# SIMON FRASER UNIVERSITY

S.84-34

## MEMORANDUM

To..... Senate

From... Senate Committee on Academic Planning
Senate Graduate Studies Committee

Subject... M.Sc. Program in Statistics

Date.... April 18, 1984

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The proposal for an M.Sc. Program in Statistics was considered and approved by the Senate Committee on Academic Planning at its meeting of April 4, 1984 and by the Senate Graduate Studies Committee at its meeting of April 16, 1984.

In discussion, it was noted that initially the proposed program could be mounted with existing faculty from the Department of Mathematics and Statistics. In the long term, with growth in enrollment, additional resources would be required.

MOTION:

"That Senate approve and recommend approval to the Board of Governors, as set forth in S.84-34, the proposed M.Sc. Program in Statistics."

WJW/gg

# SIMON FRASER UNIVERSITY

## MEMORANDUM

SCAP 84-16

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| o. Senate Committee on Academic Planning | From John M. Webster, Dean |
| | Graduate Studies |
| Subject Proposal for M.Sc. in Statistics | Date March 28, 1984 |

The proposed M.Sc. Programme in Statistics is attached for your consideration. It was approved by the Assessment Committee for new Graduate programmes on March 26, 1984, and strongly endorsed, particularly in light of the positive comments of the external reviewers.

The proposal is scheduled for consideration by the Senate Committee on Graduate Studies at its meeting April 16, 1984.

| To...... Dr. J.M. Webster | From...... G.A.C. Graham, Chairman |
|---|---|
| ......Associate Vice-President, Academic... | ......Department of Mathematics...... |
| Subject... STATISTICS M.Sc. PROGRAMME...... | Date...... 4 April 1984...... |

In response to your memorandum of 29 March, I would like to make the following comments:

1.  The program can be mounted initially without new faculty. For the past several years we have offered, through our visitors, sufficiently many courses at the graduate level to permit students to meet the requirements of the new program. In addition, in the early stages, while enrolments are low, we will be able to provide reading courses where necessary. The consulting service has been manned voluntarily in the past; we will continue to do this for the short term.

    Eventually, however, and particularly if enrolments match our expectations we will not be able to continue in this way. A reading course for six to ten graduate students is impractical. Our visitors must not be regarded as simply part of our teaching program. Our NSERC funds may not always be sufficient to provide enough visitors. Sabbaticals might place too great a strain on the system. Finally, if the consulting service is as successful here as it is elsewhere, the burden of administering it and supervising the students will necessitate some teaching relief.

    We should point out that a position in statistics was the top hiring priority in the Faculty of Science this year, and that the Mathematics Department is generally considered to be understaffed.

2.  We believe our graduates will have adequate experience in statistical computing. Statistical computing will be an integral part of consulting as well as the courses STAT 803, 804 and 805. In addition, we have always encouraged our students to take numerical linear algebra courses, which are very relevant to statistical computing. We will continue to do so.

    We believe the computing facilities at Simon Fraser are adequate to the task. They are certainly not comparable to those at Berkeley but we have a good supply of statistical packages.

    In addition, we have easy access to computing facilities. We are confident that Simon Fraser will continually update the computing equipment.

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3.  As all three reviewers indicate, the consulting service is crucial
    to a useful applied Master's Degree in Statistics. The reviewers
    make various suggestions concerning the organization of such a
    service and we respond to these here.

    Professor MacNeill suggests we charge for the service. Eventually,
    we would like to do so, in cases where the consultee has research
    funds available. Initially, however, we must establish the service in
    the client's minds as a useful tool in their work. Furthermore
    we must recognize that, at Western, the largest sources of revenue
    of this type are grants given to medical researchers. We do not have
    a Medical School here.

    Professor Brillinger wonders about credit for the consulting courses
    and payment to students participating. We believe payment to
    graduate students is the exception rather than the rule; if Simon
    Fraser wishes to emulate Berkeley, and have the Faculty of Graduate
    Studies pay the students we could hardly object but it does not seem
    necessary. As to credit for the course, we elected the present route
    after discussions with the Registrar. Our suggested method is
    administratively convenient. The actual work content of the course
    can be evaluated by other institutions on the basis of the project
    and letters of recommendation from our faculty.

    Professor Brillinger also wonders about Ph.D. students and students
    from other departments participating in the service. At Berkeley
    there is a separate department of Biostatistics and it is primarily
    these outside students who participate there. We do not expect many
    students here from outside the Mathematics Department to be interested
    or qualified but we will certainly accept any who are. We expect
    our Ph.D. students will participate in the service. There will not
    be many Ph.D. students and supervisors will have sufficient authority
    to persuade them to participate. Nowadays, every Ph.D. student in
    statistics seems to be anxious to do so.

    Professors Kalbfleisch and MacNeill suggest application to NSERC for
    support for the consulting service. We will do so.


4.  Replies to Professor MacNeill's further comments:

    1)  Experimental design and regression methods are covered at SFU
        in fourth year undergraduate courses. We will be using our
        authority over course selection to ensure that students without
        these subjects in their backgrounds make up the deficiencies.

Sample surveys form an area of statistical expertise rather different from the usual areas. At present none of our faculty have particular expertise in this area. Ideally we would like to mount a graduate course in sample surveys but our present proposal already taxes our resources to the limit. If and when further faculty are appointed we would mount a course in this area.

Statistical computing will definitely be an important part of participation in the consulting service.

2) These courses are quite peripheral and we do not have the resources to offer them. Occasionally, other departments (Economics for example) may offer courses in some of these areas. We would encourage our students to take them.

3) Projects may involve software development if the opportunity presents itself. Only time will tell.

4) We will do our best to expose students to computer graphics and database management. This will require consultation with computing science and the computing centre.

5) We have, in the past, accepted students from disciplines other than mathematics and statistics. We always require such students to make up the lacunae in their undergraduate backgrounds. Generally, they do this in a qualifying semester.

G.A.C. Graham

GACG/bcl

# SIMON FRASER UNIVERSITY

## MEMORANDUM

To...... Dr. G.A.C. Graham ....................

...... Chairman, Mathematics ....................

Subject.. STATISTICS MSC PROGRAMME ....................
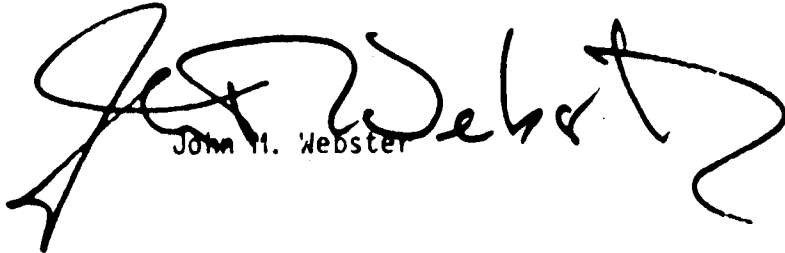
From...... John M. Webster ....................

...... Associate Vice-President, Academic .

Date...... March 29th, 1984 ....................

The Assessment Committee for the Statistics MSc Programme approved the proposed programme at its meeting on Monday and recommended its consideration by the Senate Committee.

The following points were raised by the Assessment Committee and I suggest that you respond to these issues in a memorandum addressed to me:

1. Clarify whether or not the additional faculty resources are essential for the offering of the programme, and, if so, under what circumstances.

2. The adequacy of the computing component in the programme, and of the computing availability.

3. All the reviewers were concerned about the consulting service, and the format and centrality of consulting in the programme. You may wish to address this issue.

4. A response to each of the five items raised in Professor MacNeill's review would be helpful.

I look forward to receiving your reply at your earliest convenience.

John M. Webster

JMW/cb

## CONTENTS OF PROPOSAL

## INTRODUCTION

This program is designed to provide an alternative training plan for Masters students in Statistics, working in the Mathematics Department at SFU. At present the students can take the degree by course work and thesis as in other branches of Mathematics. The statisticians at SFU feel that a very strong case can and should be made for training statisticians with more emphasis on course work and actual experience of data analysis through participation in a consulting service. This is in line with Statistics programs at major universities throughout the world. At Simon Fraser University, the formal machinery for introducing such a program is already in place; the program explains how the suggested new M.Sc. program in Statistics will fit in to the formal structure of SFU's Master degree and presses the need for such a program.

## MASTER OF SCIENCE IN STATISTICS: PROJECT OPTION

### I: General Information

1. Title of Program: Master of Science in Statistics: Project Option

2. Credential to be awarded to graduates: M.Sc.

3. Department to offer program: Mathematics

4. Date of Senate Approval: ??

5. Schedule for implementation: 1 September 1984


### II: Program Description

1. Objectives:

    a) To expose graduate students in statistics to the practical nature of the discipline through participation in the departmental consulting service and preparation of a project.

    b) To expose students to a broader range of statistical techniques by requiring (and providing) more coursework. This concentration on breadth of experience rather than depth in one area will be enhanced by the substitution of a project for the thesis.

2. Relationship of program to role and mission of university:

    This program will better serve graduate students in statistics by providing them with a broader knowledge of statistics, more soundly based in practice. Better education is, of course, a basic mission of Simon Fraser University. In addition, we hope the consulting service will enhance contacts between statisticians and researchers in other departments. This interdisciplinary effort should increase the research effectiveness of both groups.

3. Other similar programs in Statistics:

    a) In British Columbia: none. For comparison sake, as of Summer 1983:

    University of Victoria: Offers a program with a requirement of 30 semester hours of credit and a thesis or a comprehensive examination program. The thesis program requires 16 of the 30 semester hours be at the graduate level while the comprehensive examination program requires 24 of the 30 semester hours at the graduate level. Neither program has the consulting service requirement of this program. Very few students take either program in Statistics.

    University of British Columbia: A thesis program with 24 semester hours of coursework of which at least 12 hours are at the graduate level. Consulting service experience is optional.

b) **Outside of British Columbia:** Programs requiring 25 to 30 semester hours of coursework and a final examination are available at Carleton, Toronto, Western Ontario, and York. Programs requiring coursework and a "project" or "major project" or "paper" are available at McMaster, the University of Alberta, and Waterloo. At McMaster consulting service participation is required. The McMaster program is similar to our proposal.

