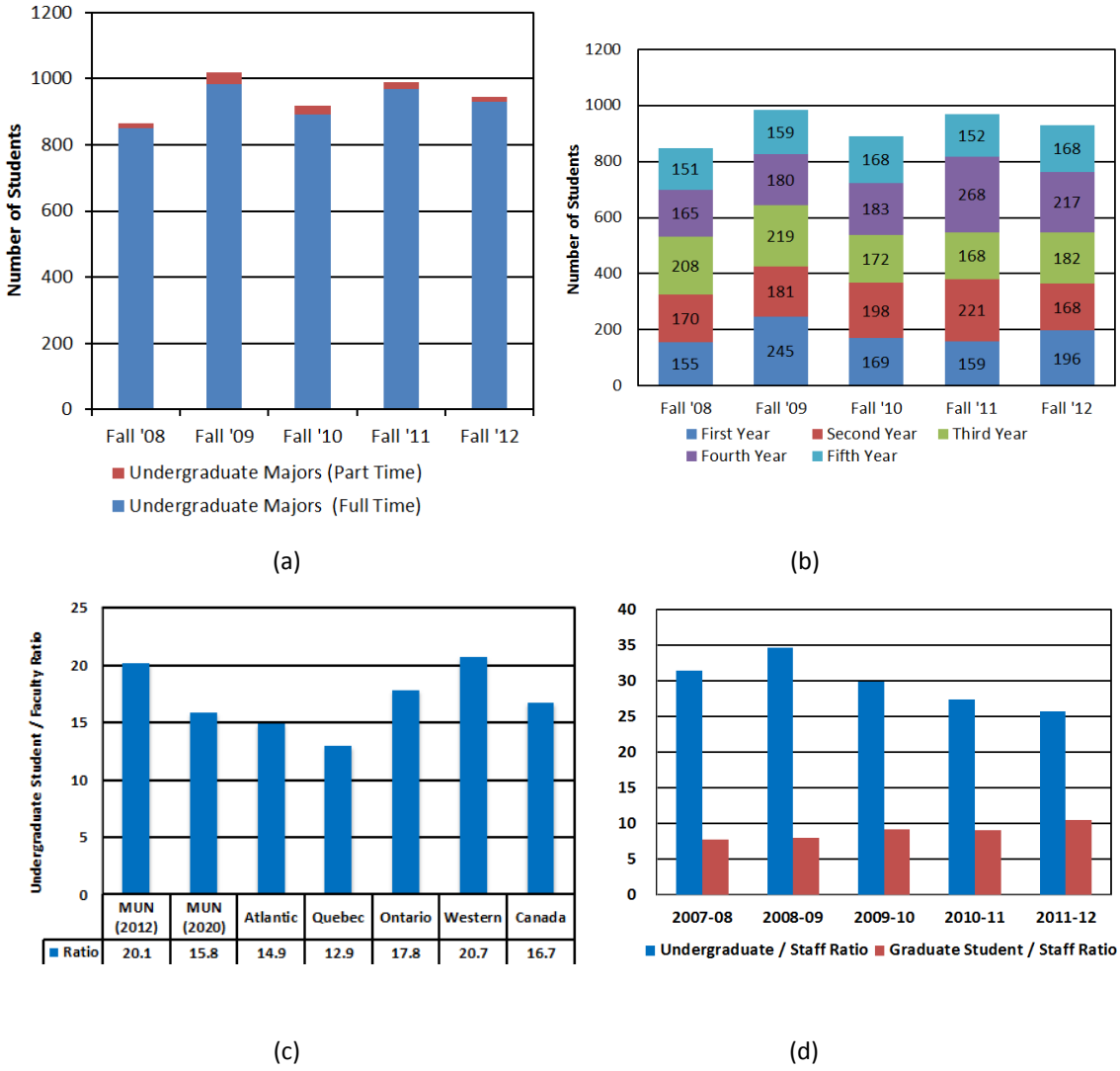


Table 12.2: Undergraduate students by (a) program, (b) year and (c) student/faculty, (d) student/staff ratios

