Flash Update from the Rochester Task Force of the AMS

March 28, 1996

The mathematics graduate program has been restored at Rochester!

We congratulate President Jackson and the mathematics department. We also now need to get the story out to the mathematics community, to university administrators, and to the public in a constructive way.

We applaud the Rochester plan to upgrade mathematics at Rochester at all levels.

Arthur Jaffe
Chair of the Rochester Task Force

I append the following Press Release from the University of Rochester:

ROCHESTER ENHANCING MATH PROGRAMS

The University of Rochester's mathematics department will implement a comprehensive proposal jointly developed by the administration and key faculty in the department, with input from leaders in other departments as well.

The mathematics faculty has agreed to a sweeping review of the courses it offers to undergraduates not majoring in mathematics, and of the department's linkages with the research specialties of faculty in other departments.

The department also will develop a new Ph.D. program in mathematics. Last November, the program was suspended and the projected faculty size was slated for a significant reduction.

The new proposal is enabled in part by resources provided by the Department of Physics and Astronomy, which will contribute through future joint appointments with mathematics.

President Thomas H. Jackson said that the new arrangement, crafted in discussions among key faculty in the math department, other departments (notably Physics and Astronomy), and the administration, meets both the financial and instructional quality goals outlined in the "Renaissance Plan" for the College, announced last November.

The five-year plan strengthens and refocuses core programs in arts, sciences, and engineering. With the entire array of undergraduate programs retained, the plan calls for a smaller, more selective student body, new investments in campus facilities and residential life, and a renewed dedication to the core principles of the goals of the College, as exemplified in the College's new curriculum.

"I am happy to say that the Renaissance Plan led to a series of unprecedented conversations between math faculty and the administration, and between math faculty and their colleagues in other departments," Jackson said. "That, in turn, led to the Department of Physics and Astronomy's offer to promote linkages by joint appointments, and a new dedication on the part of the mathematics faculty to strengthen undergraduate instruction and their ties to other departments, in concert with all of our other efforts."

"The mathematics department fully supports this plan," said Joseph Neisendorfer, department chair. "It provides both an opportunity and a challenge to the mathematics department. We are enthusiastic about the prospect of introducing some significant innovations which promise to diversify and enhance the undergraduate experience in mathematics. I am grateful that the administration has provided us with the opportunity to do this within the context of a graduate program of high quality."

"This is an important development for the University," added mathematics professor Douglas Ravenel. "I am glad to see it is renewing its commitment to mathematics, a subject lying at the heart of modern science. Excellence in math at all levels is a vital asset for any research university."

The new proposal includes the following key developments:

*Faculty in the Department of Physics and Astronomy have agreed to two future joint appointments with the Department of Mathematics. This effectively provides funding for one additional position to the mathematics department, as well as promoting tangible linkages between these fields.

*Mathematics faculty have offered to develop a plan for a smaller, high quality Ph.D. program, which they could operate with a reduced number of faculty. (The Renaissance Plan had called for the number of tenure-track mathematics faculty to decline from 21 to 10, with the ultimate addition of four to five non-tenure track faculty to teach undergraduate mathematics courses for non-math majors. Under the new proposal, the mathematics departmental size would be set at an ultimate target of 15 tenure-track faculty members and there would be no hiring of non-tenure track faculty for instructional purposes.) The new Ph.D. program is to be planned out during the next six months and would be available to doctoral students in the fall of 1997.

*Mathematics faculty have agreed to form a committee to work with other departments on improving the teaching of undergraduate mathematics, especially calculus, for non-math majors.

*The mathematics department has elected a new chair, Douglas Ravenel, who is charged with implementing the instructional program and the renewed linkages with other departments.

"This is a solution that fully meets the goals of the Renaissance Plan -- the bottom line, as before, is that we will increase the quality of our programs within our overall budget targets -- and, obviously, it is a happier solution for the mathematics faculty," Jackson said. "It will add luster to our undergraduate program and work to enhance intellectual cooperation across disciplines while implementing a Ph.D. program of

distinction. I am pleased that their active cooperation --and that of the Physics and Astronomy Department -- now enables us to move forward in this direction."

He said that Charles E. Phelps, University provost, and Richard N. Aslin, vice provost and dean of the College, have also endorsed the new proposal, as has the Executive Committee of the University's Board.

BackGround Information

In mid-November, 1995, the University of Rochester announced it would terminate its graduate program in mathematics and reduce the size of its mathematics faculty from 21 to 10. These actions were part of a plan to restructure the university in order to address its serious financial problems. Three other graduate programs at Rochester were suspended, and overall the faculty will be cut by 10%. Calculus is to be taught largely by nontenured adjuncts and by faculty from other departments.

In December, the AMS sent a fact-finding committee to Rochester to talk to members of the mathematics department, faculty in other departments, and administrators. What follows is the report of the committee, which includes an appendix containing a report by the Rochester mathematics department.

Dozens of mathematicians and prominent researchers in other areas of science have written to the university administration urging them to reconsider their plans for the mathematics department. A number of mathematics departments in other institutions have passed resolutions protesting Rochester's decision. President Cathleen Morawetz has appointed a high-level Task Force to study the situation and recommend further AMS actions.

(Managing Editor's Note: Appendix 1 and Appendix 2 were made available by scanning paper originals, and in some cases this introduced minor typographical errors. However, those errors do not compromise the accuracy of this reproduction of these documents and should not impair readers' ability to understand them.)

The University of Rochester Department of Mathematics Page.

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President Morawetz's Letters To Rochester Administration

November 27, 1995

Dr. Thomas Jackson, President
University of Rochester
Rochester, NY 14627

Dear Dr. Jackson:

I write as President of the American Mathematical Society to let you know that the mathematics community has been alarmed by the precipitous change of direction with regard to the mathematics programs at your institution.

I have, therefore, formed an ad hoc committee of the Society consisting of Professor Ronald Douglas of SUNY-Stony Brook and Professor Salah Baouendi of the University of California-San Diego. Professor Douglas (rdouglas@sunysb.edu) is Chair of our Policy Committee on Education, and Professor Baouendi (sbaouendi@ucsd.edu) is Chair of our Policy Committee on the Profession.

It is my hope that they will be able to visit your mathematics department and make contact with your administration, in particular, with the Provost and the Dean of the college.

I hope that such a visit can reassure the mathematics community that extraordinary conditions have made it necessary for your university to take such drastic measures as were outlined in Dr. Aslin�s report.

I am sure that the American Mathematical Society can provide help in this unusual situation.

Yours sincerely,

Cathleen Synge Morawetz

CSM:sjr cc: Dr. Richard Aslin, Vice Provost and Dean Professor M. Salah Baouendi Professor Ronald Douglas Professor Robert M. Fossum, AMS Secretary Professor Joseph Neisendorfer, Chair-Dept. of Math. Dr. Charles P helps, Provost

December 4, 1995

Dr. Thomas Jackson, President
University of Rochester
Administration 240
Rochester, NY 14627

Dear President Jackson:

I am very happy to hear that an ad hoc committee of the American Mathematical Society will, on December 6, be visiting the Provost and Dean as well as the Department of Mathematics at your University in connection with recent measures taken with your mathematics program.