**4. Relationship of proposed program to those at the University of Victoria and the University of British Columbia:**

The program has two crucial differences from those at both other schools: first, we require more graduate coursework than any of the thesis programs - 20 semester hours as opposed to 16 or fewer; second, and most important, we are alone in requiring participation in the Statistical Consulting service. The trade-off is that the project is less extensive than the thesis. This program is therefore more suited to providing broad exposure to statistical techniques for students.

**5. Curriculum:**

We will be requiring 28 semester hours of coursework, at least 20 of which are at the graduate level with the remainder at the 400-level or higher. In addition, students will be required to participate in the consulting service for two semesters. We propose to administer this consulting requirement by creating two courses; Statistical Consulting I and Statistical Consulting II. Treating consulting as coursework has these advantages: the students' transcripts will show that they have practical experience; the serious commitment of the statistics group to the importance of practical work will be demonstrated to the students, and formal supervision of the students' participation will be provided. Finally students will be required to submit and defend a project. This would likely consist of the thorough analysis of a data set, generally one encountered in the consulting service, with a written report on the analysis.

More detailed course requirements are listed below:

a) Existing courses: We will be using

    MATH 872-4    Probability I
    MATH 873-4    Probability II
    MATH 874-4    Probability:  Selected Topics

as optional courses.

In addition we propose to rename:

    MATH 875-4  Statistics I    as   STAT 801-4  Mathematical Statistics
    MATH 876-4  Statistics II   as   STAT 802-4  Multivariate Analysis
and MATH 877-4  Statistics -
                Selected Topics as  STAT 890-4  Selected Topics in
                                                Statistics

The renaming serves two administrative purposes. It allows all statistics graduate courses to be numbered rationally and it permits

statistics courses to be listed together in the calendar.

We will be requiring STAT 801-4 and STAT 802-4 as compulsory courses. In addition we will be using our existing undergraduate courses at the 400-level as optional courses and, where thought necessary by a student's program advisor, as required background courses for graduate courses. We will also be using on occasion some graduate courses offered in other departments (for example Time Series courses in Economics or Experimental Design courses in Psychology).

      b)  New courses:  (Course Proposal Forms attached in Appendix I)

      i) Statistics Courses

          STAT 803-4     Data Analysis
          STAT 804-4     Time Series Analysis
          STAT 805-4     Nonparametric Statistics and Discrete Data Analysis
          MATH 871-4     Applied Probability Models

The courses STAT 803-4 and STAT 804-4 are computer oriented. In order to ensure that our students have at least a minimum exposure to computer methods we require students to take either STAT 803-4 or STAT 804-4 which are computer oriented. A course in numerical linear algebra is in the approval process and we intend to permit students to use this course, when it is approved as an alternative route to satisfying our minimum computing requirements. We expect our students will generally get much more exposure than this minimum through the project, the consulting service and other coursework.

      ii) Statistical Consulting

          STAT 811-0     Statistical Consulting I
          STAT 812-0     Statistical Consulting II

These courses would both be required.  They will be graded on a Satisfactory/Unsatisfactory basis.  The use of two course numbers is intended to make it easier for the Office of the Registrar to record two semesters of participation on a student's transcript.

## 8.  Details of consultation with non-university agencies

Drs. Weldon, Routledge and Stephens have considerable contacts with government and industry; this comes about from consulting, from their official positions in Canadian Statistics and in Weldon's case because he has just finished an NSERC Industrial fellowship under McMillan-Bloedel. Stephens is president of the Statistical Society of Canada and as such has contact with the Department of Energy, Mines and Resources, Statistics Canada, etc. It is very clear that such bodies recognize the ever present need to keep statistics graduates up to date. Statistics Canada, for instance, have emphasized their approval of the University of Waterloo's co-op program, because it means that students get real experience with data, which is often of necessity

contaminated or partly lost, etc. In industry also, the need is perceived for statisticians who can interact with others in the field and also with executives and managers. Nevertheless, much education is still needed in Canadian industry to improve awareness of what can be done with better methodology.

### III. Need for Program:

1a) The need for this program arises because we feel that statisticians need better training at the Master's level. Because there are few Departments of Statistics in Canada (although this is changing), students entering Masters programs in Statistics at most Canadian universities usually have the B.Sc. in Mathematics. In their program they would have had at most three or four courses in Statistics, compared with the full program which a student in a Statistics Department would have taken. Students sometimes enter Statistics programs from other disciplines, for example, Psychology, Economics, Biological Sciences, etc; these are good backgrounds, and students from other subjects should be encouraged to study Statistics, since it leads to better applied scientists.

b) However, Statistics has now become a very vast field, and we want our students with a Masters degree to leave with a broad knowledge of this field. At present the course structure of the degree with the thesis is too limited; students take few courses, and so have no course work in wide areas of Statistics. They then write a thesis, which may or may not contain a research component (in our Department it usually does), but of necessity this is in a limited topic. The typical student spends a great deal of time and energy on the thesis.

c) It cannot be over-emphasized that statisticians occupy a special role; according to the position they hold they interact with specialists in many other disciplines, and are looked to for practical guidance of how to analyze difficult data. The Masters degree is the level at which they should receive a broad applied training. This is what this program is intended to provide, by giving a wider range of course work, together with good practice at interacting with other scientists (or other workers with data) on their statistical problems. This will be done by having the students take part in our consulting service. We expect our students to learn a great deal from this part of their degree work. Such a Statistical consulting service has been set up by many universities in Canada and the United States. It is recognized as a first class training ground for applied statisticians. (Incidentally, it also has many benefits to the University community at large).

d) Other universities also recognize this as a preferred method of training good applied statisticians, who will go out into industry, government, and research science positions of all kinds. For example, course work and no thesis is the accepted method of obtaining a Masters degree at the University of Toronto in Canada; Stanford University graduates at least twenty-five master's students in Statistics each year without a thesis; these students are statisticians who will not usually go on to do further academic research in Statistics. There are many other universities with similar programs.

It is also true that government (for example, Stats Canada), industry and business recognize that wide training plus practical experience with data is the necessity for a good statistician. The University of Waterloo in Canada enjoys a high reputation in these circles because it gives this type of training, even at the B.Sc. level.

e) Nowadays in Canada there is much stress laid, especially in high government circles, both federal and provincial, on the need for the country to develop high technology, and efficiency in its production. We cannot hope to do this without producing first class applied mathematicians and statisticians. The great centers of high technology in the United States, for example, draw extensively on the faculty and graduate students of such Universities as Harvard, MIT, Stanford and Berkeley. Provincially, the government is encouraging Discovery Parks near the Universities and Institutes of Technology. It is the Universities' job to rise to this challenge and to lead the way in producing men and women with the training to make them leaders in this field in Canada. (At present, when we do produce first class people, there is a tendency for them to emigrate). The situation is circular; first class people will produce first class technology, and first class technology will require people with first class training. We are trying to look ahead and meet the need by providing this training.

2) Enrolment

a) Evidence of student interest: our recent M.Sc. students have expressed their feelings that they would have preferred a heavier course content, over as much of the field of statistics as possible, rather than fewer courses with concentration in a thesis. On a wider scale, students (or graduates, a little later on) often express similar sentiments. There is, in fact, a continuing dialogue in the profession on how statisticians should be educated, with a broad consensus on the importance of applications, computer-methods, and practical consulting.

b & c) Present enrolments in M.Sc. programs in Statistics amount to roughly 4 new students per year. Initially this is expected to continue eventually rising to perhaps 10 per year. Since the program requires approximately two years to complete the total increase in enrollment will be 12 FTE's.

Please refer also to page 12 below titled Enrollment in New Courses.

d) Growth limits: Growth is limited primarily by availability of faculty to supervise the consulting service. It seems that an upper limit of 12 students per year ( or roughly 24 enrolled at any one time) is reasonable here. The limit is simply calculated as 4 students per faculty member at any one time; if we obtain new faculty this limit would rise.

We project a minimum enrolment of 10 students.

3) Types of Jobs for which graduates of this program will be suitable.

a) Statistics Canada, Department of Energy, Mines and Resources, and other

government agencies.

b) Corresponding Provincial Agencies.

c) Industrial jobs involving all levels of statistical analysis, e.g. managerial (sales, forecasting, trends, etc.) or related to field work - environmental, forestry, geostatistics, etc.

d) Medical Research Centres.

e) Data gathering centres such as the Cancer Control Agency of B.C.

f) Pharmaceutical companies (drug testing is a major source of employment of Statisticians)

g) The teaching profession **at all levels.**

4) Placements of our graduates over past three years.

a) Spinelli - Cancer Control Agency

b) Hutchinson - B.C. Tel., marketing

c) Holguin - Not known, now in Denmark

d) Byrd - Computing Centre at UBC; then in marketing in Ontario

e) Janicot - Research division, French Army

f) McLaren, Mah - to Ph.D. program

g) Note that several students are doing an M.Sc. while working - e.g. Chung in B.C. Systems Analysis.

IV. Present and Projected Resources

1) Administrative Personnel: No new administrative personnel will be required.

2) Faculty:

(i) To cover Stat 803, 804, 805 and Math 871 to be offered on a rotating basis (each course once every two years) we need 2/3 of a faculty member. In 83-84 we will be offering special topics versions of Math 871 and Stat 804. Initially we would hope to be able to start the program without a new faculty member by offering some reading courses. We have written our budget request on the basis of one faculty appointment in the Fall of 1984, at the Assistant Professor level.

(ii) The consulting courses can be mounted initially without any new faculty. In the long run, however, they will probably require 1 faculty member. We are not presently asking for faculty for this purpose. Our present consulting service is manned voluntarily by Statistics faculty who get no

formal credit; this situation is unlike that at most other universities and cannot be expected to continue indefinitely.

3) Library resources: No new resources needed. See the memo from E.A. Weinstein at the end of Appendix 1.

4) Capital Costs:

a) Office space: We will eventually need office space for 2 new faculty members and 12 new graduate students.

b) Computing costs: There will be no direct need for new computer services. However, the 2 new faculty members and 12 new graduate students would use the computer facilities in their courses, research and the consulting service. This probably represents only a small increase in total Mathematics Department computer usage.

