Report of the Academic Program Review Panel
On the
Department Of Mathematics and Statistics
Memorial University of Newfoundland

Prepared by:

Dr. Cathryn Button (Chair)
Department of Psychology
Memorial University of Newfoundland

Dr. George Bluman
Head, Department of Mathematics
University of British Columbia

Dr. Veeresh Gadag
Division of Community Health
Faculty of Medicine
Memorial University of Newfoundland

Dr. Kathryn Hare
Department of Mathematics
University of Waterloo

July 30, 2001

Table of Contents

1. Introduction

Academic Program Review (APR) is a new procedure established by Memorial University under the authority of its Senate to facilitate planning and program improvement in its units. It is important to stress that this process is *formative* in nature, providing an opportunity for the unit and the institution to examine, from a variety of perspectives, what it does and how it might be improved. The review of the Mathematics and Statistics Department is one of three in the first round of this new APR process. Indeed, it is the Panel's understanding that the Mathematics and Statistics Department welcomed this review in the hope of constructive change. We think it is important to note from the outset that the role of the Department in the University is a difficult and complex one. The University as a whole, its students and other departments and faculties, the school system, government, industry and the community all have a stake in the delivery of mathematics education. As a consequence, the Department must not only function as a university Mathematics Department engaged in teaching and research but also as a service-provider for many other programs and departments. In addition, the Department has had to deal with serious remedial issues since a large proportion of the incoming first year cohort have been ill prepared for university level mathematics. These tasks are made more difficult against the backdrop of decreasing resources and declining enrolments. It is thus not surprising that we found a department experiencing considerable strain in attempting to fulfill its mandate. At the same time, we appreciate the University's desire to find creative, innovative ways to meet education challenges in the 21st century. These are particularly critical in mathematics and technology education.

It is the sincere hope of the Review Panel that our report and its recommendations might constructively lead to a better situation for all stakeholders in mathematics education.

The Academic Program Review Panel received the Self–Study documents provided by the Department of Mathematics and Statistics. After studying the documents, the Panel asked for and received further documents and clarifications. The Panel met on the morning of 10th May 2001 initially with Dr. E. Simpson (VP Academic), Dr. R. Lucas (Dean of Science) and Dr. G. Gardner (Associate Dean of Science) to discuss the review procedure. Dr. Simpson reviewed the importance that the University places on the programs of the Department of Mathematics and Statistics. Later in the morning of 10th May 2001, the Panel met with University President, Dr. A. Meisen. During these meetings the following clear picture about the programs of the Department of Mathematics and Statistics, as envisaged by the administration of Memorial University of Newfoundland, emerged.

Mathematics and Statistics courses are fundamental to any university and are essential for a modern civilized education. Every student should study mathematics courses, but the level of exposure is debatable.

Subsequent to these meetings, the Panel met with the Head of the Department of Mathematics and Statistics, toured the main Departmental Facilities, as well as the Math Learning Centre facilities. Many of the faculty members of the Department of Mathematics and Statistics met with the Panel either individually or in groups belonging to either a common program or committee.

The Self-Study document provided by the Department of Mathematics and Statistics consisted of the following components.

1. Strategic Objectives, History and Goals
2. Faculty – Demographic, Strengths and Weakness etc
3. Scholarly Productivity
4. Undergraduate Programs
5. Graduate Programs
6. Administration
7. Effectiveness – Teaching and Research
8. Equity and Resource Issues
9. Conclusion

A file of Appendices and other related material supplemented the Self-Study document. There were nine sections in the Appendices with a voluminous amount of information that included: Five year plan of the Department, Academic Review of the Mathematics Learning Centre, Senate Ad-Hoc Committee report on First-Year Math Courses, Curriculum vitae of the faculty members, Mathematics Skills Inventory, sections from the Collective Agreement, Student Survey report and some correspondence with the administration.

Owing to the complex positioning of the Department of Mathematics and Statistics within the context of the broader education of the students in the Province of Newfoundland and Labrador, the Panel met with many individuals and groups of individuals from outside the Department, who had some stake in the implementation of programs of the Department. For example, since the mathematical preparedness of high school graduates is one of the contentious issues, the Panel met with Dr. B. Burnaby (Dean of Education) and other members of the Faculty of Education. Their views on the role of the Mathematics and Statistics Department and the Mathematics Learning Centre in shaping the prospective elementary and secondary school teachers in the Province of Newfoundland and Labrador were sought.

The Panel met with Dr. G. Sabin (Associate Dean of Engineering-Undergraduate) to discuss with him the association and cooperation between the Department of Mathematics and Faculty of Engineering in offering common mathematics courses to undergraduate students.

The Panel also met with the Heads of the Departments (or their representatives) of Computer Science, Physics and Physical Oceanography, Earth Science, Chemistry,

Biology and Psychology to discuss their expectations of Mathematics and Statistics courses, which are requirements of their programs.

The Panel met at the end of each day to summarize the information received and also met for the final time the entire day of 12th May 2001, to draft the report and assign remaining writing duties.

In preparing this report, the Review Panel has used the organization outlined in the document 'Procedures for Review of Units and Programs'. We have made recommendations identified throughout the report in bold letters. Some recommendations are intended for the Department of Mathematics and Statistics, some for the Administration while others are for both the Department and Administration.

2. Preparing for University Mathematics

2.1   The Mathematical Preparedness of High School Graduates

As the sole university in the province, Memorial University recognizes that it has a "special obligation to educate the citizens of Newfoundland and Labrador"[1]. The demands of our current information and technology-based economy make it imperative for graduates of the university to be scientifically and numerically literate. Mathematics is particularly important in this regard because of its foundational role in science and because it teaches critical thinking, problem solving and analytic skills.

For students who have followed the Newfoundland high school curriculum the requirements for admission to MUN are: completion of the graduation requirements for high school and an overall average of at least 70% in specified subjects, including mathematics at either the academic or advanced level. Because "many students with a passing grade on the academic mathematics high school course cannot demonstrate adequate skills in junior and senior high school mathematics – skills that are essential for success in the first-year university mathematics courses"[2], many students who qualify for admission are not prepared to begin their study of university level mathematics. If they attempt to do so their chances of success are poor; the failure rates by these students in first year mathematics at Memorial are very high.