We hope that this committee will also meet with you. I have added Morton Lowengrub to the AMS ad hoc committee. Mort is the former Chair of Mathematics at Indiana University and is presently Dean of the College of Arts and Sciences, and is also Chair of the AMS Task Force on Excellence in Mathematics Scholarship.

We would like in every way to be of assistance to the University of Rochester, which has such an excellent tradition and reputation, and to help it in its plans for the future.

Yours sincerely,

Cathleen Synge Morawetz

CSM:sjr cc: Dr. Richard Aslin, Vice Provost and Dean Professor M. Salah Baouendi Professor Ronald Douglas Professor Robert M. Fossum, AMS Secretary Dean Morton Lowengrub Professor Joseph Neisendorfer, Chair-Dept. of Math. Dr. Charles Phelps, Provost

Report of the Rochester Fact Finding Ad Hoc Committee Submitted to AMS President Cathleen Morawetz

December 11, 1995

The committee visited the University of Rochester (UR) on December 6, 1995. The committee met with Dr. Richard N. Aslin, Vice Provost and Dean of the College, for more than two hours. A second meeting took place with Dr. Thomas H. Jackson, President, and Dr. Charles E. Phelps, Provost. The committee also met with the Chair of the Mathematics Department, Professor Joseph A. Neisendorfer, as well as with a substantial number of the Mathematics faculty at UR. Finally, the committee met briefly with four other faculty members selected by the Mathematics Department: Professors Martin Feinberg (Chemical Engineering), Lionel Mckenzie (Economics), Sarada Rajeev (Physics), and Robert Waag (Electrical Engineering).

The committee was informed by the Administration that, in the face of severe financial problems, the University had decided to downsize its programs, and to focus more on undergraduate rather than on graduate education. UR hopes to reduce its deficit and, at the same time, increase the quality of its undergraduate students. UR will reduce its undergraduate student body by about 20%, to a total of 3,600. It will cut the size of its faculty by about 10% from its present total of 343 faculty members.

The committee was informed that, in deciding what graduate programs to downsize or suspend, the Administration did not rely on any external review. The Administration conducted an internal evaluation of the Ph.D. programs, and relied on the NRC poll and the U.S. News and World Report survey. The decision also was based on the appeal of UR research programs to undergraduate students and their parents. The Administration said that the faculty had been told about the financial situation for several years. It is the committee's understanding that the faculty were told at the start of the internal review process, at least a year ago, that the review would result in the suspension of some graduate programs and the downsizing of others.

Between June and August 1995, the Provost and the Dean met individually with 75 faculty members, three from each department. Each department was represented by its chair, a faculty member chosen by the chair, and another member elected by the faculty of that department. The representatives of the Mathematics Department were asked some questions about the strength of their programs and how to evaluate them. In particular, the Chair reported to us that he was asked about the process that should be used to assess the quality of the Mathematics Department. The Chair's response was that an outside review would be the only effective way to conduct such an evaluation. The Mathematics Department representatives also were asked questions about "linkages" between their programs and other departments at UR, and about the employment opportunities available to their graduate students. Our committee was told that during these meetings there was no indication that the graduate program in Mathematics might be eliminated. At the Administration's request, the Chair filled out a planning and self-evaluation questionnaire. The topics covered in this questionnaire were student satisfaction, research strength, staffing needs, etc. The Chair also was asked about the need for new faculty and the benefit that such new faculty would have on the Mathematics program. The Administration informed the committee that the decision to suspend the Mathematics

graduate program was based on the internal evaluation, the NRC rankings, the teaching effectiveness of the Department, and the relevance of the Mathematics graduate program to other programs in the University.

The Administration met with all the department chairs on November 16, 1995 and announced the specifics of the suspension of four graduate programs and the downsizing of others. A 15-page document (Appendix 1: Rationale for the restructuring plan) signed by the Dean was given to the chairs at the meeting. The Chair of the Mathematics Department was informed of the suspension of his department's graduate program in a telephone call from the Dean, less than an hour before the meeting.

The committee was given a document (Appendix 3) prepared by the Mathematics Department dated December 5, 1995, with relevant departmental data, as well as a rebuttal of the Administration's criticism of the Department.

Quality of the Research of the Mathematics Department

UR officials do not believe that the Mathematics Department at UR is a very strong one (although they acknowledge some strength in algebraic topology). The committee has failed to convince the President and his administration that the UR Mathematics Department is indeed very strong in several areas. It seems that the Administration's opinion is solely based on the NRC survey. (The Department is ranked 58 1/2 in the NRC rankings, which is somewhat lower than most of the other UR science departments.) In reference to the perceived low ranking in the NRC report, the President noted that "600 mathematicians had disagreed" with the committee conclusions regarding the quality of the department. The committee pointed out to the Administration that the federal support in grants received by the Mathematics faculty is very respectable, indeed, comparable to much more highly ranked mathematics departments. (Sixty percent of the Mathematics faculty are supported by external grants.) Although the Administration representatives acknowledged that the support is good for a mathematics department, they indicated that the total dollar amount is small.

Teaching

Profile provided to the committee by the Mathematics Department:

- 21 tenured faculty, 1 nontenure-track member.
- Enrollment: Spring '95, 3,920 credit hours (976 students); Fall '95, 4,936 credit hours (1,271 students).

- Undergraduate Mathematics degrees: Average over the past five years, 32 degrees per year.

  Graduate students: 31 students this year, down from 40 students six years ago. 37 Ph.D. degrees granted from 1989 to 1995.

The committee found a serious difference of opinions between the Administration and the Department in the area of teaching effectiveness. The Administration believes that the Department has not been doing a satisfactory job in teaching, particularly in the calculus and service courses. The Administration reported to the committee serious complaints from both students and other departments. They believe the Department has been aware of these repeated complaints and has been insensitive to them. They also mentioned that the Department has been insensitive to the issue of non-native speakers. The Department, however, contends that the Administration has rarely communicated to it any student complaints. In fact, the current Chair says he has not heard any such complaint during his tenure--now about 18 months. (He received one complaint from a parent and dealt with it immediately). In 1993, a Mathematics Task Force (MTF) was formed to revise the teaching of calculus. The MTF has been chaired by the undergraduate dean, with representatives from the Mathematics and the Physics departments, as well as some Engineering departments. The Administration reported to the committee that the Mathematics Department was uncooperative during these meetings. The Department reported that Mechanical Engineering faculty were concerned about their declining enrollments and decided to teach some calculus courses themselves, despite the objection of the mathematicians. The Mathematics Department contends that their student teaching evaluations are comparable to the average (and sometimes above the average) of other science departments (see Appendix 3). Moreover, student evaluations of classes taught by Mathematics graduate students have been substantially above average. It also was noted that one of the Department's international graduate students recently received a University teaching award.

Linkages with Other Departments

The Administration believes that the linkage of the Mathematics research and graduate program to the rest of the University is very limited. The President noted that, for instance, algebraic topology (one of the areas of strength in the Mathematics Department) has no connections to the other disciplines at UR. The Administration told us that there was no strong objection to the suspension of the Mathematics graduate program from other departments. The Provost mentioned that other departments were dissatisfied with the teaching of calculus and other mathematics service courses. He said that after the decision to suspend the Mathematics graduate program was announced, a chair of another department told him: "Great, you fixed the math problem." The Provost also reported to the committee that the Administration "tapped into student e-mail" and found out that "students were cheering" the Administration's decision to suspend the Mathematics graduate program and reorganize (improve, from the Administration's perspective) the teaching of calculus.