5) Anticipated external funds:

a) for teaching: none.

b) for research: the 2 faculty members will be expected to have NSERC grants as usual. See below.

NSERC grants for present statistics faculty for 1984-85:

| NAME | AMOUNT OF GRANT |
|------|-----------------|
| Dr. D. Eaves | $ 4,295.00 |
| Dr. R. Lockhart | $ 4,295.00 |
| Dr. R. Routledge | $ 14,500.00 |
| Dr. M. Stephens (1983-84) (1984-85 - in process) | $ 19,381.00 |
| Prof. C. Villegas | $ 12,248.00 |
| Dr. K.L. Weldon | $ 5,777.00 |

Note: (Pages 9, 10, 11 on budget deleted).

# SIMON FRASER UNIVERSITY

## ENROLLMENT IN NEW COURSES

### M.SC. IN STATISTICS: PROJECT OPTION

| Year | Credit Units of New Courses | Annual FTE Enrollments in Program | Annual FTE Enrollment in New courses |
|------|------|------|------|
| 1984-85 | 8 | 4 | 2.3 |
| 1985-86 | 8 | 8 | 4.6 |
| 1986-87 | 8 | 8 | 4.6 |

NOTE:  The program normally lasts two years. A full time load is therefore 14 credit hours per year. The column Annual FTE Enrollments in New Courses is therefore calculated as (credit units of new courses / 14) x Annual FTE Enrollments in Program.  This calculation is based on Sections A-1, A-2, B-1, B-2 and B-3 of New and Emergent Programs:  Budget Submission Guidelines.

The figures presented here are based on a continuation of present enrollment levels of roughly four new students per year.  We hope enrollments will rise reasonably quickly to roughly 10 new students per year but have not included any such increase here.

Answers to Questions Posed in Draft Minutes of Meeting of Wednesday, May 25, 1983 of Assessment Committee for new Graduate Programs and Memo of Dr. Webster to Dr. Graham of 8/6/83.

NOTE: For reference a copy of Dr. Webster's memo follows these questions and answers.

1 Questions:

(a) The proposed programme should be consistent in using the word 'project' rather than 'non-thesis'.

(f) Identify more clearly the resources needed for offering the proposed new courses; how frequently are these courses to be offered?

(g) The proposed programme should be rewritten and repackaged in a style appropriate for presentation to Universities Council. In this form it will also be forwarded for external assessment.

(i) The need (and supporting data) for a more developed rationale about the demand for such a programme? What is the manpower projection for such a programme?

(m) Are any additional computing resources needed and if so when might they be needed, the cost and who is going to pay?

Also Points 2,3,4,5,9,10 of Dr. Webster's memo.

Reply: See proposal attached in UCBC format.

2 Questions:

(b) It is not clearly stated whether or not the project is to be formally defended and lodged in the Library.

(c) Does the project carry any credit hour value?

Also point #6 of Dr. Webster's memo.

Reply: Simon Fraser University general regulations (See 1983-1984 Calendar page 213 #1.7.2.; page 214 #1.9.1. and page 216 #1.10.6.) provide three acceptable options for Masters degrees: a thesis, two extended essays, or a project. Projects are less extensive than a thesis but are subject to the same general regulations. They must be examined as a thesis would be, supervised as a thesis would be, and lodged in the library as a thesis would be. We see our projects as not very different in style and scope from those for which we have served as external examiners in the Department of Economics. The general outline of our project option is similar to theirs with the exception of consulting. The project does not carry any credit hour value.

The project itself would generally consist of the thorough analysis of some data set, generally one encountered through the consulting service,

together with a written report on the analysis.

3 Questions:

(d)  Is the M.Sc. degree programme with project option designed so as to allow direct entry into a Ph.D. degree?

(e)  If the student wishes to pursue a Ph.D. degree following the 'project M.Sc.', is the student required to do any further course work?

(o)  How may the better than average student make the transition to a broad-based research Ph.D. degree without completing a regular Master's research degree?

Point #7 in Dr. Webster's memo.

Reply:          Students who have completed our M.Sc. degree will be well prepared to begin a Ph.D. program in Statistics either at Simon Fraser or elsewhere.    Those students seeking a theoretical Ph.D. would probably need to do coursework in Probability Theory and Real Analysis.

Students proceeding to a Ph.D. at Simon Fraser would certainly need to do extra coursework in Analysis and Probability to prepare them for departmental comprehensive examinations.

The reference in (o) above to "a regular Master's research degree" is not entirely relevant to the Department of Mathematics since in some cases Master's theses in this department presently contain little or no original research.

4 Questions:

(h)  How many students do they plan to admit?   What is the impact of this type of programme on the rest of the department and the relationship of the new programme with existing programmes.

Point #8 of Dr. Webster's memo.

Reply:   Our projected enrolment initially is:  5 students per year.    Refer to section III of the UCBC proposal.

The program will have no effect on the non-statistics part of the department except in so far as it increases enrolment in numerical analysis courses.    We expect virtually all of our new M.Sc. students in statistics will pursue the project option.    All our present students have expressed enthusiasm for the concept.    The high enrolment in the very practically oriented program at the University of Waterloo indicates the general popularity of such approaches.

5 Questions:

(j)  Request additional information about the programmes at other universities and whether or nor these institutions are fulfilling current needs.

Reply:  Please refer to section II.3 and section III.2 of the UCBC proposal.

6  Questions:

(k)  Request additional information about the current statistical consulting service the Department is presently doing.  Explain the relationship of this service to the two new consulting courses.

(1)  Give an enlarged course description for the consulting courses.

(s)  What is the difference between the two consulting courses?

(t)  Could the consulting courses be renamed 'internship' courses?

Point #11 in Dr. Webster's memo.

Reply:  The Mathematics Department presently offers a free statistical consulting service staffed by Statistics faculty.  It is available to faculty and graduate students throughout Simon Fraser wanting statistical advice concerning their research.

At present the service operates as follows.  Statistics faculty make themselves available for two hours per week - generally two faculty members at a time.  Clients drop in and get whatever advice they can.  They often come when it is too late,  but the big problem is lack of follow up.

We think that mandatory participation by students in the consulting service will provide some follow up.  Statistical faculty would still make themselves available for 2 hours per week (or more if the service were in great demand and the faculty could afford the time).  They would be accompanied by our students.  When clients drop in the problems will be discussed as usual but more sophisticated analyses would be considered.  The students would, under faculty supervision, seek out the literature and apply, with the client, better techniques.  We think this process benefits all three parties. Clients, students and faculty, perhaps to different degrees, learn about the difficulties of the data, about modern techniques and about the statistical literature.

We intend to grade the courses only on a Satisfactory/Unsatisfactory basis.

The consulting courses are named consulting courses rather than "internship" because "consulting" is the statistics "industry standard" term.  We have given two course numbers for consulting purely to enable the Office of the Registrar to record easily two semesters of participation in the service on a student's transcript.

7  Questions:

(n) It should be clearly stated that if a student has already taken MATH 875, 876, 877, the student may not take STAT 801, 802, or 890.

(p) Should there be a specifically stated Calendar entry?

(q) Greater consistency of course outlines is needed, in style and content. Generally, the course outlines are too brief.

Point #12 in Dr. Webster's memo.

Reply:   A revised calendar entry for Mathematics graduate programs is attached in Appendix II.   Revised course outlines appear in Appendix I.

8  Questions:

(r) Request up-to-date CV's of faculty members.

Reply:   Current CV's for Eaves, Lockhart, Routledge, Stephens, Villegas and Weldon are attached. (Appendix III)

9  Questions:

Point #13 of Dr. Webster's memo.

Reply: Applicants for this program will be processed by the Departmental Graduate Studies Committee as usual.

## MEMORANDUM

| | |
|---|---|
| To .... Dr. C. Graham, Chairman, .......... <br> ....... Mathematics Department ........... | From ..... John M. Webster .......... <br> ........ Dean of Graduate Studies .... |
| Subject.. M.Sc (Statistics) Proposal ....... | Date .......... June 8, 1983 .......... |

I write further to my memorandum of 31 May 1983 in which I gave you a list of comments on your proposed Statistics Programme in the form of the unapproved minutes of the first meeting of the Assessment Committee. As promised, I now write and provide you with further reflections on this programme. There will be some overlap of the comments made in this memorandum with those made earlier. On the other hand, the combination of the information in the two memoranda should give you a good indication as to the response of the Committee to your proposal.

I will present my points in point form to aid clarity.

1. My sense of the meeting was that the Committee members were very much in favour of the programme but they were somewhat concerned with the proposal as it now stands and they wanted it to be revised so as to incorporate several matters that will enhance the final product.

2. The basic impression was that the programme, as presented, was somewhat confused in its packaging in that it was difficult to extract the appropriate information in order to be able to answer the various questions that are likely to be raised by SCAP and Universities Council. I urge you, once again, to refer to the suggested outline for "new proposals" that I attached to my previous memorandum.

3. I suggest that amongst other things your proposal include three clearly identifiable main areas. First, the philosophy of the programme, second the nuts and bolts of curriculum design to resarch needs and, third, the calendar entry. Many of the comments I make below will automatically fall within one or other of these three areas.

4. You should make a compelling case for the need for this programme in view of current budgetary constraints in the Province. The proposal should readily appear as a "necessity" rather than "a nice to have" programme.

5. The resources required to offer this programme must be more clearly stated and not conflict in different parts of the proposal. If new courses are to be offered then where are the resources to give these new courses. Does this require increased manpower, or are we doing it by diminishing the course offerings in other areas? This in itself is a cost even though it may appear as a hidden cost. I suggest that you also consider computing costs as well as library, hardware and personnel costs. If you believe that there is an additional pressure on the Departmental Office then perhaps you should consider whether or not there is an additional cost in that area too.

6. Please clarify further the meaning of the term "non-thesis" degree. The question arose as to whether really it should be called a "project" degree. How close is this to an extended essay format; do you intend to type-up, bind and lodge the projects in the Library the same as occurs with extended essays; how long will the project take; what is the nature of the supervision; why are there no credits for the project; will the project be formally defended like a thesis?