The lack of an adequate background in mathematics has long been recognized as a serious problem by the university. Over the years a number of committees, both internal and external to the university, have investigated the poor success rates in first year mathematics and the problem of the poor preparation of high school students.
The evidence that many students who have completed grade 12 academic mathematics have inadequate basic mathematics skills to succeed in university is compelling.

---

[1] A strategic framework for Memorial University, section I
[2] Academic Review of the Mathematics Learning Center May 2000, page 3

Standardized testing consistently shows Newfoundland students scoring well below national and international norms.

Perhaps the most striking data are the SAT Mathematics scores of Newfoundland high school seniors. In April 2000 the University administered the Scholastic Aptitude Test (SAT) Mathematics subject exams to 788 students who had applied to the University for the Fall semester 2000, from randomly selected schools in Newfoundland. The test examines mastery of high school mathematics. The results revealed that even the best Newfoundland students are not as well prepared as their American counterparts. Indeed, the upper quintile of the MUN-bound students averaged only 600 on this exam. The American students averaged 650 with three-quarters of them exceeding the Newfoundland average of 600. In comparison with American students, relatively few of even the very best MUN students are well prepared to begin studies in the scientific and technical areas that require sophisticated analytical skills.

MUN's diagnostic tests suggest that approximately 75% of beginning MUN students, who completed the academic mathematics program in high school, are effectively functioning at the grade nine level or below.[3] Consequently, many MUN students are not prepared to begin the university mathematics courses, which are necessary for science, engineering, business and many arts programs. Indeed, the deficiencies in their backgrounds are deep and substantial, and in many cases cannot be remedied by a few weeks, or even a few months, of remedial work. The University admission requirements specify that students will be expected to have "obtained a suitable level of proficiency in …"[4] basic mathematical skills. The evidence is clear that a passing grade in Grade 12 Academic Mathematics does not guarantee this.

In contrast, we should remark that the evidence also shows that students who have completed the Grade 12 advanced level of mathematics are generally adequately prepared and succeed in their university studies, but this is a minority of students. One criticism of the University, which has been made by several of the committees who have investigated this situation, is that they have not sufficiently encouraged capable students to take the advanced (or AP) stream of mathematics. In particular, the University effectively discourages students from taking the AP stream since no preference is given for this stream in scholarship decisions.

Recommendation 2.1. *The University should consider changing its criteria for admission scholarships to take into consideration that a student is taking an advanced stream of mathematics.*

We are aware that in the near future there will be a new high school mathematics curriculum, common to the Atlantic provinces. It would be naïve to believe that this new curriculum will solve the problem. A curriculum which spends even less time on mathematics is unlikely to graduate students with the significantly improved mathematical skills which are needed.

---

[3] Ad hoc senate response committee on first-year mathematics final report, Sept. 1998, page 3
[4] Memorial University 2000-2001 Calendar, Admission to the University, page 48

2.2 The Handling of Inadequately Prepared Students--Role of the Mathematics Learning Centre

If the University chooses to admit students who have the formal admission requirements of an overall 70% average and a passing grade in Grade 12 mathematics, but who may not be suitably prepared for university mathematics, then it should provide those students with opportunities to remedy that deficiency in order that the students have a reasonable chance of completing the university program to which they were admitted.

There are a variety of ways in which this could be done. While Newfoundland is unusual in the number of inadequately prepared students, it is not unique in having students who need remedial assistance, and many different approaches have been tried by other universities, some on campus and others off. Presently MUN has a Mathematics Learning Centre, which reports directly to the Dean of Science, determines the placement of students into remedial programs and provides individual attention to students who need the most extensive assistance. Approaches which have been used at other universities include: cooperation with community colleges, adult or continuing education centres and credit or non-credit remedial courses offered through the university. The University should determine the best approach for Newfoundland students.

The problem of a lack of basic mathematical skills is not the fault of the Mathematics and Statistics Department. While the Department should cooperate in the search for a solution to these problems, its teaching function begins with first-year university-level mathematics courses. The University desires to expand its focus on research and graduate studies. Research mathematicians are not the appropriate people to teach pre-university mathematics courses; they are trained to teach university mathematics at the undergraduate and graduate level, and to carry out mathematical research.

A long-term solution must be sought by the University, in cooperation with the educational community of Newfoundland as a whole. In the interim, it is our recommendation that the preparation of MUN students for first-year university level mathematics should be done by the Mathematics Learning Centre. Students should begin courses in the Mathematics and Statistics Department only when they are sufficiently prepared in order to have at least an 80% chance of succeeding in first-year mathematics.

This recommendation means that the pre-university material presently taught by the Mathematics and Statistics Department as M1090 (a pre-calculus course in elementary algebra and trigonometry) should be taught through the Mathematics Learning Centre. This does not imply that the material should be taught with the individualized approach currently used by the MLC, or the university-style, large class-lecture approach currently used by the Department in M1090. Indeed, something between these two extremes may be more suitable in assisting students to make the transition from high school to university mathematics.

Recommendation 2.2. The teaching of all pre-university mathematics courses should be done by the Mathematics Learning Centre. In particular, the teaching of M1090 should be the responsibility of the MLC. The teaching function of the Mathematics and Statistics Department should begin with first-year university level mathematics and statistics courses. Students should begin first-year mathematics courses only after they are sufficiently prepared so that they have at least an 80% chance of succeeding.

Implementing this recommendation may require the MLC to be restructured. Clearly it will need significantly more staff, space and other resources than it currently has. We must stress that these resources should *not* be diverted from the Mathematics and Statistics Department.

3. Undergraduate Program

The Department is to be commended for having an extremely accessible atmosphere for its majors and alumni who are pleased with the program. However, many aspects of the undergraduate program in Mathematics and Statistics should be reconsidered.

1. The failure rates in first year courses remain alarmingly high and both short and long-term measures should be put into effect to address this serious problem.