The Mathematics Department contends that there have been several collaborations with faculty in other UR departments resulting in joint papers or successful grant applications. For instance the fruitful collaboration

between Professor Adrian Nachman (Mathematics) and Professor Robert Waag (Electrical Engineering) on ultrasonic imaging of the breast has had an impact on researchers in the UR medical school. This is not an isolated collaboration; there have been others involving mathematicians with engineers, physicists, and economists. There have been many instances of consultations of Mathematics faculty resulting in acknowledgments in published papers by faculty from other departments. The committee was told that it is not unusual for graduate students and faculty from other departments (e.g. Economics, Physics, CS, Statistics, Mechanical Engineering) to attend graduate Mathematics courses.

It should be mentioned that the Administration called for faculty support for the UR "Renaissance Plan." The following statement can be found in Appendix 2: "We wish to make clear that in the new College environment resources will flow more generously to those departments which succeed best in supporting the overall goal of the Renaissance plan..." The committee believes that such a statement makes it difficult for a faculty member from another department to criticize the Administration's decision with regard to Mathematics. It should also be noted that the four non-Mathematics faculty members with whom we met expressed strong support for the graduate and research programs in Mathematics; they also expressed their frustration and unhappiness with the suspension of the Mathematics graduate program.

The Administration's Future Plan

The committee was told that the Administration is planning to reduce the Mathematics faculty from 21 to 10, and wants to keep a strong undergraduate mathematics major. About half of the calculus teaching will be done by full-time non-tenure-track teaching instructors. The Dean indicated to the committee that the Administration would expect a total of 40 courses per year taught by the 10 remaining faculty. He said that 20 of these would be at the upper undergraduate level, 10 at the first-year graduate level, and 10 involving the teaching of calculus. The Administration acknowledges the likelihood that the best Mathematics faculty will leave. The Administration is planning to offer an inducement for early retirement in the near future.

During our conversation with the Engineering faculty, it emerged that certain members of the Mechanical Engineering department suggested the formation of an applied mathematics group. However, it was indicated that the Mathematics Department was to be excluded from the discussion.

Concluding Remarks

We were not successful in convincing the University officials of the benefit to UR of retaining the graduate program in Mathematics, and of the harm to undergraduate education that would result by replacing full-time tenured faculty with adjunct instructors. With regard to the graduate program in English, which has been retained, the Dean states (See Appendix 1): "The NRC ranking [English] is not as high as some other departments (rank 46 and 36th percentile), but we believe it is essential to maintain a strong presence in English as a central discipline in the humanities." We pointed out to the Administration that the University does not seem to regard Mathematics as "a central discipline" in the sciences and technology.

We did not object to the process of selective cuts in the face of severe financial difficulties, but rather to the fact that Mathematics, a core subject, was chosen without proper consultation of either the Department, or mathematicians external to UR, to help assess the Department's quality and overall contributions. We emphasized that no other research university with strength in the sciences is without a graduate program in mathematics. The dangers of relying solely on the NRC and the U.S. News ratings are many, especially for small programs such as the ones at UR.

We raised the issue of the current changes taking place in undergraduate mathematics education related to calculus, the use of technology, and the role of mathematics in science and engineering. We mentioned that an eviscerated department, absent the most creative and energetic members, would be unable to respond to these challenges, putting UR behind and unable to participate.

We also raised the issue of the important unifying role of mathematics in science and engineering, including the social sciences, and what will be lost at UR if all mathematical activity takes place at the periphery in the disciplines and there is no active, vibrant core. We suggested that if UR believed that sufficient linkage did not exist between Mathematics and other units, then the proper reaction would be to foster or facilitate such connections, not to cut out the core.

We indicated our belief that UR would find it impossible to have a strong undergraduate Mathematics program either in the major or service area under the plan proposed by the Administration.

We see the termination of the Mathematics graduate program at UR as a tragedy for American mathematics. While there may be some doctoral programs that should be eliminated, UR's is clearly not one of them.

The Administration heard our arguments but "agreed to disagree."

Respectfully submitted,

Salah Baouendi (Chair), Ronald Douglas, Morton Lowengrub

News Release: University of Rochester versus Mathematics

The American Mathematical Society has appointed a task force in response to a plan by the University of Rochester to reduce drastically the size and functions of its mathematics department.

Rochester is endeavoring to resolve its severe fiscal problems, but mathematics has been singled out for the most extreme measures. "What Rochester plans to do downgrades mathematics not only as a major science but in its key role underpinning all of the physical sciences," says AMS President Cathleen S. Morawetz, former Professor of Mathematics at the Courant Institute for Mathematical Sciences at New York University.

"Rochester aims to be a very good research university with particular strength in science and economics. This aim simply is not viable without a good mathematics department."

The University of Rochester has eliminated its graduate program in mathematics and will reduce its mathematics faculty by more than half over five years. In addition, responsibility for lower-level courses such as calculus will be shifted mainly to temporary adjuncts and faculty from other departments.

There will be other changes at Rochester as part of its major restructuring effort. Three graduate programs besides mathematics will be closed (chemical engineering, comparative literature, and linguistics), and the University faculty will be cut by 10%. The University's plans also call for reducing undergraduate enrollments in order to raise student quality in the hope that the University can increase tuition revenue.

Dozens of scientists from a range of disciplines---including 6 Nobel Laureates and a large number of members of the National Academy of Sciences---have written to the Rochester administration urging them to reverse their decision on the mathematics department. At the Joint Mathematics Meetings in Orlando, Florida yesterday, the Council of the AMS passed a resolution condemning the University's actions.

In late November the AMS appointed a three-member fact-finding committee chaired by Salah Baouendi of the University of California at San Diego, chair of the Committee on the Profession of the AMS. The fact-finding committee visited the Rochester campus on December 6, 1995. A week later, President Morawetz sent their report to University of Rochester President Thomas Jackson. She also offered the assistance of the Society in finding a way to preserve the integrity of the mathematics program consistent with the overall goals of the University.

In the absence of any change in the Rochester administration's position, President Morawetz is appointing a task force to monitor the situation, to facilitate help for Rochester, and to solicit support. The chair will be Arthur Jaffe of Harvard University, who is President-elect of the AMS. The task force will be composed of prominent scientists as well as mathematicians.

"The overwhelming outcry from scientists and others outside the mathematics community demonstrates that the proposed plan for the Rochester mathematics department is not only bad for mathematics, but it is also bad for the University of Rochester, it is bad for science in general, and it is bad for America," says Jaffe. "We are extremely concerned and hope that we can help to turn this around."

Further information is posted on the AMS World Wide Web site, at the
URL http:///committee/profession/rochester/rochester.html.

Founded in 1888 to further mathematical research and scholarship, the 30,000 member AMS fulfills its mission through programs and services that promote mathematical research and its uses, strengthen mathematical education, and foster awareness and appreciation of mathematics and its connections to other disciplines and everyday life.