7. I suggest that further consideration is given to clarifying the possible flow from an M.Sc. in this area into a Ph.D. programme. Is there a problem with transferring from an M.Sc. in Statistics into a Ph.D. programme? In other words what would the admission requirements be for entry into a Ph.D. after having taken this form of a master's degree.

8. It would be worth-while relating the programme to the area of interest and strengths in the Department. This no doubt would form part of the introduction and would clarify for outsiders and, indeed, for other members of the University the thrusts and directions within your Department. Furthermore, it would indicate how this new emphasis on the Master's degree would integrate with other programmes and strengths.

9. How large are the programmes in other universities. Do these programmes satisfy the needs for statisticians with a master's degree, if not why not? In other words, the fact that other universities do have this form of degree is no justification for us doing it also. On the contrary, it may be a good reason for us not putting forward this degree.

10. A forecast of enrolments in association with the comments made to the item above would be helpful, together with associated rationale. I fully understand that such figures would be guesstimates but, nevertheless, they would provide the Committee with samples of data from elsewhere and the line of thinking that the Department is using in preparation of the programme.

11. Please clarify the mode of operation of the Statistics Consulting courses. Will these operate as internships or are credits offered for these courses, and if so why two credits? Do individuals get paid for a consultation as well as obtaining credits? This may well be a conflict of interest. In what way does this consulting course differ from the current problem-solving consultation which already is offered by the Department?

12. There is a feeling in the Committee that the course description was rather inadequate and certainly inconsistent from one course to another, especially as regards to the description of the course content and the sample reading and general material. Some statement should be made on possible overlap of credits between courses if this occurs.

13. One final point that arose was the question of the organizational procedures to be used within the Department. In other words, will applicants for this programme be processed by the regular Departmental Graduate Committee just the same as applicants for other degree programmes within the Department.

I shall be very pleased to meet with you at our mutual convenience to discuss aspects of the above points and those made in the earlier memorandum. Best of luck in your initial deliberations. The Assessment Committee I am sure will look forward to seeing the rewritten application of the proposal.

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

## CALENDAR INFORMATION:

Department: MATHEMATICS          Course Number: MATH 871-4

Title: Applied Probability Models

Description: Applications of stochastic processes: Queues, inventories, counters, etc.  Reliability and life testing.  Point processes. Simulation.

Credit Hours:  4      Vector:  4-0-0      Prerequisite(s) if any:  Math 387 or equivalent

---

## ENROLMENT AND SCHEDULING:

Estimated Enrolment:  5    When will the course first be offered:  84-3

How often will the course be offered:  Every second year

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## JUSTIFICATION:    (see attached)

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## RESOURCES:

Which Faculty member will normally teach the course:  Lockhart, Weldon and others

What are the budgetary implications of mounting the course:  1/6 of a faculty member.

Are there sufficient Library resources (append details):  Yes, see attached.

Appended:  a)  Outline of the Course.
           b)  An indication of the competence of the Faculty member to give the course.
           c)  Library resources.

---

APPROVED:  Dept. Graduate Studies Ctte: _____  Date: _____

Faculty Grad. Studies Ctte: _____  Date: _____

Faculty: _____  Date: _____

Senate Grad. Studies Ctte: _____  Date: _____

Senate: _____  Date: _____

## COVERING MEMO CONCERNING MATH 871-4:    APPLIED PROBABILITY MODELS

### Justification:

This course is part of the proposed project option in Statistics.    The topics covered have broad application in such diverse areas as biology, epidemiology, demography, traffic engineering, quality control, astronomy and many others.    This breadth makes the course important and useful to practising statisticians.

### Competence of faculty members:

Dr. Lockhart has done and is doing research in this area.    Dr. Weldon has consulting and research experience in this area.    (Dr. Weldon has previously given a special topics course in this area.)

### Library Resources:

The library is well supplied with texts in this area and subscribes to all the major statistical journals.    See attached memo from E. A. Weinstein.

## MATHEMATICS 871-4

## APPLIED PROBABILITY MODELS

### Course Outline

Many processes which produce data are known to be probabilistic in nature - such processes are called stochastic processes. Examples are: the times at which clients are served in a bank, or by a telephone exchange; the time interval between arrivals of cosmic rays, or of events such as incidence of a disease or of earthquakes; the genesis and spread of cells; the locations of mineral deposits (spatial processes). This course covers the probabilistic analysis of such processes which produce data to be analyzed by statistical techniques. Specific processes and topics are:

1.  Review of basic results in probability and stochastic processes: random walks, Markov chains, simple queuing systems, Poisson processes, branching processes, birth and death processes.

2.  General queuing systems: inventories, storage, counters, traffic flow and other applications.

3.  Renewal processes: reliability, life testing, survival analysis.

4.  Sampling models in stochastic processes, e.g. applications to engineering and medicine.

5.  Point processes: in space in time; general theory and applications to biology, mining, geostatistics, astronomy, demography.

6.  Simulation techniques in exploring the properties of complicated models.


Suggested Text:   Ross, Sheldon M., Introduction to Probability Models. Academic Press, 1972.
This book will be supplemented by course notes in areas such as 5 and 6 above.

## SIMON FRASER UNIVERSITY

## New Graduate Course Proposal Form

**CALENDAR INFORMATION:**

**Department:** MATHEMATICS          **Course Number:** STAT 801-4

**Title:** Mathematical Statistics

**Description:** Advanced mathematical statistics.  A survey of basic concepts in point estimation, interval estimation and hypothesis testing.  Principles of inference.

**Credit Hours:** 4     **Vector:** 4-0-0     **Prerequisite(s) if any:** Students with credit for Math 875-4 may not receive credit for Stat 801-4.

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**ENROLMENT AND SCHEDULING:**

**Estimated Enrolment:** 5   **When will the course first be offered:** N/A

**How often will the course be offered:** Once a year

---

**JUSTIFICATION:**

This course is replacing MATH 875-4 (Statistics I).  This is a name change only.

---

**RESOURCES:**

**Which Faculty member will normally teach the course:** Eaves, Lockhart, Routledge, Stephens, Villegas & Weldon

**What are the budgetary implications of mounting the course:** None.

**Are there sufficient Library resources (append details):** Yes.  None needed.

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| APPROVED: | | Date: | |
|---|---|---|---|
| Dept. Graduate Studies Ctte: | _____ | Date: | _____ |
| Faculty Grad. Studies Ctte: | _____ | Date: | _____ |
| Faculty: | _____ | Date: | _____ |
| Senate Grad. Studies Ctte: | _____ | Date: | _____ |
| Senate: | _____ | Date: | _____ |

## SIMON FRASER UNIVERSITY

### New Graduate Course Proposal Form

## CALENDAR INFORMATION:

Department: MATHEMATICS                   Course Number: STAT 802-4

Title: Multivariate Analysis

Description: An advanced course in Multivariate Analysis.    Factor analysis, discriminant analysis, principal components, canonical correlations. Multivariate regression and analysis of variance.

Credit Hours: 4      Vector: 4-0-0        Prerequisite(s) if any:  Students with credit for Math 876-4 may not receive credit for Stat 802-4.

## ENROLMENT AND SCHEDULING:

Estimated Enrolment:  5    When will the course first be offered: N/A

How often will the course be offered:  Once a year

## JUSTIFICATION:

This course is replacing MATH 876-4 (Statistics II).    This is a name change only.

## RESOURCES:

Which Faculty member will normally teach the course:  Eaves, Lockhart, Routledge, Stephens, Villegas & Weldon

What are the budgetary implications of mounting the course:  None.

Are there sufficient Library resources (append details):  Yes.   None needed.

APPROVED:   Dept. Graduate Studies Ctte: _____  Date: _____

Faculty Grad. Studies Ctte: _____  Date: _____

Faculty: _____  Date: _____

Senate Grad. Studies Ctte: _____  Date: _____

Senate: _____  Date: _____

SIMON FRASER UNIVERSITY

## New Graduate Course Proposal Form

### CALENDAR INFORMATION:

Department: MATHEMATICS             Course Number: STAT 803-4

Title: Data Analysis

Description: A problem based course emphasizing the exploratory aspects of statistical analysis with emphasis on modern computer-oriented methods.

Credit Hours: 5     Vector: 4-0-0     Prerequisite(s) if any: Math 472 or equivalent or permission of the instructor

---

### ENROLMENT AND SCHEDULING:

Estimated Enrolment: 4     When will the course first be offered: 85-1

How often will the course be offered: Every second year

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### JUSTIFICATION:     (see attached)

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### RESOURCES:

Which Faculty member will normally teach the course: Weldon, Routledge & others.

What are the budgetary implications of mounting the course: 1/6 of a faculty member.

Are there sufficient Library resources (append details): Yes, see attached.

Appended:   a)   Outline of the Course.
            b)   An indication of the competence of the Faculty member to give the course.
            c)   Library resources.

---

APPROVED:   Dept. Graduate Studies Ctte: _____   Date: _____

            Faculty Grad. Studies Ctte: _____   Date: _____

            Faculty: _____   Date: _____

            Senate Grad. Studies Ctte: _____   Date: _____

            Senate: _____   Date: _____

:7.

## COVERING MEMO CONCERNING STAT 803-4:   DATA ANALYSIS

### Justification:

This course is part of the proposed project option in Statistics.   The course deals with modern techniques widely used in the initial exploration of large data sets.   Such data sets are now very common in the social sciences, medicine and other fields. · Exposure to the largely computer based techniques in this course is important to any practising statistician.

### Competence of Faculty Members:

Dr. Weldon has had extensive experience through consulting and research in this area.   This material is standard in the consulting experience and training of Dr. Routledge and other members of the statistics group.

### Library Resources:

The library is well supplied with texts in this area and subscribes to all the major statistical journals.   See attached memo from E. A. Weinstein.