2. Unlike the situation for Statistics courses, the Department offers only one calculus stream. Most universities of MUN's size offer at least three streams of calculus (e.g., calculus for physical sciences/engineering, calculus for life sciences, calculus for social sciences/business).

3. The number of Majors and Honours students in the various programs is respectable for a comprehensive university of MUN's size. However the number has dropped significantly in recent years but should likely increase if the recommendations we suggest are implemented.

4. More attention should be paid to programs for prospective teachers.

3.1 Placement

Currently, the Department gives a diagnostic test to all incoming students to decide whether or not students can take Mathematics 1000 (differential calculus), 1050 (finite mathematics) or 1090 (algebra and trigonometry). Students not achieving a high enough score to take any of these courses are directed to the Mathematics Learning Centre (MLC). The taking of the diagnostic test is not a welcoming experience to MUN for an entering student. Students are unhappy that the diagnostic test does not deal with the

topics of 1090 even though the topics covered in the last high school course are connected with 1090.

The re-introduction of provincial high school examinations in Newfoundland in 2000/01 should eliminate the need of a required diagnostic Mathematics test for students entering MUN in September 2001. Placement in the appropriate Mathematics course should now be based on the admission Mathematics marks.

Recommendation 3.1*. Effective immediately, the Department should no longer be involved in the placement of entering students. This task should be transferred to the Mathematics Learning Centre consistent with Recommendation 2.2.*

3.2 Streaming

The Department should investigate alternatives for presenting first year Mathematics courses. It should consider models of courses offered at other Canadian universities. Currently, the Department's only first year calculus offering is a traditional first year course, which would be of interest to prospective mathematics, physics, and computer science majors. This is inappropriate for a course that is intended to appeal to a broad group of students. In particular, the technical dexterity required may not serve the needs of students in other departments. Students are motivated by topics of relevance to their fields of study. For example, the Department might consider calculus streams aimed at students in physical sciences/engineering, life sciences, social sciences/business, etc. These courses should emphasize understanding calculus and how it is used in these areas. Their exams should have more word problems and require fewer calculations that are routinely done on the computer nowadays.

The current first year finite mathematics courses appear to be suitable for students in Arts. An alternative stream should be considered for students entering Elementary Education programs, for such students there should be more of an emphasis on topics appearing in the school curriculum, especially geometry.

The Department should consider service courses to be as high a priority as courses for Mathematics and Statistics Honours and Majors students. It is in the best interests of the Department and MUN to have quality mathematics service courses. Respect for mathematics by other departments and the administration should increase with careful attention to appropriate University needs.

Recommendation 3.2*. The Department should seriously consider introducing alternative streams of calculus courses.*

Recommendation 3.3*. The final examinations of calculus courses should have more relevant questions that test the understanding of calculus and its applications.*

Recommendation 3.4*. The Department should consider the introduction of an alternative stream of mathematics courses for prospective Elementary Education students.*

3.3 Lowering Failure Rates

A consequence in offering a wider selection of first year courses should be reduced failure rates. In designing new courses for first year students, the Department should seriously consider the active involvement of appropriate faculty in other departments/faculties (including Education, Economics, Psychology, Business school, all Science and Engineering departments). The combination of placing students based on the blended mark from school/provincial examination and appropriate new courses should lead to more students being able to directly enter and complete university level courses. The Department should strive to have a failure rate of less than 20% in elementary courses.

Recommendation 3.5. When designing alternative streams of calculus courses and an alternative stream of courses for prospective Elementary teachers, the Department should actively involve faculty from appropriate MUN units.

3.4 Routes to Elementary Education

All routes arising from revamping first year courses should qualify students for admission to the elementary education program (for teaching to the Grade 6 level). The Department should seriously consider offering a new route for prospective elementary and junior high school teachers—appropriate courses for such students are usually very intensive and require class sizes not exceeding 35 to be effective.

3.5 Class Sizes for First Year Courses

Ideally, the teaching and learning of mathematics is an interactive process. Students do not learn mathematics by passively listening to a lecturer; they must think, question, experiment and practice. In the classroom, a mathematics teacher tries to promote an atmosphere which supports and encourages these activities. The larger and more diversified the class, the more difficult this is to achieve. Consequently, the quality of the teaching/learning experience generally declines as the class size increases significantly.

However, we recognize that fiscal realities require larger than ideal enrolments for elementary courses in order to accommodate the small enrolment senior level and graduate courses that are necessary to provide a minimal undergraduate and graduate Mathematics program.

Math 1050/1051: There should be at most 70 students/section for these courses and their modifications. Students in such courses need more attention and need to be well prepared for Statistics 2500.

First year calculus courses: Section sizes should accommodate at most 100 students.

It is essential that for any section exceeding 70 students, there should be designated help in a much-expanded Help Centre, to provide the individual attention that is not feasible in a large class.

3.6 Class Sizes for Second Year Courses

Section sizes for second year courses should not exceed 70. If a second year course has a considerably smaller number than this, it should not necessarily be offered each term.

3.7 Class Sizes for Upper Level and Graduate Courses

 In order to offer a nationally recognized Mathematics and Statistics program, it is necessary to offer a broad as well as a rigorous set of Mathematics and Statistics courses. While we expect that the number of students in Department programs will grow as new research faculty are hired, the Department will need to offer many courses with low, albeit rising enrolments. Currently the Department is offering the right number of senior level and graduate courses.

3.8 Laboratories and Help Centre

In recent years, many Mathematics departments have found that scheduled tutorials (labs) do not work effectively for Mathematics courses. Most departments have moved to an expanded Help Centre model. In order to have increased class sizes for first and second year courses and the elimination of labs for all Mathematics courses, it is essential for MUN to provide additional funds to staff and train staff. It is also essential that a much-expanded space be provided for the Help Centre. The Help Centre must also be in a central location within the Mathematics and Statistics Department, and should be coordinated by an experienced Mathematics instructor. A Help Centre can only work effectively, if it is staffed by competent students who understand well the mathematics they will be explaining. Moreover, the students must be properly trained. In order to attract qualified undergraduate TAs, it is essential to pay them a premium of at least 50% more than the minimum wage. They should be hired and trained so that help is available when classes begin (the time when help is most needed). Efforts should be made to ensure that faculty teaching appropriate courses are aware of the Help Centre and are supportive of its role. Although we recommend the cancellation of lab components of all Mathematics courses, we repeatedly learned that there needs to be substantial improvement in the computer laboratory component (facilities and software) for Statistics courses.