Attachment: Resolution of the Council

Resolution Passed by the Council of the American Mathematical Society, January 9, 1996

The Council of the American Mathematical Society is deeply concerned over the University of Rochester's announced intention to severely downgrade its strong mathematics program by eliminating Ph.D studies, shrinking the mathematics faculty "over time" by more than one half, and assigning the teaching of calculus to faculty in other departments and to nontenured adjuncts.

This plan displays a lack of understanding of the nature of mathematics, its role as a core discipline among the sciences, and its place in a well-rounded education.

The entire Rochester academic community is ill-served by such a strategy. Calculus students will be taught by instructors much less likely to have either the wideranging overview of mathematics or the involvement with the subject necessary for truly effective teaching. Nor will these instructors be likely to stay abreast of current evolution in the pedagogy and content of calculus.

The hiring of low-paid adjuncts with no long-term commitment to or from the institution will undermine educational quality. It could lead to an egregious violation of principles of non-exploitation enunciated in the January 1994 resolution adopted by the Council in the name of the Society, on "Supportive Practices and Ethics in the Employment of Young Mathematicians."

Advanced undergraduates in mathematics and graduate students in other scientific disciplines will be deprived of the support that a mathematics graduate program provides to their studies. Faculty in quantitative disciplines will miss opportunities to consult and collaborate with their colleagues in mathematics. In the absence of excellence in mathematics, the attractiveness of Rochester as a first-rate research center in physical science, engineering, and economics will diminish.

On intellectual, educational and practical grounds, Rochester's intended treatment of mathematics is incompatible with its aspirations to national distinction as a research university emphasizing quality undergraduate education.

The Council strongly urges the University of Rochester's administration to reconsider its proposed course of action with regard to mathematics.

Rochester Task Force of the American Mathematical Society

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Appendix 1: Rationale for Restructuring by Dean Aslin

November 16,1995

T0: Faculty of the College
FROM : Richard Aslin, Vice Provost and Dean
RE: Rationale for the restructuring plan

A clear and consistent message conveyed by the 75 faculty who met individually with Provost Phelps and me last Spring and Summer was that, whatever the final restructuring plan, a comprehensive rationale must be provided to the faculty. This rationale, although unlikely to be agreed upon by all faculty, should clarify the thinking that went into the final restructuring plan and provide a means by which faculty can understand the future role that they will play in the College. The purpose of the present memo is to describe our rationale in detail; it accompanies the letter from the President, the Provost and myself detailing the various interconnected pieces of the Renaissance Plan for the College that was just approved by the Board of Trustees.

The Context for Restructuring

Over the past 17 months of the Jackson administration, we have attempted to convey to the faculty three essential facts: (1) the current balance of revenues and expenditures is unsustainable, (2) increases in revenues alone cannot solve our budgetary problem, and (3) significant cuts are required in programs that by all objective standards are meritorious on some dimensions. The issue is not whether we need to cut programs, but rather which cuts will be least harmful to the institution. The term "least harmful," of course, is a matter of judgment. An overriding focus in our restructuring plan has been to maintain, and if possible enhance, our current strengths, but only if those strengths can be nurtured without sacrificing the balance required of a major research university. By necessity, this focus demands the scaling back of resources to some doctoral programs. It does not imply, however, that those scaled back programs are irrelevant to our undergraduate teaching mission, that faculty in those programs will no longer be expected to maintain high standards of scholarly achievement, or that those programs are generally less "relevant' to a research university. Rather, we must face the fact that the nurturing of some, doctoral programs should be left to institutions other than Rochester. In sum, it was clear to us, particularly given the past five years of budget cuts, that we simply could not sustain the overall mission of the College if all programs were required to submit to a steady erosion of support.

The process of change has occupied our collective energies for several years. The uncertainties, and associated lowering of faculty and staff morale, have taken a toll on us all. We firmly believe it is time to make the difficult decisions that will lead the College forward, to reduce the uncertainties that have faced each and every program in the College, and to rectify our financial problems with a balanced range of programs and a balanced budget. In short. it's time to get on with it.

As outlined in the September memo from the President, the Provost, and myself, we concluded that suspending enrollments in several graduate programs was the only sensible way to selectively downsize the faculty. This conclusion is based on three premises: (1) retaining a number of outstanding Ph.D. programs is essential to our overall-reputation as a first rate research University, (2) across-the-board reductions in faculty size will likely render our strongest PhD programs second rate, and (3) given the considerable amount of faculty time spent on graduate education in departments with PhD programs, and the constraints (in budget and in faculty size) already placed on these departments, any further reductions in faculty size are often incompatible with the presence of a Ph.D. program. Given the necessity of further reducing overall faculty size in the College, we cannot afford to.jeopardize the quality of our undergraduate programs by diverting limited resources to weakened Ph.D, programs. In sum, we must protect our most "important income stream "undergraduate tuition --- not only to deliver a quality education to undergraduates, but also to maintain the quality of our best Ph.D. programs. The planned reductions in faculty size will reduce departmental expenditure by an estimated $3Million (in 1995 dollars). thereby allowing us to better support the remaining graduate program and to better support the delivery of quality instruction to undergraduates. On balance, we viewed this as the best strategy for Rochester to retain its 30-year legacy as a premiere research university and its prior 100-year legacy as a quality liberal arts college.

Of course, we were, concerned whether our stature as a research university would be diminished by a reduction in the number of Ph.D. programs. thereby placing us in a less competitive position among prospective undergraduates (and their parents). However, we judged it important to note that several institutions ranked higher by U.S. News and World Report than the University of Rochester (ranked 29th among national research universities) had fewer numbers of Ph.D. programs as indicated by the recent ranking of Ph.D. Programs from the National Research Council (NRC) report (see Table A). In fact, of the 9 private institutions from the U.S. News "second 15," the mean number of Ph.D. programs is 16 compared to Rochester's current 24. We take this as a clear indication that it is not necessary to have the full complement of Ph.D. programs to attain a national ranking higher than Rochester's as an institution attractive to undergraduates, and that a modest reduction in the number of Ph.D. programs at Rochester will not tender us an oddity in the world of successful research universities. Although one could question the use of the U.S. News rankings of undergraduate programs as a meaningful benchmark, it is obvious from the list in Table A that many first-rate, research institutions are included in the U.S. News top-30. In subsequent references to this top-30 list, we do not wish to support its validity in detail, but merely to employ it as a reasonable cohort with which the University of Rochester can be compared.

Expectations and responsibilities

No transition is easy, particularly in academia, where faculty in research universities must come to grips with a world that is no longer expanding and where the balance of teaching and research being carefully reevaluated. In addition to those faculty who will be distressed by the loss or shrinkage of their Ph.D, programs, faculty whose Ph.D. programs are being retained may be disappointed by the absence of significant planned growth in their departmental faculty. This expectation for faculty growth is a natural response to the. across-the-board loss of faculty during the past five years and the message that once selective cuts were made reinvestments would follow.

However, the key feature of the overall plan for improving the balance of revenues and expenditures in the College is a focus on quality that, in turn, leads us to a smaller undergraduate student body. This key feature brings with it a necessary recalibration of expectations for faculty size, even among departments who are not being targeted for suspension of their Ph.D. programs. In short. for the next several years, while we evaluate the revenue enhancements expected from the overall plan, even our best departments will not see the kind of growth in faculty size that they have been expecting based on planning documents submitted to the administration within the past few years.