## STATISTICS 803-4

## DATA ANALYSIS

## Course Outline

A striking revolution has occurred in Statistics with the arrival of the computer. Valuable methods of analysis were in the past not available because of lack of rapid computation. These methods, for example in analysing large quantities of data, or data which is multivariate, are now available. Also, new methods have been developed, which are computer intensive, for which the property can be found out by extensive computer analysis. Finally graphical methods are now developed for rapid assessment of data. Computer-oriented statistical analysis is the subject of this course. The intention is to bring the student to the forefront of modern methods of statistical analysis.

Specific topics are as follows:

1. **Reduction of dimensionality.** This is useful in simplifying the data set when the information content of several variables may be represented by values of only a few variables.

2. **Study of multivariate dependencies.** The main problem in this section is that of determining whether (and to what degree) two sets of variables carry any information in common.

3. **Multidimensional classification and clustering.** Classification is the allocation into describable categories of uncategorized items. Clustering is the determination of the existence and nature of categories that are previously unknown or unexpected in the group of items measured.

4. **Assessment of statistical models.** In this section the parametric models (and related estimation and hypothesis tests) that have been proposed for multivariate data are discussed, along with methods to check the applicability of such models in particular instances, and to improve the fit of such models when necessary.

5. **Summarization and exposure of multivariate data.** The emphasis here is on graphical methods of exploring multivariate data sets.

Suggested Text:     Tukey, J. W., _Exploratory Data Analysis._ Addison-Wesley, 1977

This text will be supplemented by course notes and journal articles.

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

## CALENDAR INFORMATION:

Department: MATHEMATICS          Course Number: STAT 804-4

Title:  Time Series Analysis

Description: An introduction to time series models and their analysis.  Both time-domain and frequency-domain techniques will be studied.

Credit Hours: 4      Vector: 4-0-0        Prerequisite(s) if any:  Math 472 or equivalent or permission of the instructor.

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## ENROLMENT AND SCHEDULING:

Estimated Enrolment: 5    When will the course first be offered: 85-3

How often will the course be offered:  Once every two years

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## JUSTIFICATION:

See attached memo.

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## RESOURCES:

Which Faculty member will normally teach the course:  Villegas, Routledge & others.

What are the budgetary implications of mounting the course:  1/6 of a faculty member.

Are there sufficient Library resources (append details):  Yes, see attached memo.

Appended:  a)  Outline of the Course.
           b)  An indication of the competence of the Faculty member to give the course.
           c)  Library resources.

---

APPROVED:  Dept. Graduate Studies Ctte: _____   Date: _____

Faculty Grad. Studies Ctte: _____   Date: _____

Faculty: _____   Date: _____

Senate Grad. Studies Ctte: _____   Date: _____

Senate: _____   Date: _____

## COVERING MEMO CONCERNING STAT 804-4:    TIME SERIES ANALYSIS

### Justification:

This is part of the proposed project option in Statistics.    This course studies techniques for analyzing observations on time-dependent processes. Such techniques have wide applicability.    Example of areas of application include the analysis of seismic data in geology, the search for patterns in the fluctuations in economic activity, and the study of periods in the vibrations of aircraft speeding down a runway.    Such breadth of applicability makes this an important part of statistics.

### Competence of Faculty Members:

Prof. Villegas is currently active in research in this area.    Dr. Routledge has worked on both theoretical and applied problems in time series. Time Series Analysis is an important part of the background of most members of the Statistics Group in the Department of Mathematics.

### Library Resources:

The library is well supplied with texts in this area and subscribes to all the major statistical journals.    See attached memo from E. A. Weinstein.

## TIME SERIES ANALYSIS

### Course Outline

A time series is a sequence of values (or a vector of values) occurring in time. Examples are the strengths of earthquake shocks at various times, the daily stock price of a commodity, the sales of airline tickets per month, the unemployment figures per quarter, etc. In analyzing such series a model is proposed, and the required parameters estimated. Testing the model is also very important. This course describes the historical approaches to finding the correct model, together with methods of analysis, and of predicting future values.

1.  The separation of trends, cycles and random perturbations in a time series. Moving averages and seasonal adjustment. The autocorrelation function; its estimation and interpretation.

2.  Models for time series data. Stationary processes, autoregressive-moving-average processes, Gaussian processes.

3.  Statistical inference on autoregressive-moving-average processes. Fitting a model to such a process. Regression analysis with serially correlated data.

4.  Introduction to spectral analysis and the search for cyclical fluctuations.

5.  Prediction and Control.


Suggested Text: Box, G.E.P. and Jenkins, G.M., Time Series Analysis: forecasting and control. Holden-Day 1976.

## SIMON FRASER UNIVERSITY

### New Graduate Course Proposal Form

**CALENDAR INFORMATION:**

**Department:** MATHEMATICS          **Course Number:** STAT 805-4

**Title:** Non-Parametric Statistics and Discrete Data Analysis

**Description:** Order statistics, rank statistics, procedures based on the empirical distribution function. Asymptotic efficiencies. Goodness-of-fit. Contingency tables, log-linear models. Further topics.

**Credit Hours:** 4     **Vector:** 4-0-0     **Prerequisite(s) if any:** Math 372 & Math 473 or equivalent or permission of the instructor.

---

**ENROLMENT AND SCHEDULING:**

**Estimated Enrolment:** 4   **When will the course first be offered:** 85-3

**How often will the course be offered:** Every second year

---

**JUSTIFICATION:**

See attached.

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**RESOURCES:**

**Which Faculty member will normally teach the course:** Stephens, Lockhart & others.

**What are the budgetary implications of mounting the course:** 1/6 of a faculty member.

**Are there sufficient Library resources (append details):** Yes, see attached.

**Appended:**
a) Outline of the Course.
b) An indication of the competence of the Faculty member to give the course.
c) Library resources.

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| APPROVED: | | Date: | |
|---|---|---|---|
| Dept. Graduate Studies Ctte: | _____ | Date: | _____ |
| Faculty Grad. Studies Ctte: | _____ | Date: | _____ |
| Faculty: | _____ | Date: | _____ |
| Senate Grad. Studies Ctte: | _____ | Date: | _____ |
| Senate: | _____ | Date: | _____ |

COVERING MEMO CONCERNING STAT 805-4:   NON-PARAMETRIC STATISTICS AND DISCRETE
DATA ANALYSIS.

## Justification:

This course is part of the proposed project option in Statistics.   Both
of the fields covered by this course are important to practising statis-
ticians.   Techniques in these areas are widely used - particularly in the
social sciences, management science, biology and medical research.

## Competence of faculty members:

Dr. Stephens has published numerous papers in this area and is an inter-
nationally recognized expert in the field of goodness-of-fit.   Dr. Lockhart
is currently working on problems in this area.   The material covered in this
course is standard in the backgrounds of all the members of the Statistics
Group in the Department of Mathematics.

## Library Resources:

The library is well supplied in this area and subscribes to all the major
statistical journals.   See attached memo from E. A. Weinstein.

STATISTICS 805-4

Non-parametric Statistics and Discrete Data Analysis

COURSE OUTLINE

Non-parametric statistics is the area of statistical analysis especially adapted to situation whenever the assumptions of classical statstical analysis are likely, or known, to be false; for example, the often-used assumption of normality, exponentiality, or independence may be relaxed. This field has been much developed in recent years, particularly with availability of computers. The ranks of the observations are often used, and the problems of distribution theory frequently become combinatoric. Another important area is model justification, that is, to decide if a model, classical or otherwise, appears justified by the data. This is the area of goodness-of-fit, also much developed in recent years. Thirdly, discrete data, usually based on counts, occurs often in statistics. A major tool is contingency tables, and there exist several techniques for modelling and analyzing such tasks. This course covers these three major topics.

Content:

1. Brief survey of undergraduate work in non-parametric statistics, the sign test, the Mann Whitney test.

2. Procedures based on ranks: the Wilcoxon rank sum test, the Wilcoxon signed rank test, Spearman correlation.

3. Distribution-free procedures and goodness-of-fit. Techniques based on the empirical distribution.

4. Other goodness-of-fit procedures: Chi-squared tests; regression tests.

5. Properties of the above procedures: Asymptotic efficiency, etc.

6. Contingency tables: exact tests and large sample approximations.

7. The log-linear model.

8. Logit, probit and normit analysis.

Suggested Texts:

Plackett, R.C., The Analysis of Categorical Data, 2nd ed. MacMillan, 1981.

Cox, D.R., The Analysis of Binary Data. Methuen, 1970.

Fienberg, Stephen E., The Analysis of Cross-classified categorical data. 2nd ed., MIT press, 1980.

D'Agostino, R. and Stephens, M.A., Goodness-of-fit Techniques. (To appear, Marcel Dekker).

Conover, W.J., Practical Non-parametric Statistics, Wiley, 1971.

# SIMON FRASER UNIVERSITY

## New Graduate Course Proposal Form

**CALENDAR INFORMATION:**

**Department:** MATHEMATICS          **Course Number:** STAT 811-0

**Title:** Statistical Consulting I

**Description:** Students will participate in the department statistical consulting service under the direction of faculty members.
    This course will be graded on a Satisfactory/Unsatisfactory basis.

**Credit Hours:** 0      **Vector:** 0-0-2      **Prerequisite(s) if any:** This course
                              is open to M.Sc. and Ph.D. students in Statistics.

---

**ENROLMENT AND SCHEDULING:**

**Estimated Enrolment:** 5    When will the course first be offered: 84-3, if
                                                                      possible

How often will the course be offered:  Every semester (3 times per year).
                                       Initially possibly only Fall & Spring

---

**JUSTIFICATION:**

    See covering memo.

---

**RESOURCES:**

Which Faculty member will normally teach the course:  Eaves, Lockhart,
Routledge, Stephens, Villegas & Weldon

What are the budgetary implications of mounting the course:  Initially none.
Eventually 1 faculty member will probably be required for STAT 811-0 and STAT
812-0 and generally to run the consulting service.

Are there sufficient Library resources (append details):  Yes, see attachment.

Appended:   a)   Outline of the Course.
            b)   An indication of the competence of the Faculty member to give
                 the course.
            c)   Library resources.