Recommendation 3.6. *The laboratory components for Mathematics (not Statistics) courses should be discontinued. In place of lab components, the Department should have a greatly expanded Help Centre that is properly funded, properly located, and properly staffed.*

Recommendation 3.7. *The laboratory components of Statistics courses need to be updated with better facilities and appropriate software.*

3.9 Length of Examinations; Use of Calculators

The final examinations in Department courses appear to be two hours in length unlike the standard 2.5-3 hours in other Canadian universities. In the Newfoundland school system as well as AP Calculus examinations, students are allowed to use graphing calculators. The Department should seriously consider allowing the use of calculators on final examinations, as is the case in many universities.

Recommendation 3.8*. The Department should seriously consider extending the length of final examinations as well as its policy on the use of calculators.*

3.10 Undergraduate Advising

Currently the Department has an Undergraduate Officer who does no teaching. In most departments, many of his duties are undertaken by regular faculty as part of their responsibilities. The Undergraduate Officer does all of the Department's formal advising for Mathematics and Statistics. For the recruitment and retention of students, it is important that regular faculty do all advising for the Department. A careful and caring advising system, especially by instructors of courses, encourages students to study a subject. Such a system compels faculty, especially newer faculty, to become fully informed about a Department's students and programs. This naturally leads to well-understood improvements.

Recommendation 3.9*. The role of the Undergraduate Officer should be re-examined. Regular faculty should be fully involved in advising students.*

3.11 Integration of Applied Mathematics (AM) and Pure Mathematics (PM)

It is outdated to have separate undergraduate programs in AM and PM, including separately named courses. Many of the currently labeled PM courses would be considered applied and vice versa. Integrating the programs would provide more choice of courses for students and bring the faculty closer together. Many of the newer faculty are in favour of such an amalgamation. Oddly, there is no distinction between "pure" and "applied" Mathematics in the existing graduate program. Serious thought should be given to extending this amalgamation to the undergraduate program.

Recommendation 3.10*. Serious consideration should be given to eliminating distinctions between "pure" and "applied" mathematics in the undergraduate program.*

3.12 Course Duplication at MUN

Beyond first year the Department does little mathematics service teaching in comparison with most mathematics departments in Canada. For instance, the only course the Department teaches to Engineering students is first year calculus. There are nine courses in Engineering[5] (all with significant numbers of students), three courses in Physics[6] and five courses in Computer Science[7] which in large part duplicate existing courses in mathematics (often with small enrolments) and which are normally taught by a mathematics department. For example, CPSC 2740 and PM 2320 have essentially the same curriculum—in fact the text for CPSC 2740 used to be the text for PM 2320. The programming course, Mathematics 2120, should be replaced by a CPSC course. The Mathematics and Statistics Department should initiate discussions regarding the possible amalgamation of suitable courses and the sharing of teaching responsibilities.

Recommendation 3.11. *The university should consider the amalgamation of suitable courses and the sharing of teaching responsibilities where appropriate.*

3.13 Requirements for the Majors Degree

The Department should seriously examine the requirements for the Majors degree. At most universities only four Mathematics courses are required at the second year level, unlike the recommended six courses (plus one on programming, normally taught by Computer Science elsewhere) at MUN. The second year course offerings should be re-considered carefully. On the other hand, a Majors degree at almost every Canadian university requires 10 courses at the 3rd and 4th year levels compared to 7-8 at MUN. The interviewed AM students complained about the lack of flexibility in choice of courses whereas the interviewed PM students complained about too much flexibility!

Recommendation 3.12*. The Department should seriously examine the number of courses required for its Majors degree for each year level.*

3.14 Requirements for the Honours Degree

The number of Mathematics courses required for the Honours degree far exceeds the requirements at other Canadian universities. A student should normally be able to complete an Honours degree within four years. It appears that this is quite difficult at MUN—apparently some students have taken as long as six years to complete the program! This discourages students from taking the Honours program.

---

[5] Engineering 1405, 2422, 3422, 3423, 4422, 4423, 5432, 1534, 1535
[6] Physics 3810, 3820, 3821
[7] CPSC 2740, 2741, 4734, 4735, 3731

Recommendation 3.13. *The Department should seriously examine the number of courses it requires for its Honours degree.*

3.15 Programs for Teachers

The Department in conjunction with the Faculty of Education should identify a set of courses which is suitable for prospective secondary school teachers. We saw no such identification of courses in the Undergraduate Guide or the Education and Mathematics sections of the MUN Calendar. MUN is in the fortunate position of having a virtual monopoly on the training of teachers for the Newfoundland school system. On the other hand, such a monopoly carries with it added responsibility. As Newfoundland teachers may be called upon to teach any subject in the school, a serious attempt should be made that every prospective elementary and secondary school teacher graduating from MUN's Faculty of Education has adequate mathematics preparation to at least teach up to the Grade 9 level of mathematics. New courses for accomplishing this should be designed and taught jointly by the Department of Mathematics and Statistics and the Faculty of Education.

In order to encourage more mathematics students to enter the secondary Education program, MUN should discuss with the Ministry of Education the possibility of allowing entry to Mathematics Majors without 24 credits in a second subject as is the case in some other provinces.

The Mathematics and Statistics Department, jointly with Education and the Ministry of Education, should establish a summer Certificate Program to upgrade practising teachers of Grades 5-9 with little or no mathematics background.

3.16 Miscellaneous

The Department should update its Undergraduate Guide ensuring that the information given is clear and current, that course descriptions are accurate (for example, Math 2000 is not) and that references are up-to-date. The Department is lauded for having an annual career night.