There are, however, several other very positive outcomes of the overall plan that will become apparent while we await the evaluation of revenues. First, faculty hiring will continue in a steady and predictable manner. There will be no hiring freezes or sudden changes in the allocation of faculty slots tied to short-term fluctuations in the endowment or net tuition revenue. Second, overall faculty raises will return to a reasonable level (comparable to our peer institutions). There will be no salary freezes. Third, departments whose Ph.D. programs are retained will generally have higher graduate stipends and those stipends will grow at a reasonable and steady rate comparable to our peer institutions. Fourth, all faculty will benefit from the significantly higher quality of our undergraduates and their smaller numbers. We expect that the joy of teaching about which many of our senior faculty reminisce, will return as our students become better able to handle the intellectual rigors of a research university. Fifth, we can all expect to see visible signs of enhancements to the infrastructure of the College. including classrooms, the library, computing, and areas of student life. All of these benefits of our overall plan will be tangible and immediate.

Of course, none of these benefits will materialize if the faculty decide, by their disengagement from the institution, that their loyalties lie elsewhere, The central feature of our plan --- the improvement in undergraduate student quality --- cannot be attained without the persistent and positive engagement of the faculty in all departments and programs with prospective and current students. We must be able to call on the faculty to assist the administration and the staff in recruiting the best and the brightest, and, once matriculated, ensuring that they have a quality experience that links them as alumni to our great institution. Failing this, no plan can succeed in the long run.

The logistics of downsizing

Several constituencies will be affected by the changes we outline below, most notably the faculty in departments whose Ph.D. programs are being suspended. Others who will directly or indirectly bear the brunt of these changes include current graduate students, former graduate students, and current staff.

With regard to faculty, we must emphasize that we are not terminating tenure or tenure-track faculty. No tenure contracts will be violated and non-tenured faculty will be evaluated by the same process that has been in place since they were hired. However, instructional duties and expectations will change in some cases, most notably by shifting faculty time in departments whose Ph.D. programs are suspended from a combined undergraduate/graduate population to an exclusively undergraduate one (except as faculty interact with graduate students in other departments and in interdisciplinary programs). Faculty time for research and scholarship is not expected to decline --- and indeed may be enhanced--- in these departments. Some faculty in affected departments may choose to leave the University. Others may opt for early retirement, and we are preparing a one-time incentive program to encourage that form of voluntary attrition

for those who are eligible. That program will be outlined in detail once approved by the Board of Trustees in mid December.

For current graduate students, all commitments for financial support will be honored. Courses required to obtain the Ph.D. will be offered, with current or temporary faculty, so that students can complete their degree in a timely fashion. For students who wish to transfer to another institution, we will provide modest financial support to assist in the application process. Generally, we expect all current graduate students in affected departments to have completed their formal coursework and to have exhausted their stipend support within three more years, although completion of the Ph.D. may require additional time.

Current staff will not be affected by these program changes except as these changes result in the need for fewer support-personnel in a given department to administer the Ph.D. program and to provide technical support. Every attempt will be made, at appropriate times in the future, to relocate these staff into other University positions.

Former graduate students, as alumni of the Ph.D. program will naturally be upset with the suspension of admissions in their disciplines. A letter of explanation will be sent to all graduate alumni to reaffirm our commitment to support the undergraduate teaching and research missions of the department and to explain our rationale for downsizing. Emphatically.we are not creating---and will not allow a self-definition of --- departments whose only function is "service" to undergraduate majors in other disciplines. We expect the same quality of research and scholarship in departments without a Ph.D. program and we have built into our budget a modest pool of resources to enhance the opportunities for research and scholarship among faculty who win no longer have access to graduate students. In addition, we will encourage joint appointments and other forms of interaction with faculty from Ph.D. degree-granting programs at Rochester.

General principles: Factors and their importance

No formula can capture the richness and complexity of a department's contribution to the College. The metrics chosen by the Planning and Evaluation Task Force were useful in pointing out differences among readily comparable disciplines, but, in our judgment, they alone could not be used to determine which programs are most beneficial (or least necessary) to the College. Similarly, the national rankings provided by the recent report of the National Research Council (NRC) were helpful, but they did not contain information since 1992 or information known only internally (such as linkages to other programs or centrality to our undergraduate experience). Thus, no single indicator was used in the decision-making process. However, several global factors played an important role in our decisions about which Ph.D. programs should be suspended. Those factors included:

- the quality of the faculty and graduate students (as evidenced-by awards and honors, extramural grant funding relative to similar disciplines, publications, hiring markets, GRES, Sproulls, placements, and external rankings)
- the costs (both absolute and relative) of supporting the research/scholarly mission of the program

- the centrality of the discipline and its current-or projected importance to the undergraduate population
- the role of graduate students in the, delivery of undergraduate instruction and in the conduct of faculty research and scholarship
- critical linkages that exist (or should exist) between scholarly or instructional programs across departments
- a consideration of which disciplines are distinctive to Rochester or could be with a modest investment.

Note that no specific weighting function can be applied to these factors across all disciplines. Rather, the importance of these factors must be combined with an overall sense of what is best, and most feasible given Limited resources, for the College as a whole. Examples of such contextual decisions are embedded in the summary below, and some relevant statistics are listed in Tables A and B.

Ph.D. programs whose admissions are being suspended:

Graduate admissions to the following Ph.D. programs are being suspended for the entering class of Fall 1996: Chemical Engineering, Comparative Literature, Linguistics, and Mathematics. Targeted faculty sizes in these departments range from modestly smaller to significantly smaller. We want to emphasis that these decisions, although not irrevocable in the long run, represent at minimum a 5-10 year change in the mission of each affected department, since the earliest reevaluation of the budgetary consequences of this overall restructuring plan will not occur until the Fall of 2001.

Chemical Engineering. The situation in the three accredited engineering departments (ChemE, MechE, and EE) is similar in some respects and different in others. Historically, these faculties totaled approximately 30 FTEs until an upsurge in undergraduate enrollments in the early 1980s, coupled with a higher endowment spending rate in the late 1980s, led to the hiring of 14 more faculty. In ChemE, faculty size increased from 7 in 1982 to 12 in 1992, yet the NRC ranking of their graduate program fell by 16 to 40th (43id percentile). As shown in Table B for the top-30 cohort of national research institutions from U.S. News & World Report, 17 have higher ranked ChemE graduate programs, 9 do not offer a Ph.D. in ChemE, and only 3 have poorer ranked graduate programs. It is clear that to bring the Ph.D. program in ChemE to a level comparable to our overall ranking would require a significant investment (e.g., the average size of a top quartile ChemE program is 19 FTES). Given ChemE-'s modest record of success in attracting outside grant funds and their relatively high costs compared to other science and engineering departments, such an investment was not viewed as justifiable.

In our judgment, a reduction in steady-state faculty size from 11 to 6 FTEs (with modest assistance from adjuncts) will enable the ChemE Department to offer a quality ABET-accredited undergraduate B.S. in ChemE

and enable linkages for relevant faculty to the interdepartmental Ph.D. program in Materials Science (which is being retained). We are cautiously optimistic about the prospects for enhanced visibility for the interdepartmental Ph.D. program in Materials Science because of other strong faculty in the College. Our NRC ranking of 36.5 in Materials Science (56th percentile) was somewhat disappointing, but a number of reporting errors, and a poorly coordinated effort to bring in key faculty from departments other than its home department (MechE), may have suppressed this ranking. Modest support of the Materials Science Ph.D. program (with participating faculty from ChemE, Chemistry, EE, MechE, Optics, and Physics & Astronomy) will ensure a strong research base for faculty whose departmental Ph.D. program has been suspended.