---

APPROVED:  Dept. Graduate Studies Ctte: _____  Date: _____

           Faculty Grad. Studies Ctte: _____  Date: _____

           Faculty: _____  Date: _____

           Senate Grad. Studies Ctte: _____  Date: _____

           Senate: _____  Date: _____

## COURSE PROPOSAL FOR STAT 811-0:   STATISTICAL CONSULTING I

### Justification:

Participation in a consulting service is an essential part of the training of a statistician.   This course is an integral part of the project option in statistics.

### Competence of Faculty Members:

Statistical consulting is an important part of any academic statistician's background.   All of the statisticians in the Mathematics Department have substantial experience of this type.   The statistics group has been running a consulting service for the university for several years now.

### Library Resources:

This course needs the same library resources academic statisticians need for their work at all times.   See attached memo from E. A. Weinstein.

# STATISTICS 811-0

## STATISTICAL CONSULTING I

### OUTLINE OF COURSE

Students will be expected to participate in the analysis of problems brought to the consulting service from start to finish. This means they will be present when problems are first brought in; they will help in the formalization of these problems and selection of appropriate techniques; they will carry out analyses and they will participate in the interpretation of the results. As they gain experience they will play larger and larger parts in the process. We expect that, in the second semester of consulting, they will find a problem suitable for the basis of the M.Sc. project.

SIMON FRASER UNIVERSITY

New Graduate Course Proposal Form

**CALENDAR INFORMATION:**

**Department:** MATHEMATICS          **Course Number:** STAT 812-0

**Title:** Statistical Consulting II

**Description:** Students will participate in the department statistical consulting service under the direction of faculty members. This course will be graded on a satisfactory/unsatisfactory basis.

**Credit Hours:** 0     **Vector:** 0-0-2       **Prerequisite(s) if any:** This course is open to M.Sc. and Ph.D. students in Statistics.

---

**ENROLMENT AND SCHEDULING:**

**Estimated Enrolment:** 5     **When will the course first be offered:** 85-1

**How often will the course be offered:** Every semester (3 times per year).
Initially possibly only Fall and Spring.

---

**JUSTIFICATION:**

See covering memo.

---

**RESOURCES:**

**Which Faculty member will normally teach the course:** Eaves, Lockhart, Routledge, Stephens, Villegas & Weldon

**What are the budgetary implications of mounting the course:** Initially none. Eventually 1 faculty member will probably be required for STAT 811-0 and STAT 812-0 and generally to run the Consulting Service.

**Are there sufficient Library resources (append details):** Yes, see attachment.

**Appended:**  a)  Outline of the Course.
b)  An indication of the competence of the Faculty member to give the course.
c)  Library resources.

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APPROVED:  Dept. Graduate Studies Ctte: _____  Date: _____

Faculty Grad. Studies Ctte: _____  Date: _____

Faculty: _____  Date: _____

Senate Grad. Studies Ctte: _____  Date: _____

Senate: _____  Date: _____

# COURSE PROPOSAL FOR STAT 812-0:   STATISTICAL CONSULTING II

## Justification:

Participation in a consulting service is an essential part of the training of a statistician.   This course is an integral part of the project option in statistics.

## Competence of Faculty Members:

Statistical consulting is an important part of any academic statistician's background.   All of the statisticians in the Mathematics Department have substantial experience of this type.   The statistics group has been running a consulting service for the university for several years now.

## Library Resources:

This course needs the same library resources academic statisticians need for their work at all times.   See attached memo from R. A. Weinstein.

## STATISTICS 812-0

## STATISTICAL CONSULTING II

## OUTLINE OF COURSE

Students will be expected to participate in the analysis of problems brought to the consulting service from start to finish.  This means they will be present when problems are first brought in;  they will help in the formalization of these problems and selection of appropriate techniques;  they will carry out analyses and they will participate in the interpretation of the results.  As they gain experience they will play larger and larger parts in the process.  We expect that, in the second semester of consulting, they will find a problem suitable for the basis of the M.Sc. project.

| To | Prof. J. F. Cochran | From | E. A. Weinstein |
|---|---|---|---|
| | Dean of Science | | Library - Sciences |
| Subject | Library Support for Applied Probability and Statistics | Date | 82/10/22 |
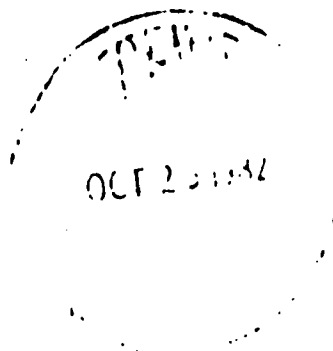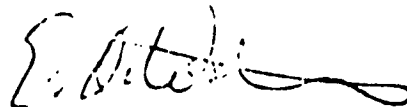
The proposed expanded graduate program in applied probability
and statistics consists of twelve (12) new course proposals.
I have examined these proposals and find no new areas of
research or teaching therein, but rather extensions of areas
of long-time standing at S.F.U.

The library collection in the areas of mathematical statistics,
probability and numerical analysis are currently complete and
have been for some years. The older literature in support of
our collection is readily available from U.B.C. and the National
Science Library. Absolutely no additional funds will be needed
by the Library in support of this program.

ah

c.c. Prof. C. Villegas
Dept. of Mathematics

**SIMON FRASER UNIVERSITY**

New Graduate Course Proposal Form

## CALENDAR INFORMATION:

Department: MATHEMATICS                Course Number: STAT 890-4

Title: Selected Topics in Statistics

Description:

Credit Hours: 4      Vector: 4-0-0      Prerequisite(s) if any: _____

## ENROLMENT AND SCHEDULING:

Estimated Enrolment: 5    When will the course first be offered: N/A

How often will the course be offered:  Once a year

## JUSTIFICATION:

This course is replacing MATH 877-4 (Statistics:  Selected Topics).

## RESOURCES:

Which Faculty member will normally teach the course:  Eaves, Lockhart,
Routledge, Stephens, Villegas & Weldon

What are the budgetary implications of mounting the course:  None.

Are there sufficient Library resources (append details):  Yes

Appended:  a)  Outline of the Course.
           b)  An indication of the competence of the Faculty member to give
               the course.
           c)  Library resources.

APPROVED:  Dept. Graduate Studies Ctte: _____  Date: _____

           Faculty Grad. Studies Ctte: _____  Date: _____

           Faculty: _____  Date: _____

           Senate Grad. Studies Ctte: _____  Date: _____

           Senate: _____  Date: _____

## DEGREE REQUIREMENTS

### M.SC. PROGRAM

A candidate for the M.Sc. degree will normally be required to obtain a total of at least 20 semester hours of credit for coursework beyond courses taken for the Bachelor's degree. Of these 20 hours, at least 12 are to be in graduate courses or graduate seminars, and the remaining 8 may be chosen from graduate courses or graduate seminars or 400-level undergraduate courses. He/she will also be required to submit a satisfactory thesis and to attend an oral examination based on that thesis and related topics.

### Project Option in Statistics

Students interested in pursuing an M.Sc. program in Statistics may follow a project option. The project option is intended to give students instruction in a wide range of statistical techniques and also to provide experience in the practical application of statistics. The program should be of interest to students who wish to acquire statistical expertise.

Students in the program will be required:

(i) To complete at least 28 semester hours of credit for coursework in Statistics and related fields beyond courses taken for the Bachelor's degree. Of these 28 hours, at least 20 are to be in graduate courses or graduate seminars, and the remaining 8 may be chosen from graduate courses or graduate seminars or 400-level undergraduate courses. Normally these courses will include STAT 801-4 (Mathematical Statistics), STAT 802-4 (Multivariate Analysis) and at least one of STAT 803-4 (Data Analysis), and STAT 804-4 (Time Series Analysis).

(ii) To complete satisfactorily STAT 811-0 (Statistical Consulting I) and STAT 812-0 (Statistical Consulting II).

(iii) To submit and defend successfully a project based on some problem of statistical analysis (as outlined in the GENERAL REGULATIONS). This problem will ordinarily arise out of the statistical consulting service.

Students with backgrounds in other disciplines, or with inadequate background in statistics, may be required to take certain undergraduate courses in the Department in addition to the above requirements.

### PH.D. PROGRAM

A candidate for the Ph.D. degree will generally be required to obtain at least 28 semester hours of credit for coursework beyond courses taken for the Bachelor's degree. Of these 28 hours, at least 16 are to be in graduate courses or graduate seminars or 400-level undergraduate courses. The course-

work in all cases will involve study in at least four different areas of Mathematics, at least one of these areas being in Analysis (Applied, Complex or Real). Applied Analysis is understood to include Differential and Integral Equations and Methods of Applied Mathematics.

Candidates for the Ph.D. degree will normally be required to pass a general examination. At the option of the candidate's Committee, this shall consist of either written papers in four areas of study, or written papers in three areas of study, and graduate coursework in an approved fourth area in which a grade of 'B' or higher is obtained. In either case, one of the written exam areas must be in Analysis (Applied, Complex or Real). A candidate ordinarily will not be allowed to take the general examination more than twice. Students will be interviewed and advised regarding appropriate courses and examination curricula. Course programs and examination programs require Departmental approval.

Students who have completed a Master's degree will normally be required to attempt the general examination within one year of their initial registration in the Ph.D. program.

A candidate for the Ph.D. may be required by his/her Supervisory Committee to acquire proficiency in reading mathematical papers in either French, German or Russian.

Students will be required to submit and successfully defend a thesis which will embody a significant contribution to mathematical knowledge.

For further information and regulations, refer to the General Regulations section (1).

January 26, 1984

Professor David Brillinger
Department of Statistics
University of California
Berkeley, California
U.S.A.
94720

Dear Professor Brillinger:

Thank you for agreeing to serve as an assessor of the proposed
M.Sc. Statistics Programme.

The honorarium paid by this University for such services is
$200. I enclose a copy of the proposal, a copy of the University
Graduate Regulations governing all graduate students at Simon
Fraser, and a description of the proposed programme.

The Assessment Committee would appreciate your frank comments
on the academic merit and suitability of the proposed programme.
Please include in your report answers to the following questions:

1. Is the available academic expertise (see attached curricula
   vitae) sufficient to implement the programme?

2. Do you think that graduates of the programme will be of quality
   comparable to those produced at the leading institutions in the
   field?