4. Graduate Program

The Mathematics and Statistics Department at MUN offers graduate programs in mathematics and statistics at the masters and doctoral levels. There are currently 19 students in the program, 13 Masters students and 6 PhD students. Eleven of the students are in statistics and the remainder in mathematics.

4.1 Program Size and Quality

One of the stated goals of the Department is to expand the graduate program to 60 students. This is unrealistic considering the current shortage of graduate students in North America, pressures to expand graduate programs elsewhere, and the significant increase in staff and funding that would be required. Expanding to 25 students would already require substantial recruitment efforts and new sources of funding, but would be a reasonable number of graduate students for a research-active department of the size we propose (see section 6.3). In particular, growth in the statistics graduate program seems quite promising if resources are increased as the Department is currently turning away qualified students.

The number of graduate courses offered by the Department is small, with limited choice for the students. As resources for small enrolment classes are limited, the Department must carefully select the graduate courses to offer, taking into account the needs of the students, as well as the expertise of the faculty members. The Department should also consider the possibility of combining some Masters level and 4th year honours courses. Graduate students should be supervised by faculty members active in research, and graduate courses should generally be taught by this same group.

The current graduate program appears to be comparable in quality to programs at other Canadian universities with a similar research profile and size.

Recommendation 4.1*. The Department should seek to expand its graduate program to about 25 students.*

4.2 Funding

At present graduate students typically receive a financial package totaling approximately $12,250 per year. This consists of a teaching assistantship, graduate fellowship from the School of Graduate Studies and contributions from the supervisor's grant. Students who hold an NSERC graduate fellowship or teach can earn more. In interviews with graduate students, we found that a proper financial package was essential in their recruitment.

This subsistence level funding is not competitive by North American standards where typical support is in the $16-20,000 range for students without NSERC awards**.** There must be increased funding if the graduate program is to grow. As mathematics and statistics grants are very small in comparison with the other sciences, much of this increase will need to come from the University.

Recommendation 4.2*. The Department and University should work together to increase funding for graduate students.*

4.3 Graduate Student Teaching

The opportunity to teach can be very beneficial for graduate students because of the experience it provides those preparing for an academic career. Graduate students (and postdoctoral fellows) can be viewed as faculty members in-training and the Department has a responsibility to prepare them for all aspects of the job, including teaching. Teaching also provides financial benefits, both for the graduate students and the University.

The Department also has a responsibility to Memorial's undergraduate students to provide good quality instruction, thus each prospective graduate student teacher should receive training in teaching university mathematics before they are placed in the classroom. The University should assist the Department with this by helping to provide the needed resources for training workshops.

The students offered teaching assignments should be carefully selected based on their commitment to teaching and their performance in the teaching workshops. It is *essential* that they be proficient in the English language. This may mean that many foreign students (and we would expect much of the growth in the graduate program to consist of overseas students) will not be able to teach during their first few years in Canada. First year Masters students and statistics graduate students preparing for non-academic careers may also be unsuitable candidates for teachers.

It must always be kept in mind that the first priority for a graduate student should be the completion of their studies and research. Teaching should not interfere with this or noticeably extend the length of their program. We recommend that students teach no more than two courses per year. The university should be aware that NSERC regulations prohibit NSERC holders from teaching more than two courses annually.

Recommendation 4.3. *We recommend that suitable graduate students be given the opportunity to teach one or two courses per year. Graduate students desiring to teach should first be given training in the teaching of university mathematics and those offered teaching assignments should be chosen carefully.*

4.4 Administration

In interviews with faculty and students, there were concerns raised that rules and regulations for graduate students were not transparent. In particular, there appear to be no guidelines on comprehensive examinations. Moreover there were claims that essential information was not always provided in a timely manner.

The Graduate Officer should chair the Graduate Studies Committee as is the normal practice at other universities. He or she should respond to requests in a timely manner. It is suggested that the Graduate Officer should be a faculty member with an external research grant.

Recommendation 4.4. *The Graduate Officer should chair the Graduate Studies Committee*.

5. Faculty Research and Scholarship

The research and scholarship activity of the Mathematics and Statistics Department at Memorial is fairly typical of a comprehensive Canadian university which has historically had an emphasis on teaching. The scholarly activities of the individual faculty members are quite diverse as is the case in most mathematics departments and reflect, in large part, the hiring priorities at the time of their hiring. Most of the research is carried out by about half the faculty.

Nineteen faculty hold NSERC grants, including all of the ten hired in the last three years. It is good to see that the young hirees of the last few years have all won NSERC grants. This clearly reflects the greater weight placed on research potential in hiring, due to the increased emphasis of Memorial on research and graduate studies. These new people seem energetic and enthusiastic. They are eager to increase the research profile of the Department and supervise graduate students. They have become involved in the spectrum of Department activities in a variety of ways, including the graduate and undergraduate committees, interdisciplinary activities and collaborations both within and outside the University. Those without grants are typically older mathematicians who were hired in an era of different research expectations from today. Their scholarly contributions are varied and include such things as involvement with high school mathematics contests and the production of the magazine CRUX. The average NSERC grant size at MUN is about 2/3 of the average Canadian grant in mathematics and statistics.

The active researchers in the Department have connections with mathematicians and statisticians across Canada and internationally. The applied mathematics group has established links with other departments at Memorial, as well as outside. Members are involved in the interdisciplinary Computational Sciences program, C-Core, the Institute for Marine dynamics, MITACS, and industrial partnerships. There is one joint appointment with Engineering. The statisticians have also collaborated with faculty members of other departments at Memorial, and have relationships with Statistics Canada, Health Canada, Fisheries and Oceans, etc.

Members of the Department have a number of plans for future research activities that could be supported in part by AARMS or one of the Canadian mathematical institutes. For example, they are planning a workshop on algebra this summer and have arranged for the Fields medalist, Zelmanov, to be a key speaker. A proposal has been submitted for a graduate student summer school/workshop in the summer of 2002. Such activities, if

they occur, would bring a large group of research mathematicians to Memorial, stimulate research activity and aid in recruiting both graduate students and future faculty members.