We do not wish to prejudge which of several models for restructuring the various programs in ChemE is best for Rochester. For example, the B.S. degree in ChemE might be eliminated and replaced with a B.A. in Engineering Science and an M.S. in ChemE. Such a 3-2 program is being discussed seriously at other institutions as a model for graduate education in engineering. Alternatively, an AB ET-accredited B.S. in ChemE- may be retained but in a larger department of Engineering Science that combines faculty from ChemE and MechE. We have asked SEAS Dean Moore to coordinate an extensive internal review of these issues and to provide us with a strategic plan for the Department of ChemE by the summer of 1996.

Comparative Literature. The Ph.D. in CompLit (administered by the Department of Modem Languages and Cultures) was reinitiated in 1986 after a decade-long hiatus and has achieved modest success in recent years. However, it has not yet achieved distinction and is unlikely to do so without further major investments. In fact, in the absence of new faculty hiring in CompLit per se, rather than faculty in national languages and literatures with secondary expertise in CompL!t, faculty affiliated with the program are only marginally capable of sustaining the Ph.D. degree. Rochester's NRC ranking in CompLit is 31 (70th percentile). As shown in Table B, 17 institutions in the. top-30 have higher ranked CompLit graduate programs, 11 do not offer a Ph.D. in CompLit, and only 1 has a poorer ranked graduate program. The previous revitalization of the CompLit Ph.D. has led to significant reallocation of faculty time to courses, some at the graduate level, so that much of basic language instruction is now covered by adjunct faculty. Thus, costs of the Ph.D. program include a significant adjunct teaching budget. In our judgment, much of the intellectual excitement of the CompLit Ph.D. program can be met by already strong ties to the inter-departmental Ph.D. in Visual & Cultural Studies and to the Susan B. Anthony Institute. A reduction in steady-state faculty size from 18 to 15 for the Department of Modern Languages and Cultures will enable the continuation of all current majors and minors, as well as Master's programs in Spanish, French, and German.

Linguistics. The Ph.D. program in Linguistics, which lay dormant for many years, was revitalized in the mid-1980s with the hiring of several faculty in theoretical linguistics to the former Department of Foreign Languages, Literatures, and Linguistics (FLLL). As these faculty, and their newly attracted Ph.D. students, forged linkages with strengths in psycholinguistics (in Psychology) and computational linguistics (in Computer Science), the linguistics program attained sufficient strength to warrant status as a separate department in 1993, with a faculty size of 8. Unfortunately, demand for linguistics at the undergraduate level (as indicated by majors and credit hours) failed to materialize, reinforcing a national -trend. We cannot justify the faculty hiring required to support a department whose undergraduate impact is limited (the Linguistics Ph.D. program at Rochester was not evaluated by the 1992-93 NRC survey due to a reporting omission). The

Linguistics Department will be retained with a steady-state faculty size of 5, but the current Linguistics Ph.D. program will be suspended. At the graduate level, the Department will forge stronger ties to the interdepartmental Cognitive Science program by linkages with faculty and graduate students in psycholinguistics (in Brain & Cognitive Sciences) and computational linguistics (in Computer Science). At the. undergraduate level, a broader major that links to the symbolic systems track in Cognitive Science should be examined. The current Linguistics minor will be retained. The ASL program at the undergraduate level will become autonomous, with administrative support provided by the Office of Interdepartmental Programs.

Mathematics. Effective teaching of calculus is an essential ingredient of a quality undergraduate educational experience at Rochester, particularly given the large proportion (over 70%) of first year students who enroll in the calculus sequences. Although arguments could be made that graduate students in Math play a key role in calculus instruction, much like the role that graduate students in English play in basic-level writing courses, the dwindling numbers of Math graduate students undercut one rationale for retaining a Ph.D. program in Math. There are other ways to service our need for calculus instruction, including the hiring of non-research (adjunct) faculty and/or the redirection of other qualified faculty from other disciplines.

Coupled with these concerns is a Ph.D. program in Math that is of modest distinction (though certain subgroups of faculty are nationally prominent). Its NRC ranking is 58.5 (42 percentile). As shown in Table B, 25 of the top 30 institutions have higher ranked Math graduate programs, 3 do not offer a Ph.D. in Math, and only 1 has a poorer ranked graduate program. Despite good intentions by several faculty in Math, undergraduate instruction is less than optimal, the best graduate students are going to other programs, and no reasonable investment in the department would push our ranking to a level commensurate with the overall institution.

For these reasons, we do not believe that continuation of the Ph.D. program in Math is justified. Linkages with other departments and programs are minimal, as is grant income (generally true of Math departments). We believe that a refocused department that emphasizes quality calculus instruction (to a smaller undergraduate student body), attention to majors and minors, and individual research excellence, will best serve the overall needs of the College. A reduction in steady-state faculty size over time from 21 to 10 FTEs, with additional non-tenure-track teaching faculty who staff much of the elementary calculus sequences, can achieve these goals.

Ph.D. programs that are being reduced/focused

Two departments --- History and Philosophy --- stand out as combining a strong undergraduate program with a Ph.D. program of relatively high rank and relatively low cost. Two other departments --- Earth & Environmental Sciences and Mechanical Engineering --- were less well ranked yet have considerable strengths, particularly as they bridge to other programs. In all four cases, we could not justify continuation of business as usual, in large part because attaining or continuing national stature of the first rank was unlikely and because financial constraints demanded that we look for additional cost savings beyond the Ph.D. programs that are being suspended. As a result, we have decided to reduce the size of the graduate student classes (and associated College stipend support) in these departments by approximately 50%, with modest

decreases in targeted faculty size. Assuming sufficient quality can be achieved, faculty in these four departments may retain a smaller Ph.D. program, perhaps with greater focus, or they may opt to suspend their Ph.D. program and allocate their reduced stipend budget for postdoctoral fellows and/or visiting faculty. Plans should be developed in each department, and submitted to the Dean's Office by June of 1996, outlining how the department intends to improve its Ph.D. program given its reduced size or eliminate it in favor of a different form of support for faculty research and scholarship.

Earth & environmental Sciences. Undergraduate, majors in the Department of Earth and Environmental Sciences have grown significantly over the past five years; they are now the second largest science major behind biology. Unfortunately, the NRC rankings (73.5 rank; 73rd percentile; see Table B) do not capture the great strides that faculty research the department has made in recent years, including two recent hires (from Stanford/Scripps and CalTech). With a faculty of 8, the department's teaching load is higher than any other science or engineering department, in essence creating a Ph.D. program as an overload. As with many small departments, however, it is difficult to attract the best graduate students and place them in the best positions (though recent placements have been very strong). In the context of a department on an upward trajectory, with large numbers of majors, and in an area that is likely to maintain strong undergraduate interest that can benefit greatly from a small graduate program, we believe E&ES should not have its Ph.D. program suspended at this point. For a 3-year period we will maintain a reduced graduate stipend budget and encourage the faculty in E&ES to evaluate critically whether maintaining a Ph.D. program is the best model to meet their teaching and research missions with a steady-state faculty size of 7 FTEs, pending approval of a strategic plan submitted to the Dean's office by June of 1996.