3. How large is the need for the graduates that this programme
   would produce and is it a continuing need?

4. Is the particular programme proposed likely to meet the stated
   objectives?

You should note that these questions are not meant to limit the
range of your comments in any way.

.....$/2$
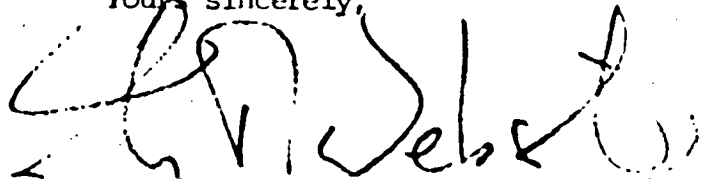
Furthermore, it would be most helpful if you could make, in
addition to your other comments, specific recommendations on
either the approval, modification, delay, or disapproval of the
programme.

Your report will be made available, upon request, to members
of the Committees and other governing bodies both within and without
the University that must approve the programme before it can be
implemented.

It would be appreciated if you could see your way to responding
within the next couple of weeks.

Yours sincerely,

John M. Webster, Associate Vice-
President, Academic, and Dean of
Graduate Studies.

JMW/dle
Attachments

TELEPHONE: (415) 642-2781
CABLE: UNIVCALB

DEPARTMENT OF STATISTICS
BERKELEY, CALIFORNIA 94720

29 February 1984

John M. Weber

Dean of Graduate Studies

Simon Fraser University
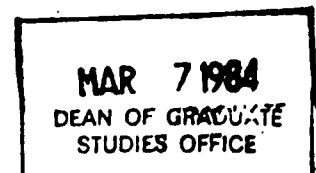
Burnaby, B.C.

Canada V5A 1S6

Dear Dean Weber,

Enclosed please find my assessment of the proposed M.Sc. Statistics Programme. I think that it is a fine programme, one likely to contribute measurably to the stock of statistical workers in your province and country.

Yours sincerely

David R. Brillinger

Professor

29 February 1984

## Assessment of Proposed M.Sc. Statistics Programme

## at Simon Fraser University

### David R. Brillinger

<u>The Proposal</u>. Cut to bare details this programme is seen to involve:

   i). 28 semester hours of coursework with at least 20 hours at the graduate

level,

   ii). participation in consulting course for two semesters,

   iii). submission and defence of a project, to be later lodged in the

Library,

   iv). residence for 4 semesters,

   v). early hiring of 2/3 faculty member,

   vi). later hiring of a further faculty member,

   vii). initiation of various new courses.

<u>Masters Degrees in Statistics</u>.  The M.A. and M.Sc. degrees in Statistics

have two fundamental roles: a) as preliminaries to doctoral work and b) as

terminal preparation for applied work. The doctoral work may be in Statistics,

or some other field such as Economics or Education. When a thesis or project

is involved, it is meant to lay the foundation for later independent work.

The students may be recent Bachelors or individuals with work experience

seeking further advanced training. Those obtaining the degree go on to
positions in education, industry, agriculture, government, health, business
and other professions.

## Comments on the Present Proposal

The programme under consideration has all the characteristics just
listed for masters degrees and in addition is innovative in several respects.
Its academic merit is high. It incorporates a close correlation between
theory and application as is vital for Statistics and recognises that good
work in applied statistics nearly always calls for more than mechanical
application of prepackaged methods. It recognises, further, that the amount
of statistics subject matter is now vast.

Answers to some questions:

1. "Is the available academic expertise ... sufficient ...?" The calibre
of the current faculty is fine and their areas of interest are appropriate.
The new courses would give the programme character. As indicated in the
proposal, these could be reading courses to begin; however early hiring
of a new faculty member (junior level) seems in order.

2. "... graduates ... quality comporable to ... leading institutions ...?"
Yes, because of the substantial personal attention and supervision they
would experience; however I make one proviso. I do not know how contemporary
computing facilities are at SFU — these days the leading institutions
produce graduates with real experience of statistical computing.

3. "... need for the graduates ...?" The demand for statisticians with
consulting and computing skills is dramatically high already and increasing
rapidly. Some of the fields have been listed above. Individuals with Masters

degrees are probably in greatest demand.

4. "... programme ... to meet the ... objectives?" Yes, providing the requested courses and staffing are approved.

### Recomondation

I recommend that the indicated programme be approved in its present form. In the attached Appendix, I indicate a few suggestions for consideration.

David R. Brillinger

Professor

## Appendix

I. I wonder if STAT 802 is the best choice for the compulsory course after STAT 801. Perhaps, a somewhat modified, STAT 803 would be better.

II. Perhaps credit should be given for STAT 811, 812. They will have S/U grades and so would not count towards the 20 required hours. Giving credit will allow other institutions to assess the amount of work involved, Ph.D. students might chose to attend, so too might students from other Departments. Further, consideration might be/~~paying~~ given to paying the students for their work here. (At Berkeley the Graduate Division does pay the students in a comparable course about $150. per semester. Further, at Berkeley the faculty member responsible for the course receives teaching credit for it.)

III. Perhaps I missed it, but I am not sure whether all the courses are meant to be those of the Mathematics Department. If outside department courses are to be allowed, I would suggest that it is imperative that any student's programme be approved in advance by the Graduate Advisor.

IV. It would appear that the enrolments in the every-other-year courses would be higher, as they could contain a mix of first and second year students.

V. I would expect the Consulting Service as well as providing educational opportunities for the students, to provide research motivation for the faculty. It will help students and faculty of many departments. It would be in SFU's interest to support it to the maximum extent possible.

# University of Waterloo

Waterloo, Ontario, Canada
N2L 3G1

Faculty of Mathematics
Department of Statistics
and Actuarial Science
519 885 1211

March 1, 1984

Professor John M. Webster
Dean of Graduate Studies
Simon Fraser University
Burnaby, B.C.   V5A 1S6

Dear Professor Webster:

     I have examined the proposal for an M.Sc. programme in Statistics with project option at Simon Fraser University.  In my opinion, this is a strong proposal which should be approved.  My report is enclosed.

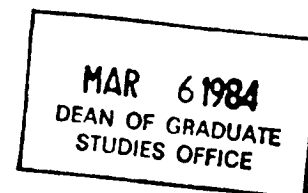     Please let me know if I can be of any further assistance.

Sincerely yours,

James G. Kalbfleisch
Professor

JGK:mk

Encl.

Report on the proposed

M.Sc. in Statistics – Project Option

Department of Mathematics

Simon Fraser University

Prepared by
James G. Kalbfleisch, Professor
Department of Statistics and Actuarial Science
University of Waterloo

March 1, 1984

# Report on M.Sc. in Statistics - Project Option

## General Comments

A successful applied statistician must have
    (1) basic mathematical skills so that theory can be understood and modified as necessary;
    (2) a thorough grounding in statistical principles and a wide variety of statistical methodologies;
    (3) familiarity with computers and their uses;
    (4) the ability to communicate effectively with clients, so that problems are properly formulated and results are communicated in the language of the client.
Beginning graduate students in Statistics are almost always deficient in areas (2) and (4), and depending upon their backgrounds, they may also require additional work in (1) and (3).

It is practically impossible to cover all of these areas in a masters programme which involves a substantial thesis and a limited amount of coursework. As a result, a coursework masters with project, such as that proposed at Simon Fraser, has become standard at many universities. It can be argued that this sort of programme is preferable even for those who will continue to the Ph.D. and an academic career, since they will undoubtedly be involved in consulting and service teaching to non-mathematicians.

At the University of Waterloo, we have about 20 masters students in Statistics. Almost without exception, they are advised to choose a coursework masters with project. The situation is similar at other Ontario universities with which I am familiar.

## Anwers to Dean Webster's Questions

(1) Is the available academic expertise sufficient to implement the programme?
Yes. Simon Fraser University is fortunate in having an active and well-qualified group of faculty members in Statistics. My only concern is with the extra workload which this programme will create. If this programme is approved, and I believe that it should be, then high priority should be given to hiring an additional faculty member in Statistics.

(2) Do you think that graduates of the programme will be of quality comparable to those produced at leading institutions in the field?
Yes. Given the quality of the faculty, the provision of hands-on consulting experience, and the variety of areas covered in the proposed course offerings, graduates will be well prepared for careers in government or industry, or for Ph.D. work in Statistics.

(3) How large is the need for graduates that this programme
    would produce and is it a continuing need?
Our experience at Waterloo has been that there is a strong
demand for Masters graduates in Statistics. A recent
manpower survey in the U.S. identified Statistics and
Computer Science as areas in which the projected number of
job openings at all levels greatly exceeds the expected
number of graduates. There is no reason to suppose that the
situation in Canada will differ markedly from that in the
U.S. Most of the job openings will be for graduates with
expertise in statistical applications and computing. This is
precisely the sort of graduate which the proposed programme
aims to produce.

(4) Is the particular programme proposed likely to meet
    the stated objectives?
Yes. Consulting experience plus courses such as Stat 803-4
and 804-4 will expose students to statistical applications
and give them a greater breadth of training. Preparation and
defence of the project will help them to develop important
communication skills.


## Recommendation

I strongly recommend that the proposed M.Sc. in Statistics
with project option be approved, and that high priority be
given to the hiring of an additional faculty member in
Statistics.


## Additional Comments

It is commendable that Statistics faculty members provide a
consulting service to the university community. Undoubtedly
they feel that it is worthwhile for their own professional
development as well as for the assistance it provides to
others on campus.

If graduate students are to be involved, it will be necessary
to formalize and further develop the consulting service, and
the consulting service is likely to develop into a major
activity of the Statistics group. They should receive
recognition, perhaps in the form of reduced teaching loads,
for providing this service. In addition, they should seek
funding for support staff from the University, and from
external agencies such as N.S.E.R.C.

James G. Kalbfleisch,
University of Waterloo,
March 1, 1984.