6. Faculty and Staff

6.1 The Head

The Review Committee was very impressed with the very strong and genuine support that the current head, Herb Gaskill, has from his colleagues. Dr. Gaskill is open to new ideas. He is caring, compassionate, passionate, and congenial.

6.2 Workload

Normally, in a comprehensive, research-level Canadian university, faculty members in mathematics and statistics departments are expected to engage in research, teaching and service. A faculty member holding a research grant would normally teach four courses annually *and* carry out significant service within the university. Those with very substantial administrative responsibilities in the university such as head or deputy head, or in an external professional organization, such as director of AARMS, would generally have a reduced teaching load.

As part of their collective duties, faculty are expected to look after the following within the department: teaching at all levels from first year to specialized graduate courses, supervising graduate students and honours theses, active advising and counseling of students, program and curriculum development, mentoring junior faculty and graduate students, recruiting undergraduate and graduate students, preparing graduate comprehensive exams and serving on defense committees, handling scholarship applications, chairing departmental committees, serving on appointments and promotion/tenure committees, timetabling and finding rooms for courses, liaising with other departments and with the registrar's office, approving students for graduation, determining transfer credits, organizing colloquia and seminars As well, faculty are expected to serve on faculty and university-level committees.

We strongly recommend that Memorial follow this accepted standard model. In particular, recently hired faculty should be expected to teach courses at all levels, supervise graduate students and honours theses, participate in the collective duties of the department, and be active in research. We anticipate that the energy and stimulation that this model will bring to the environment will attract larger cohorts of majors, honours and graduate students. It should also enhance the cohesiveness of the department.

Recommendation 6.1. *We recommend that the Mathematics and Statistics Department at Memorial follow the accepted standard work model in which faculty are active in research, teach at all levels, supervise students and participate in the collective duties of the department.*

6. 3 Department Size and Hiring Needs

As of September 2001 there will be 34.5 faculty members available to teach in the Mathematics and Statistics Department. In spite of the fact there have been ten people hired in the last three years, this is a significant decline from the early 1980's when there were 50 department faculty members. There has been no corresponding decline in student registrations and, as a result, class sizes have increased substantially and course offerings been reduced.

It is our recommendation that within the next ten years the department should have 39 regular tenure track or tenured faculty members who are engaged in research, teaching and service, including at least nine appointments in statistics. This recommendation is based on the Canadian standard workload model which we have just described. It takes into account the maximum class sizes we have recommended for first and second year courses, the current number of senior and graduate level courses which are necessary for majors, honours and graduate programs, the elimination of pre-university teaching (including M1090) from the Department's direct responsibility, the replacement of laboratories by a much enhanced Help Centre, a growing graduate and postdoctoral program which would provide teaching support, and allows for sabbaticals which active researchers should be encouraged to take.

If the responsibility for teaching M1090 remains with the Department an additional 2-3 faculty members would be required.

The figure of 39 is based on the assumption that there will be no teaching by sessional instructors other than graduate students and postdoctoral fellows. It is generally accepted that the mandate of a comprehensive university with both strong research and teaching responsibilities is best fulfilled by those engaged in both endeavours and having a long-term commitment to the institution. (Graduate students and postdoctoral fellows arguably have only a short-term commitment to the institution, but we recommend an exception be made for them as they have a special relationship with the university and should be viewed, in part, as faculty members in-training.) There are already fewer than the 39 regular faculty we recommend for the Department and many retirements expected in the next five years. It is essential that new faculty members be hired in a timely fashion.

In order to provide first rate graduate and undergraduate programs the Department must maintain expertise in the fundamental areas of mathematics and statistics. The expected retirements of the next two to three years will leave the Department with essentially no activity in several fundamental areas of mathematics including analysis, geometry/topology and number theory. Filling the vacancies in these areas should be one hiring priority. The Department is also very short of staff in statistics. As this is an area with potential for growth in the graduate program, the Department should hire several statisticians.

Another hiring priority for the Department should be to continue to build research groups in concentrated areas of expertise such as applied mathematics and combinatorics. This will enable the department to have the necessary critical mass to stimulate productive research and attract graduate students.

The NSERC University Faculty Award program is a good way to bridge to future retirements. We recommend that the Department look for opportunities to take advantage of such programs

Recommendation 6.2. *Within the next ten years the Department should have 39 regular tenure track or tenured faculty members who are engaged in research, teaching and service, including at least nine in statistics. They should be hired in a timely fashion.*

Recommendation 6.3*. The Department should develop a hiring plan which takes into account their current strengths and weaknesses.*

6. 4 Young faculty

In addition to being needed to handle the mathematics and statistics teaching demands of the University, new faculty members will rejuvenate and re-energize the Department. Young people will bring with them fresh new ideas and enthusiasm for tackling the mathematics of the 21st century.

In our meetings with faculty members, the review committee could clearly see that the young faculty hired in the last three years have the potential to be a dynamic force in the Department. In order to make the most of that potential, senior Department members should mentor junior faculty and continue to provide them with opportunities to participate in varied ways within the Department, including in leadership roles.

Because there was relatively little hiring in the last twenty years, informal mentoring was sufficient. With the increased hiring which must take place in the next ten years and the almost complete changeover of the Department, it is important that a more structured and formal mentoring program be put into place. It should provide support for junior faculty members in all aspects of their job. In particular, it is very important that new faculty be made aware of the University promotion and tenure policies and the Department's expectations and standards.

Recommendation 6.4. *The Department should have a formal mentoring program for junior faculty.*

6.5 Teaching Effectiveness

We were provided with minimal information to allow us to measure the effectiveness of teaching in the Department. The external reviewers were astonished that even the Head of the Department does not have access to individual teaching evaluations of his faculty and comparative data. Data from systematic evaluations, while imperfect, are more relevant and reliable than rumours and folklore.

The lack of these evaluations is quite surprising for a university whose goals include "to provide strong academic support to undergraduate students"[8]. If the University is to assist faculty members in improving their teaching, strong and weak teachers need to be identified.

We were pleased to learn that there are regular peer teaching reviews of junior faculty. This should continue to be part of the mentoring process for junior faculty.