13.3 GRADUATE STUDIES DATA

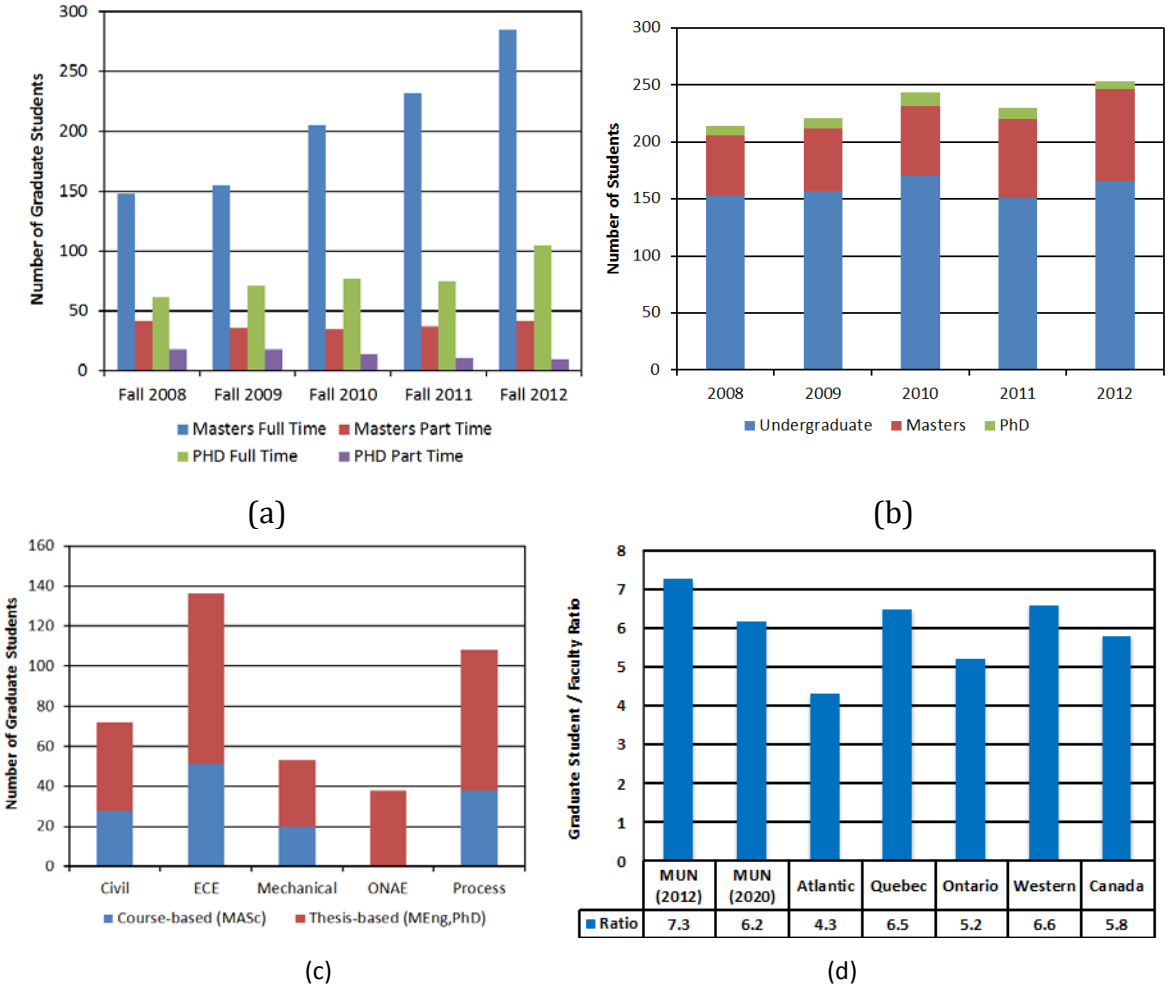
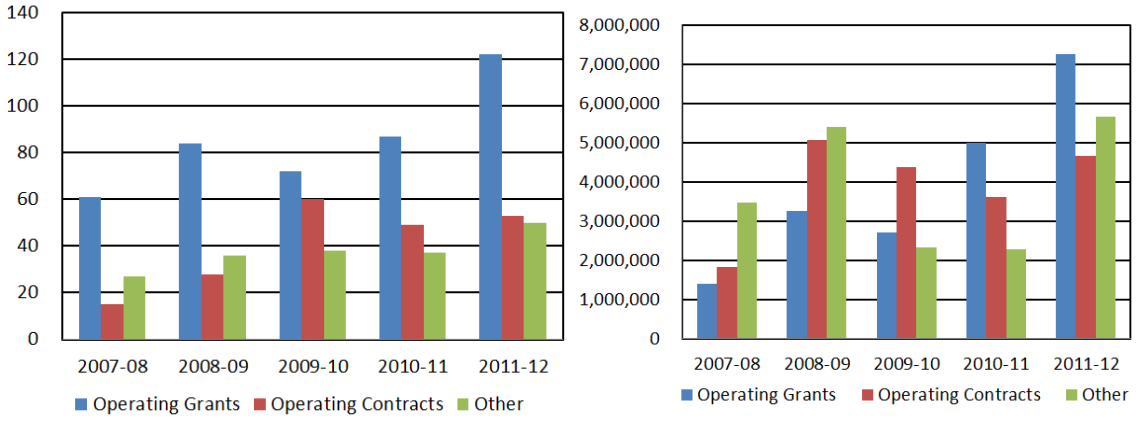