# The University of Western Ontario

Department of Statistical and Actuarial Sciences
Faculty of Science, Room 3005 EMSc
London, Canada
N6A 5B9

1984 02 23


Dr. John M. Webster
Associate Vice President, Academic
Office of the Dean of Graduate Studies
Simon Fraser University
Burnaby, B. C.
V5A 1S6

Dear Dr. Webster:

I am enclosing my assessment of the M.Sc. Statistics Program: Statistics
Option proposed by the Department of Mathematics. My assessment is that
the plan is timely and that the faculty, particularly augmented as
suggested in the proposal, is entirely suitable and certainly capable of
implementing this program.

I would be most pleased to respond to a request if it was felt that I
could provide further information.

Cordially yours,

Ian B. MacNeill
Professor and Chairman

:j

A Critique Of The Proposal For

Master of Science in Statistics:

Project Option

Submitted by the

Department of Mathematics
Simon Fraser University

February 20, 1984

Ian B. MacNeill
Chairman and Professor
Department of Statistical
    and Actuarial Sciences
and Director of Statlab
University of Western Ontario

I PROPOSAL

The statisticians in the Department of Mathematics propose a new M.Sc. program in Statistics differing from the traditional in two respects; first, more course work is to be required; and second, in place of writing a thesis, a project is to be carried out analysing data acquired under the aegis of the statistical consulting service (SCS). It is expected that graduates from this program will possess skills useful in many fields.

II ASSESSMENT (Answers to questions posed in the letter accompanying the appraisal documentation).

Q. Is the available academic expertise sufficient to implement the program?

A. The statistical group at SFU is very capable, and is recognized as such by the NSERC Operating Grants Committee. They possess fine publication records, and have demonstrated substantial interest and ability in the application of statistical methodology. The group possesses expertise in the area of statistical computing. Additional strength in the area of sample survey design and analysis might be provided in future additions to the faculty complement.

Q. Do you think the graduates of the program will be of quality comparable to those produced at the leading institutions in the field?

A. Students graduating from this program will have been exposed to the kind of training being required widely by employers of statisticians; provided admission standards are suitably high, the quality of the graduates should be more than competitive. Employers are asking for demonstrated ability to apply statistics and to use the growing array of statistical software. If such a program is not instituted, SFU may have difficulty attracting students to their MSc programs in statistics.

Q. How large is the need for the graduates that this program would produce and is it a continuing need?

A. It is my assessment that there is a large and growing need for masters-level graduates with both interest and aptitude for applications and with computing ability.

Q. Is the program likely to meet the stated objectives?

A. The stated objective is, "to provide an alternative training plan for Master's students in Statistics...". This objective certainly will be met. However, implicit in the proposal is the objective of training students who will be effective applied statisticians

capable of independent work in a variety of fields. It is my assessment that the program is highly likely to achieve this objective provided the quality of the students drafted into the program is high, and provided the flow of projects into the SCS is sufficient to permit each student to work on a meaningful project. The latter point may be a major problem if the enrolment stated on page 6 materializes because it is likely that only a fraction of the projects coming to the SCS will be suitable as MSc projects.

## III  DISCUSSION

### A. Rationale

The proposal makes the case that the approach to Masters-level graduate education typically followed in Mathematics Departments may not always be appropriate for training statisticians. This is so since statistics is a discipline with unique character among the mathematical sciences, the uniqueness being determined by the role statistics can play in scientific inference. In fact, many of the early contributors to statistical methodology, including Fisher and Youden, were active participants in the process of scientific inference. The route to statistics through the world of mathematical deduction does not fit into this tradition. Anyone who has taught science students knows that for them concrete examples provide much clearer "proof" than abstract arguments. This is simply a reflection of the fact that experimental verification is the scientist's route to the truth. Thus, the science student is not generally disturbed by the fact only one of a number of cases has been settled, because that is how science often advances. The mathematician, however, has less concern with the slow unfolding of imperfect knowledge and is less interested in the untidiness of scientific reality than is a statistician. Although this dichotomy is somewhat of an oversimplification, it illustrates a source of much missed communication between the scientist and either the mathematician or the statistician who emerges from a mathematical milieu. Students of statistics often need to be reminded of the role of statistics and statisticians in science; they should think of themselves as statistical scientists rather than as mathematicians. Indeed, statistics provides philosophical bases and the technology of the scientific method, and has found application in many new scientific fields, with the consequence that statistics has become, within relatively recent times, the matrix in which are set the biological, social and, to a certain extent, the physical and engineering sciences.

Part of the reason for this proliferation of the use of statistical models has been the availability of increasingly sophisticated computing hardware and software. Without access to the appropriate computing resources, certain statistical tools, such as spectral methods for time series and graphical methods for multi-variate data, could be studied only in the abstract. Modern computing facilities now make routine what was once a curio.

## B. Statistical Consulting Service

To be effective, the proposed M.Sc. program must have available a good source of real statistical projects. I believe this will be accomplished by providing consistent and effective service in the areas of statistical consulting and statistical computing. This requires extensive facilities, operated by well-trained and experienced staff, and effectively organized so that clients may be dealt with in a business-like fashion. I have noted at Western that it is not sufficient to be able only to provide to clients the experimental design at the beginning of a study and the statistical analysis of the data at the end. If one is unable to provide data-management resources in the interstices between design and analysis one may never see the client, either for design or for analysis; instead he may go to the computing specialist who can give advice on database management systems but who then may lead the client up some rather exotic path which, often as not, terminates in an expensive set of data which cannot be analysed to answer the questions originally posed. Important roles that the consulting service operated by the statistician at SFU can serve are discussed below.

### 1. Statistical Computing

The SCS can participate in the management of the interface between statistics and computing. It can ensure that good statistical software developed elsewhere will be purchased and implemented on your systems. When need for a specific piece of software arises, and none is available commercially, it can press for local development. The SCS has, I believe, qualified staff who can evaluate the algorithmic and mathematical performance of statistical packages and subroutines. The SCS should ensure that database management systems are available for the benefit of research studies that produce large amounts of data.

The computing activities of the SCS will benefit graduate and senior undergraduate students who, through their association with SCS, will develop expertise in computing as it applies to statistics. The statisticians have recognized that such expertise will be required of all who graduate from their M.Sc. program. Statisticians with such skills are presently in short supply.

2. ## Statistical Consulting

The major objective of SCS is the provision of a statistical consulting service for researchers at SFU. Experience shows that consultations can vary greatly in length and complexity, from a one-hour discussion of basic statistical concepts, to a collaborative research project. Furthermore, many kinds of expertise can be called for in consulting work; there may be demand for knowledgeable advice in such diverse areas as: design and analysis of experiments, non-parametric methods, regression analysis, sample survey design and analysis, time series analysis and multivariate analysis. Also, associated problems of data management may arise. It should be the ultimate aim of the SC and the SCS to accommodate this entire range, to the extent that resources permit.

Coping with such a range of problems is beyond the scope of any single individual. A client should have available to him the services of a well-balanced team; it is important that a sample survey expert should design surveys, and that an expert in the design and analysis of experiments should give advice in such matters. It is also important that a consultant be backed-up by other statisticians to whom he can turn for advice when difficult matters arise. Another requirement is that good statistical software and advice on the computer-processing of large data sets be available to the consultant. In addition, it is helpful if good support staff is available to handle the routine aspects of consultations.

A SCS consultant can be backed-up by the faculty members whose interests and abilities cover the main areas of specialization in statistics and statistical computing. In addition, these statisticians have the depth of training and experience to enable them to fill lacunae in their coverage. Also, these statisticians are aware of developments on the national and

international statistics and statistical computing scenes. Each has connections with the outside statistical community which enables him to obtain second opinions on almost any matter concerning statistics and statistical computing. It would be a difficult and expensive matter to duplicate this expertise and these connections.

According to the proposal, statistical consulting and statistical computing will be considered part of the training of M.Sc. students in Statistics, which suggests each graduate student will be asked to participate in the consulting and computing aspects of SCS. This can serve a dual role. First, students can be placed in an excellent learning environment. They can observe experienced consultants at work, thus gaining, firsthand, knowledge that is difficult to come by in any other way. Also they can learn to use the computer to analyze large data sets by working on problems requiring this knowledge and by having specialists close at hand who can give cogent advice when required. The second benefit to accrue from having graduate students exposed to the consulting program is that they themselves can contribute to the program. In the beginning, before much learning has taken place, they can do necessary but routine jobs that otherwise would take up the time of experienced consultants. Later, as the graduate students gain confidence and experience, they can be asked to assume greater responsibilities in consultations. By graduation they should be competent consultants in their own right.

## C. Financial Considerations

The discussion above implies that as the SCS evolves it may acquire more resources. I have several suggestions as to how these acquisitions may be financed. First, the SCS might apply for a NSERC Infrastructure Grant. Given the high quality of the statistical faculty and their applied interests, it seems entirely reasonable that such an application should be successful. Also, the SCS might consider applying for NSERC equipment grants to purchase such computing equipment as may not likely be available in a mathematics department; in particular I have in mind graphics equipment. Another source of funds is the clients themselves. At Western we try to charge all clients for consulting

time of faculty, staff and graduate students. Our experience is that most clients have research funds that allow for such costs. Furthermore, graduate students who come for assistance from other departments usually have supervisors with financial resources sufficient to pay for the required assistance. However, we do not charge for initial consultations, and anyone who cannot afford our rates is provided nevertheless with service to the best of our abilities. We find that advice and work that is paid for often is better appreciated than that which is obtained free. It is my belief that statisticians in the SCS should not be modest about charging for their consulting services; what they have to offer is valuable, and the funds generated can be helpful in embellishing their programs.

## IV  Further Comments and Questions

1. The proposed new courses are important. However, it is not clear to me where students will obtain instruction in sample surveys, experimental design, and regression methods. I assume statistical computing will be a significant part of Stat 811-0 and Stat 812-0.

2. Other courses which could be considered for addition to the program are: quality assurance sciences; survival analysis; forecasting; and operational research methods.

3. Will projects involve software development and/or implementation? Such projects can have residual benefits for the SCS.

4. Will students be exposed to database management systems and to statistical computer graphics methods? Such exposure will be valuable for job-seeking purposes.

5. Taking students into the MSc program from such fields as Economics and Biology is commendable (see page 5). It might prove to be necessary to have them take a make-up semester to avoid unnecessary attrition in the probability and mathematical statistics courses.