However, for a modern university this is not nearly adequate enough, particularly for a department which has received much implied criticism of its teaching over the years. It is very important that the Department find new ways of measuring teaching effectiveness in order to continually improve its teaching.

Recommendation 6.5. *The Department should find acceptable ways of measuring teaching effectiveness for all faculty members.*

6.6 Reward System

The Department has been critically examined a number of times over the last 20 years because of the high failure rates in first year mathematics, and it is clear that the morale of its members has been detrimentally affected.

The Mathematics and Statistics Department is an important partner in the University and its contributions should be acknowledged in tangible ways. In particular, innovation, creativity and extraordinary achievements of both individual faculty members and the Department as a whole should be rewarded. This will have many benefits including increased morale, productivity and a more collegial environment within the University.

Recommendation 6.6. *We recommend the University consider instituting a system in which outstanding accomplishments are acknowledged in a formal way.*

---

[8] Statement of university principles and goals, page 1.

7. Service and Outreach

The Department has been very actively involved on a continuing basis in the Canadian mathematical community including recent activities such as:

- playing leadership roles in the Canadian Mathematical Society (CMS). [MUN is probably the most active Canadian department.] Several Department members have held or hold executive positions (Brunner, Goodaire), served on the Board of Directors (Booth), led or served on important CMS committees such as the Canadian Mathematical Olympiad Committee (Booth, Shawyer), Competitions Committee (Shawyer), Nominating Committee (Goodaire), Electronic Services Committee (Goodaire), Publications Committee (Shawyer), Outreach Planning Committee (Shawyer), Fundraising Committee (Williams)
- playing a leadership role in the Canadian Applied and Industrial Mathematics Society (CAIMS). Kocabiyik is currently a CAIMS Council member-at-large and serves on the Nominating Committee and Scientific Program Committee
- chair, NSERC GSC 337 Grant Selection Committee (Brunner)
- member, NSERC Statistical Sciences Grant Selection Committee (Sutradhar)
- member, Mathematics National Steering Committee for NSERC Reallocation (Brunner)
- hosting the CMS Summer meeting in 1999
- chair, program committee for 1997 meeting of Statistical Society of Canada (Sutradhar)
- hosting the Canadian Undergraduate Mathematics Conference in 1999
- Board of Directors of AARMS (Brunner, Goodaire)
- editorial duties for Crux Mathematicorum with Mathematics Mayhem (Shawyer—current Editor-in-Chief, Eddy)
- associate editor of the Canadian Journal of Statistics (Sutradhar)
- co-chairing the first two annual Chairs of Canadian Mathematics Department meetings (Gaskill)
- organising AARMS workshops (Shalaby)

Internationally, Department members have played and continue to play prominent roles including
- editor, Indian Journal of Mathematics (Singh)
- member of the program committee of JSM (Sutradhar)

The Department has played an important role in promoting mathematics competitions in Newfoundland and Atlantic Canada including the national Euclid Contest for Grade 12 (Newfoundland has the highest participation rate of all provinces), the NLTA Senior High School Mathematics League, APICS mathematics contest (for undergraduates in Atlantic Canadian universities), Mathematical Challenge for Junior High School students. The Department has also been involved in "Math in the Mall" outreach programs.

Within MUN, several Department members have played active service roles including:
- chair, search committees for Heads of Computer Science and Physics (Goodaire, Watson)
- Computational Science M.Sc. Program Committee (Brunner, Kocabiyik)
- membership on Senate committees (Singh, Williams)
- member of Senate (Watson)

Shawyer was the 1997 winner of the CMS Adrien Pouliot Award for Public Awareness of Mathematics—the only winner of this award outside of Ontario and Quebec.

The above accomplishments are exemplary and praiseworthy, especially those connected with the Canadian mathematical community.

Some suggestions for further involvement in outreach in Newfoundland include:

- *development of a problem-solving workshop program for elementary, junior and senior high schools*. This could involve faculty, undergraduate and graduate students developing problems and presenting them in school workshops throughout Newfoundland to students and teachers. This could also include development of an eventual course related to such workshops. Funding for such workshops could come from sources such as the federal program for Scientists and Innovators in the Schools, Ministry of Education, Faculty of Science, central MUN administration and fees associated with marking of the Euclid Contest. Such visitations would make the Department more fully aware of the math preparation in Newfoundland schools, especially in rural areas. This could lead to better informed, and significant suggestions for improvements in, school Mathematics programs as well as to the encouragement of participating undergraduates to enter Education programs. This would also lead to better public appreciation of the work of the Department. For a model of such a program, check the website of the UBC Mathematics Department, www.math.ubc.ca.

- *development of an in-service upgrading program for teachers of Mathematics* in elementary and junior high schools in conjunction with the Ministry of Education and the Faculty of Education. Such a program could be conducted during summers and would be a most valuable initiative for those not actively involved in research. Such a program is sorely needed based on the evidence of the Mathematics preparation of entering MUN students.

- *conducting studies of factors affecting preparation of students entering MUN* such as textbooks, curriculum, role of provincial exams, length of school year, semestering, preparation of teachers, etc.

- *development of a co-op program for undergraduates*. This would enhance the Department's connections with industries in Newfoundland, and attract more majors.

Recommendation 7.1. *The Department should explore the development of a workshop program for schools that involves MUN faculty and MUN students.*

Recommendation 7.2. *The Department in conjunction with the Faculty of Education should explore the development of an in-service upgrading program for teachers in elementary and junior high schools.*

Recommendation 7.3. *The Department with the help of the University's support services should consider the conducting of studies on factors affecting preparation of students entering MUN.*

8. University Support

8.1 Space

The Department is currently occupying extremely cramped quarters in the Henrietta Harvey Building, which was originally designed to house a library. Its conversion to faculty/teaching space has been less than successful. A review of the space allocation according to the University's Space Management Guidelines in 1999 also concluded that the Department had a space shortage in several critical areas.

Our tour of the facilities revealed severe space limitations that made the proper functioning of the Department very difficult.