Table 12.3: Graduate students: (a) part/full time, (b) program, (c) discipline and (d) faculty ratios

13.4 RESEARCH DATA



(a) (b)

Table 12.4: Research grants and contracts by (a) number and (b) value

13.5 OTHER DATA AND REPORTS (BUDGETS; ACCREDITATION REPORT)

In May 2013, the Faculty submitted its budget request for the 2013-14 fiscal year. It was comprised of permanent and contractual salaries and benefits, teaching assistantships, funds for the VERIP and PDTER commitments made by senior administration, and operating costs. The budget included expenses for the unspent growth funding from the year 2012-13 and the new 2013-14 allocation to engineering in the provincial budget. The combined total budget request from the Faculty was $17,248,620. This includes $4.5M of growth funding that was allocated from government to the Faculty's base budget. The details of the budget request are attached.

Amidst the period of exciting growth of the Faculty, there are also major budgetary challenges involving a large structural deficit and teaching credit debt / deficit. Due to a number of "(base) unfunded" permanent positions over the past 5 years, the Faculty has a structural deficit of about $1.9M, due to about 18 permanent faculty and staff, including an allocation of a Senior Administrative Officer to the Faculty and an external dean, without a corresponding base funding allocation. Increasingly over time, the unfunded positions have been paid with base allocation, thereby eroding and eliminating the base allocation reserved for operating funds. This is a major problem that will need to be addressed in the near future.

Also, FEAS has a large teaching credit deficit that has accumulated over the past several years with at least 130 course reductions owed to core faculty members. This implies an unfunded liability of about $700K, if course credits are paid at the sessional instructor rate, due to the total teaching credit debt and annual deficit of teaching release. This unfunded liability has accumulated due to programs and courses offered beyond the resources available to the

Faculty. The deficit must be reduced and eliminated gradually over a period of 3-4 years, through a combination of new faculty hiring, consolidation of shared courses across disciplines (plan to ensure sustainable programs that each achieve a surplus state within 3-4 years), and offering a credit payout option to professors, both for past and future courses taught. The Dean and Senior Administrative Officer are working collaboratively with the Provost's Office to resolve these challenges.

The Faculty has experienced instability with staff positions which are essential to operations, but temporary contractual positions. According to a 2011 survey report of Engineers Canada, our ratio of staff to faculty members is far below the average in Canada and Atlantic Canada, for example, the MUN engineering ratio of 0.2 is 50% lower than the national average of 0.4. Three new staff positions were allocated in each of Years 1-2 of the Faculty Growth Plan. The Faculty is doing its part in alleviating structural deficits. Three contractual staff positions were converted to permanent positions from the Year 1 growth funds. The Faculty recently received approval from Vice Presidents Council to proceed with the Year 2 staff growth positions. A development officer was appointed in February 2012, but departed in the Fall 2012. The Faculty has been working with Alumni Affairs to hire a replacement, in order to help the Dean engage with potential donors in fundraising initiatives. A successful candidate has been identified and started the role in January 2014.