History. The History Department has a long and illustrious legacy that was borne out by the NRC rankings. It was ranked 27th (24th percentile). As shown in Table B, 17 of the top-30 departments have higher ranked History graduate programs, 4 do not offer a Ph.D, in history, and 8 have poorer ranked graduate programs. At least some of this relatively solid ranking can be attributed to the outstanding reputation of Christopher Lasch. For example, the NRC report provided a measure of non-uniform publication rates, which is an index of the disproportionate impact that a few faculty had on the overall program ranking. This index shows that very few faculty at Rochester contributed equally to the NRC ranking and this information is consistent with the much lower NRC rank (79. 5) for citations per faculty member. In addition to some concerns about whether the NRC rankings reflect past accomplishments, the stipend budget in History is quite large and it is allocated largely to fellowships and not to TA-ships. Thus, we believe that the History Department must decide if it can be even more focused than it is at present (with three sub-areas of Ph.D. coverage). With a reduced stipend budget, the department may decide that it can mount a more focused Ph.D. or that it makes more sense to suspend the Ph.D. program and invigorate the scholarly activity of its faculty with postdocs and/or visiting professors. Thus, for a 3-year period we will reduce the size of the entering class of graduate students and encourage the faculty in History to determine the best model to meet their teaching and research missions with a steady-state faculty size reduced from 19 to 15 FTES, pending approval of a strategic plan submitted to the Dean's office by June of 1996.

Mechanical Engineering. The situation in MechE, although similar both historically and currently, to that in ChemE, also differs in some important respects. Like ChemE., faculty size grew between 1982 and 1992 (from 12 to 17), yet the NRC ranking fell by 16 to 58th (53rd percentile). As shown in Table B, 19 of the top-30

institutions have higher ranked MechE graduate programs, 9 do not offer a Ph.D. in MechE, and only I has a poorer ranked graduate program. It is clear that to bring the Ph.D. program in MechE to a level comparable to our overall ranking would require a significant investment (e.g., the average size of a top quartile MechE program is 38 FTES).

However, there are significant strengths in MechE that lead us to propose a detailed internal analysis of the possibility of retaining the Ph.D. program in MechE. For example, despite an overall quality ranking of 58th and an effectiveness ranking of 88th in the NRC report, mecHe achieved a rank of 8th in citations per faculty member. In addition, while grant funding is modest, there are strong linkages to the Medical School, the Laser Lab, and the Center for Optics Manufacturing. In our judgment these strengths could be maintained without a Ph.D. program in MechE by forging stronger ties to the Department of Physics & Astronomy, the Institute of Optics, the Laboratory for Laser Energetics, and to the interdepartmental Ph.D. program in Materials Science. At present, our preference is for faculty in MechE and other relevant departments to focus their energies on the Ph.D. program in Materials Science, which has greater prospects for achieving a higher national ranking with a smaller investment. However, we do not wish to pre-judge this current preference given the interaction between the MechE and Materials Science programs. What is clear is that we must reduce the steady-state faculty size in MechE from 15 to 10 FTES. This size will enable the MechE Department to offer a quality ABET accredited undergraduate B.S. in MechE, with the possibility of a 3-2 and an M.S. program. The question of retaining the Ph.D. in MechE, or dropping it in favor of concentrating on the Ph.D. in Materials Science, must be evaluated by the relevant faculty. We have asked SEAS Dean Moore to coordinate an extensive internal review of these issues and to provide us with a strategic plan for the Department of MechE by the summer of 1996.

Philosophy. The Philosophy Department, like the History Department, has an illustrious legacy, and currently plays a significant role among non-majors at the undergraduate level, with ties to Religion & Classics, History, Political Science, Linguistics, and Cognitive Science. Its NRC ranking is 33 (46th percentile) . As shown in Table B, 16 of the top-10 institutions have higher ranked Philosophy graduate programs, 4 do not offer a Ph.D. in Philosophy, and have poorer ranked graduate programs. Although these rankings are solid for a small department, we believe that the department is not ranked sufficiently highly to justify further investments. However, the combination of a significant undergraduate credit-hour load and a Ph.D. program of relatively high rank and modest cost led us to the decision to reduce rather than suspend admissions to the Ph.D. program in Philosophy. We believe that a reduction in the steady-state faculty size from 8 to 7 FTEs can provide an outstanding undergraduate program to our students, while allowing a smaller Ph.D. program to flourish. The nature of such a program, and plans to achieve it within these constraints, should be part of a strategic plan submitted to the Dean's office by June of 1996.

Ph.D. programs that are being retained

Twelve other Ph.D. programs are being retained --- Biology, Chemistry, Computer Science, Economics, Electrical Engineering, English, Materials Science, Optics, Physics & Astronomy, Political Science, Psychology (now separate departments of Brain & Cognitive Sciences and Clinical & Social Sciences in Psychology), and

Visual & Cultural Studies. One additional Ph.D. program (Biostatistics/Statistics) is being gradually phased out of the College and into the Medical School.

As summarized earlier, it is important to note that with an undergraduate student body reduced in the steady-state by 20% (an entering class size of 900), we must all recalibrate our expectations for growth in faculty size. Neither the demand for instruction at the undergraduate level nor the immediate financial resources associated with a smaller student body allow for additional faculty hiring at this point. To achieve our financial goals, we have targeted a reduction in faculty size from 343 to 306, almost exclusively in departments whose Ph.D. programs are being suspended or refocused. Any growth in faculty size in departments whose Ph.D. programs are not being suspended or refocused must come from further declines in other departments. In the interests of disciplinary balance and program viability, we do not believe that a faculty size below 300 is viable. Further growth in faculty size is not achievable, unless revenue enhancements actually reach hoped-for results. If so, we can consider faculty growth at that time. Given the risk and pain of faculty downsizing, however, it would be irresponsible to add faculty positions based solely on that hope.

Biology. The Biology Department has a strong research faculty and the largest number of science majors. Although the NRC rankings did not single out the Biology Department because faculty from the River Campus and the Medical School were combined by subfield into four Ph.D. disciplines, an aggregate ranking of the Biology Department's Ph.D. program was estimated to be in the 32nd percentile. In Table B, data derived from combining the relative rankings of the biological sciences Ph.D. programs listed in each subfield indicate that Rochester is ranked approximately 20th in the cohort of top-30 institutions. All of these top-30 institutions have at least one Ph.D. program in the biological sciences, and 29 of the 30 have two. Given Rochester's strong undergraduate niche for pre-med students, and the need for graduate students to serve as TA's and as RA's for nearly $3 million/year in extramural grants, it is imperative that the Ph.D. program in Biology be maintained and strengthened. Additional strength must come from collaborations with the Medical School, an issue that we are exploring in detail with the new Vice President and Vice Provost for Health Affairs.