Faculty offices are far too small and constitute a barrier to any student advising or tutoring. In many instances, there is not sufficient room for a second chair. Most offices lack a white board or black board, essential to mathematicians teaching students. The offices are warm and stuffy. Sessional instructors are forced to share one office among five people, a situation that is hardly conducive to interacting with students or grading papers.

The Head's office is too small to accommodate small meetings or interviews comfortably.

The support staff office is small and crowded. There is no room to properly house equipment, materials and duplicating services.

Classroom space is minimal and the computer lab is too small. The corridors are narrow and barely let two people pass. Ventilation is poor throughout the building.

The Help Centre is far too small and not designed to facilitate its function. It is often crowded. This is one of the clearest examples of how space limitations interfere with academic functioning.

Recommendation 8.1. *We strongly recommend that the Mathematics and Statistics Department be provided with expanded facilities, particularly larger faculty offices, larger staff space, storage facilities, and a much larger Help Centre space.*

8.2 Computing Facilities & Support

The Department's computer facilities, a network of 32 computers in a laboratory, a Beowulf Cluster with 50 nodes, and various PC's in faculty offices appear adequate. However, the expansion of the Help Centre will increase the demand on the Computer lab and hence the laboratory will need expansion.

The level of computer support personnel in the form of the existing 1.5 permanent positions to service the Department's computer needs is not sufficient to meet the demand. Expansion of the Help Centre and/or the computer laboratory will increase demand further.

8.3 Administrative Staff

The Department has two secretaries as well as an administrative staff specialist and a secretary to the Head. This level of administrative support appears to be meeting the Department's needs.

9. Conclusions

In summary, the Review Panel would like to thank all of the people who participated in interviews and submissions for this review. In particular, we appreciated the very engaged attitude of the Department of Mathematics and Statistics, in their desire for constructive change and their willingness to share ideas. We have carefully listened to all of the stakeholders in this process. The recommendations we have made are in large part a result of their contributions. It is our sincere belief that implementation of these recommendations will contribute to the advancement of their goals. A list of our recommendations follows.

Recommendation 2.1. *The University should consider changing its criteria for admission scholarships to take into consideration that a student is taking an advanced stream of mathematics.*

Recommendation 2.2. *The teaching of all pre-university mathematics courses should be done by the Mathematics Learning Centre. In particular, the teaching of M1090 should be the responsibility of the MLC. The teaching function of the Mathematics and Statistics Department should begin with first-year university level mathematics and statistics courses. Students should begin first-year mathematics courses only after they are sufficiently prepared so that they have at least an 80% chance of succeeding.*

Recommendation 3.1*. Effective immediately, the Department should no longer be involved in the placement of entering students. This task should be transferred to the Mathematics Learning Centre consistent with Recommendation 2.2.*

Recommendation 3.2*. The Department should seriously consider introducing alternative streams of calculus courses.*

Recommendation 3.3. *The final examinations of calculus courses should have more relevant questions that test the understanding of calculus and its applications.*

Recommendation 3.4*. The Department should consider the introduction of an alternative stream of mathematics courses for prospective Elementary Education students.*

Recommendation 3.5*. When designing alternative streams of calculus courses and an alternative stream of courses for prospective Elementary teachers, the Department should actively involve faculty from appropriate MUN units.*

Recommendation 3.6*. The laboratory components for Mathematics (not Statistics) courses should be discontinued. In place of lab components, the Department should have a greatly expanded Help Centre that is properly funded, properly located, and properly staffed.*

Recommendation 3.7. *The laboratory components of Statistics courses need to be updated with better facilities and appropriate software.*

Recommendation 3.8*. The Department should seriously consider extending the length of final examinations as well as its policy on the use of calculators.*

Recommendation 3.9*. The role of the Undergraduate Officer should be re-examined. Regular faculty should be fully involved in advising students.*

Recommendation 3.10*. Serious consideration should be given to eliminating distinctions between "pure" and "applied" mathematics in the undergraduate program*

Recommendation 3.11. *The university should consider the amalgamation of suitable courses and the sharing of teaching responsibilities where appropriate.*

Recommendation 3.12*. The Department should seriously examine the number of courses required for its Majors degree for each year level.*

Recommendation 3.13 *The Department should seriously examine the number of courses it requires for its Honours degree.*

Recommendation 4.1*. The Department should seek to expand its graduate program to about 25 students.*

Recommendation 4.2. *The Department and University should work together to increase funding for graduate students.*

Recommendation 4.3. *We recommend that suitable graduate students be given the opportunity to teach one or two courses per year. Graduate students desiring to teach should first be given training in the teaching of university mathematics and those offered teaching assignments should be chosen carefully.*

Recommendation 4.4. *The Graduate Officer should chair the Graduate Studies Committee.*

Recommendation 6.1. *We recommend that the Mathematics and Statistics Department at Memorial follow the accepted standard work model in which faculty are active in research, teach at all levels, supervise students and participate in the collective duties of the department.*

Recommendation 6.2. *Within the next ten years the Department should have 39 regular tenure track or tenured faculty members who are engaged in research, teaching and service, including at least nine in statistics. They should be hired in a timely fashion.*

Recommendation 6.3. *The Department should develop a hiring plan which takes into account their current strengths and weaknesses.*

Recommendation 6.4. *The Department should have a formal mentoring program for junior faculty.*

Recommendation 6.5. *The Department should find acceptable ways of measuring teaching effectiveness for all faculty members.*

Recommendation 6.6. *We recommend the University consider instituting a system in which outstanding accomplishments are acknowledged in a formal way.*

Recommendation 7.1. *The Department should explore the development of a workshop program for schools that involves MUN faculty and MUN students.*

Recommendation 7.2. *The Department in conjunction with the Faculty of Education should explore the development of an in-service upgrading program for teachers in elementary and junior high schools.*

Recommendation 7.3. *The Department with the help of the University's support services should consider the conducting of studies on factors affecting preparation of students entering MUN.*

Recommendation 8.1. *We strongly recommend that the Mathematics Department be provided with expanded facilities, particularly larger faculty offices, larger staff space, storage facilities, and a much larger Help Centre space.*