Faculty of Engineering and Applied Science

Regular Budget 2013-14 Request (does not include growth budget or expenditures)			Budget 2013-14 Growth Funding Request			Total Combined Budget 2013-14 Request		
Initial Allocation		**$12,342,200**	**Growth Funding (Balance of 2012-13 & 2013-14 Allocation)**		**$3,753,828**	**Initial Allocation and Growth Funding (Balance of 2012-10 & 2013-14 Alloc**		**$16,096,028**
Permanent Salary Expenses								
Fringe Benefits								
Fringe Benefits to be charged (permanent salaries only)		1,934,275	**Fringe Benefits**			**Fringe Benefits**		1,934,275
Fringe Benefits Cost of Faculty Term & Contractual Staff		199,713						199,713
Salaries			**Salaries**			**Salaries**		
Professors (Permanent)		8,306,024	Professors		1,200,000	Professors		9,506,024
Staff (Permanent)		2,094,736	Staff		324,693	Staff		2,419,429
Regular Term Salaries		564,619				Regular Term Salaries		564,619
Contractual Staff Salaries		624,123				Contractual Staff Salaries		624,123
Per Course Appointments		269,280				Per Course Appointments		269,280
Extra Teaching		137,088				Extra Teaching		137,088
VERIP		55,855				VERIP		55,855
			Co-op student jobs (unplace/CAP students)		20,000	Co-op student jobs (unplace/CAP students)		20,000
		14,185,713			**1,544,693**			**15,730,406**
PDTER (61 + 6 professors x 1600)		**107,200**	**PDTER**		**16,000**	**PDTER**		**123,200**
Total Salaries, Benefits and PDTER		**14,292,913**	**Total Salaries, Benefits and PDTER**		**1,560,693**	**Total Salaries, Benefits and PDTER**		**15,853,606**
Operating Expenditures			**Operating Expenditures**			**Operating Expenditures**		
Student Assistants	41000	495,000	Student Assistants	41000	50,000	Student Assistants	41000	545,000
Dean's Office	41000	250,000	Dean's Office	41000	221,200	Dean's Office	41000	471,200
Engineering Computer Centre	41004	166,337	Engineering Computer Centre	41004	10,000	Engineering Computer Centre	41004	176,337
Civil	41017	48,400	Civil	41017	10,000	Civil	41017	58,400
Electrical & Computer	41018	37,950	Electrical & Computer	41018	10,000	Electrical & Computer	41018	47,950
Mechanical	41019	45,530	Mechanical	41019	10,000	Mechanical	41019	55,530
ONAE	41020	24,700	ONAE	41020	34,700	ONAE	41020	59,400
Process	41028	44,175	Process	41028	20,000	Process	41028	64,175
Laboratories	41021	206,261	Laboratories	41021	20,000	Laboratories	41021	226,261
Development	41022	15,000	Development	41022	5,000	Development	41022	20,000
Recruitment	41029	20,000	Recruitment	41029	60,000	Recruitment	41029	80,000
Communication	41030	12,000	Communication	41030	5,000	Communication	41030	17,000
Help One Centre	41031	5,000	Help One Centre	41031	5,000	Help One Centre	41031	10,000
Undergraduate	41032	30,000	Undergraduate	41032	5,000	Undergraduate	41032	35,000
Core (Materials & Supplies)	41034	25,000	Core (Materials & Supplies)	41034	5,000	Core (Materials & Supplies)	41034	30,000
Graduate	41033	25,000	Graduate	41033	6,300	Graduate	41033	31,300
Research Office	41035	20,000	Research Office	41035	12,800	Research Office	41035	32,800
Total Operating Expenditures		**1,470,353**	**Total Operating Expenditures**		490,000	**Total Operating Expenditures**		1,960,353
			Equipment		861,397	**Equipment**		861,397
			Contingencies, growth space renovations		254,000	**Contingencies, growth space renovations**		254,000
			Teaching capacity recovery		159,360	**Teaching capacity recovery**		159,360
			Base salary for permanent faculty		100,000	**Base salary for permanent faculty**		100,000
Recovies and Savings on Faculty and Staff Positions		1,940,096	**Recovies and Savings on Faculty and Staff Positions**		-	**Recovies and Savings on Faculty and Staff Positions**		1,940,096
Total Deficit		**(1,480,970)**						
TOTAL REGULAR BUDGET REQUEST		**$13,823,170**	**TOTAL GROW BUDGET REQUEST**		**3,425,450**	**TOTAL COMBINED BUDGET 2013-14 REQUEST**		**17,248,620**

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REF: 145.5.15 Memorial – VISIT 12

CONFIDENTIAL

June 10, 2013

Dr. Greg Naterer, P.Eng.
Dean
Memorial University
Faculty of Engineering and Applied Science
240 Prince Phillip Drive
St. John's, NL A1B 3X5

Dear Dr. Naterer:

RE: Accreditation Decisions for the Following Programs at Memorial University

CIVIL ENGINEERING
COMPUTER ENGINEERING
ELECTRICAL ENGINEERING
MECHANICAL ENGINEERING
PROCESS ENGINEERING

On January 27 to 29, 2013, a visiting team chaired by Danilo Candido, FEC, P.Eng., reviewed the programs listed above for the purpose of accreditation by the Canadian Engineering Accreditation Board. The team's report was sent to you for comment to ensure its accuracy and completeness. You were also invited to comment upon improvements being implemented in the current academic year. The Accreditation Board Secretariat received your comments, with thanks.

Dossiers containing the visiting team report as well as your comments were distributed to the Accreditation Board members in advance of the accreditation decision meeting, which took place June 1, 2 and 3, 2013. The visiting team chair was present at the meeting to discuss information and answer questions about your programs.

We wish to inform you that the Accreditation Board made the following decisions:

Civil Engineering	}	**Accredited for four (4) year to June 30, 2017 to coincide with the accreditation period of the other accredited programs.**
Computer Engineering	}	**Accredited for four (4) year to June 30, 2017 to coincide with the accreditation period of the other accredited programs.**

Electrical Engineering	}	**Accredited for four (4) year to June 30, 2017 to coincide with the accreditation period of the other accredited programs.**
Mechanical Engineering	}	**Accredited for four (4) year to June 30, 2017 to coincide with the accreditation period of the other accredited programs.**
Process Engineering	}	**Accredited for four (4) year to June 30, 2017 to coincide with the accreditation period of the other accredited programs. Accreditation begins with the graduating class of 2013.**

The details of these decisions are attached herewith as Appendix 1, of which you are the only recipient.

As you know, the Accreditation Board maintains a policy of strict confidentiality regarding accreditation decisions. However, since this review was undertaken at your request, you may distribute them as you see fit. The Accreditation Board expects you to inform students and staff of the process of accreditation and of the accreditation status of your programs.

As a courtesy, I will send Dr. Gary Kachanoski, President and Vice-Chancellor, Memorial University, a letter advising him of the accreditation decisions taken by the Accreditation Board.

I take this opportunity to remind you that the Accreditation Board must be notified of any significant change to an accredited program during the period of accreditation. Any change that alters the circumstances under which a program was accredited may necessitate an immediate reassessment. Submission of documents may be sufficient for the reassessment. The Accreditation Board has issued a *Statement of Interpretation on Significant Change* as a guide.

On behalf of the Accreditation Board, I thank you for the kind hospitality extended to the visiting team and for your cooperation in reviewing the report of the visiting team and providing comments in advance of our meeting.

Yours truly,

Malcolm J. Reeves, FEC, P.Eng.
Chair, Canadian Engineering Accreditation Board

Encl.: Appendix 1

MJR/jl

Institutions offering engineering programs which are accredited by the Canadian Engineering Accreditation Board are encouraged to inform students, prospective students, and the general public of the current accreditation status of such programs. The Accreditation Board accredits only individual undergraduate degree programs, and not departments, schools or entire institutions, therefore, any reference to the accreditation must identify specific programs by name. Accordingly, the following statement is authorized for use in official University publications where references to accreditation are made:

"The Baccalaureate degree program(s) in [name(s) of program(s)] at (name of institution) is (are) accredited by the Canadian Engineering Accreditation Board of Engineers Canada"

CANADIAN ENGINEERING ACCREDITATION BOARD

CEAB Accreditation Decisions
Taken at the June 1, 2, and 3, 2013 CEAB Meeting

Institution: **Memorial University**

Concerning the programs in:
Civil Engineering (focused visit)
Computer Engineering (focused visit)
Electrical Engineering (focused visit)
Mechanical Engineering (focused visit)
Process Engineering

Arising from: Accreditation visit of January 27 to 29, 2013

CEAB DECISIONS:

MOTION:

"That the programs in:

Civil Engineering
Computer Engineering
Electrical Engineering
Mechanical Engineering
Process Engineering

at Memorial University be accredited for four (4) years to June 30, 2017 to coincide with the accreditation period of the other accredited programs at the institution. For re-evaluation of these programs, the Accreditation Board must receive a request for an accreditation visit by January 1, 2016."

Definitions
Comment: For information only.
Concern: Criterion satisfied; **potential** exists for non-satisfaction in near future.
Weakness: Criterion satisfied; **insufficient strength of compliance** to assure quality of program will be maintained.
Deficiency: Criterion **not** satisfied.

COMMENTS, CONCERNS, WEAKNESSES AND DEFICIENCIES
(References are to the 2011 CEAB Criteria used at the time of the visit.)

FINDINGS THAT APPLY TO THE FOCUSED VISIT

The issues pertaining to the focused visit were fully addressed.

FINDINGS THAT APPLY TO PROCESS ENGINEERING

Graduate Attributes:

Comment:

The Graduate Attributes are being addressed through the creation of a curriculum map and activity rating based on a three-level classification of content. A well-structured system for implementing the Graduate Attributes, with appropriate indicators and assessment tools, is under active development. (Criterion 3.1)

Continual Improvement:

Comment:

A feedback mechanism for continuous improvement is at the concept stage. It is expected that this component will develop more fully as analysis of data from graduate attribute assessment becomes available. (Criterion 3.2)

Based on the information provided in the self-study questionnaire and the report of the visiting team, the Accreditation Board believes that if progress continues at the same pace, the programs are on track to comply with Criteria 3.1 and 3.2 by 2014.

The above comments are provided for your information, and are not intended to provide assurances regarding future accreditation decisions.

The National Council of Deans of Engineering and Applied Science has been working on Graduate Attribute assessment on behalf of all engineering programs in Canada. You may wish to benchmark the activities you have undertaken to date against the series of activities identified through the NCDEAS initiative, in order to gauge your progress toward full compliance with the Accreditation Board's Graduate Attribute criteria by 2014. Up to date information about the NCDEAS initiative is available online at http://engineering.queensu.ca/egad/.

When the Graduate Attribute criteria were adopted in 2008, a transition and development period of six years was allowed. Starting in June 2015, the Accreditation Board will make decisions about compliance with the Graduate Attribute criteria. Deficiencies may be assessed in cases of non-compliance, which in turn could result in a loss of accreditation. The Accreditation Board encourages you to contact your peers to share information and approaches and to make best use of lessons learned. Please know that the Accreditation Board is available to respond to any questions you may have during the transition and development period.

PROGRAM SPECIFIC FINDINGS

Process Engineering

Curriculum:

Weaknesses:

The program is expected to include elements of mathematics appropriate to the discipline. The coverage of partial differential equations (PDE) was found to be marginal. (Criterion 3.4.3.1)

Program elements essential to the capstone design (e.g. engineering economics) should be completed before the design projects are started. (Criterion 3.4.4.4)

Civil Engineering:

The focused visit team identified no issues for this program.

Computer Engineering:

The focused visit team identified no issues for this program.

Electrical Engineering:

The focused visit team identified no issues for this program.

Mechanical Engineering

The focused visit team identified no issues for this program.

June 10, 2013

Malcolm J. Reeves, FEC, P.Eng.
Chair, Canadian Engineering Accreditation Board