Brain and Cognitive Sciences and Clinical and Social Sciences in Psychology. The former Psychology Department has been formally divided into a natural science department (Brain and Cognitive Sciences) and a social science department (Clinical and Social Sciences in Psychology). The combined department, on all metrics of quality and instruction (including grant income, majors,and credit hours),was very strong. Its NRC rank was 3lst (17th percentile). As shown in Table B, 15 of the top-30 institutions have higher ranked Psychology graduate programs, 2 do not offer a Ph.D. in Psychology, and 12 have poorer ranked graduate programs. With the advent of the BCS Department, approval for a new Ph.D. program, combining three former Ph.D. degrees in Psychology, will be applied for with the State of N.Y. Two other Ph.D. degrees in Psychology will be administered by the CSSP Department. The undergraduate major in Psychology will be administered jointly by the two departments.

Chemistry. By all objective standards, the Chemistry Department is very strong, though its number of majors is rather modest. Grant income is very high and a large number of non-majors are served by several highly subscribed introductory courses and laboratories. The large size of its graduate program is driven, in part, by

the high demand for TA's in undergraduate chemistry labs. Its NRC rank is 31.5 (19th percentile). As shown in Table B, 16 of the top-30 institutions have higher ranked Chemistry graduate programs and 13 have poorer ranked graduate programs. Despite the relatively high cost of a chemistry department, this is an investment that is worth maintaining, particularly given the strong market for Ph.D.s in Chemistry.

Computer Science. The Computer Science Department is already a niche program both in breadth of coverage and overall faculty size. It has some of the most talented graduate students in the College and, with its new undergraduate major, an opportunity to create a new intellectual focus for undergraduates. Its NRC ranking is 3Oth (28th-percentile), and publications/faculty was ranked 5th. As shown in Table B, 16 institutions have higher ranked Computer Science graduate programs, 5 do not offer a Ph,D. in Computer Science, and 8 have poorer ranked graduate programs. Given the high quality of its faculty and graduate students, its linkages to Electrical Engineering, and its projected attractiveness to talented undergraduates, support for the Computer Science program is well justified.

Economics. The Economics Department is the 2nd highest ranked Ph.D. program in the College, with an NRC rank of 14 (13th percentile). It routinely has some of the most talented graduate students in the College, an excellent placement record at major research universities, and a large number of undergraduate credit hours and majors. As shown in Table B, 12 top-30 institutions have higher ranked Economics graduate programs, 5 do not offer a Ph.D. in Economics, and 12 have poorer ranked graduate programs. Despite higher than average operating costs, this is a program that we believe should be nurtured.

Electrical Engineering. The Department of Electrical Engineering has the potential of linking with other science and applied science departments and becoming a major player in the engineering disciplines. Its NRC rank is 46.5 on quality (37th percentile), 19th on citations/faculty, and its grant income, is comparable to Optics (and substantially higher than ChemE or MechE). As shown in Table B, 18 top-30 institutions have higher ranked EE, graduate programs, 8 do not offer a Ph.D. in EE, and 3 have poorer ranked graduate programs. In contrast to the growth of faculty size in the 1980s in ChemE- and MechE, the increase of 5 faculty in EE during this decade improved their NRC rank by 8. We believe that the modest investment needed to maintain a viable Ph.D. program in EE is essential to our overall reputation in the physical sciences and engineering, and that important and exciting linkages can occur given our current strengths in Computer Science and in the Medical School.

English. The Department of English not only has severe outstanding faculty (as revealed by Guggenheims and other awards), but graduate students in English play an important role in the teaching of freshmen writing. The NRC ranking is not as high as some other departments (rank 46 and 36th percentile), but we believe it is essential to maintain a strong presence in English as a central discipline in the humanities. As shown in Table B., 20 top-30 institutions have higher ranked English graduate programs, 4 do not offer a Ph.D. in English, and 5 have poorer ranked graduate programs. We believe that despite our plan to retain the Ph.D. in English, it is advisable to reduce the steady-state faculty size slightly (from 25 to 22) and to downsize the number of graduate students (in part to reflect the smaller class size of 900), while increasing their individual stipend levels.

Materials Science. By tradition, the Ph.D. in Materials Science, has been largely a part of the Department of Mechanical Engineering. However, Materials Science is an interdisciplinary program with faculty expertise in

MechE, ChemE, EE, Optics, Chemistry, and Physics & Astronomy. The program was ranked 36.5 (56th percentile) and, as summarized earlier, can achieve a considerably higher ranking with very little, additional investment. We plan a consolidation of this Ph.D. program within the College to capitalize on the expertise both within and outside of MechE.

Optics. The Institute of Optics is an outstanding example of a signat ure department that has attained national prominence by focusing on a limited subdiscipline. Grant income and national ranking are excellent, as are graduate student quality and placement (though majors have declined over the past decade). The NRC report included optics in the much broader physics category; yet it still was ranked a solid 25th (17th percentile). Our clear strength in Optics should be enhanced by closer ties to related departments and programs in the physical sciences and medicine.

Physics and Astronomy. The Department of Physics and Astronomy, like the Department of Chemistry, is very strong on all dimensions except their modest number of majors. We believe that Rochester can retain its strength in physics even while, shrinking the department's steady-state faculty size slightly (from 29 to 26). The department's NRC ranking of 26.5 (18th percentile) is very strong in a highly competitive discipline. As shown in Table B, 15 top-30 institutions have higher ranked Physics graduate programs, 2 do not offer a Ph.D. in Physics, and 12 have poorer ranked graduate programs. We believe, that Rochester's reputation in the physical sciences requires a strong Physics Department, and that closer ties with Optics, the Laser Lab, Chemistry, and the Ph.D. program in Materials Science will maintain our strong national presence in Physics and related disciplines.

Political Science. The Political Science Department received Rochester's highest quality ranking in the NRC report (rank 11,11 th percentile), and was even higher ranked in effectiveness and citations/faculty. Like Optics, Political Science at Rochester has achieved national stature by a distinctive focus, despite a relatively small faculty size. Its balanced contribution to the College includes a large presence among undergraduates and a small but high quality graduate population, which has achieved a superior rezord of job placements. As shown in-Table B, only 8 of the top-30 institutions have higher ranked Political Science graduate programs, 4 do not offer a Ph.D. in Political Science, and 17 have poorer ranked graduate programs. Higher graduate stipends will allow Political Science at Rochester to retain and enhance its outstanding national reputation.

Visual and Cultural Studies. Despite its relative youth (so new that it was not ranked by the NRC), the Ph.D. program in Visual and Cultural Studies has become a model for similar innovative programs at other high quality institutions. Graduate students in VCS complement the teaching needs of the undergraduate program in Studio Arts, and recent degree recipients have obtained outstanding job placements. Retaining a small but distinguished Ph.D. program in the humanities, particularly one that bridges with English, Film Studies, and Women's Studies, will provide a balance to the College that we judge to be essential at a research university. As with and other Ph.D programs retained in the humanities, increases in individual graduate student stipends will enable VCS to attract the very best graduate students.

Biostatistics/Statistics. The Ph.D. program in Statistics has been jointly staffed with the Department of Biostatistics, and several faculty have joint appointments in the Medical School. Recent deliberations with the Medical School have resulted in the movement of 3 partial FTEs from the College to the Medical School and an explicit agreement that over the next five years the primary responsibility for the Ph.D. program will shift

to the Department of Biostatistics. Current faculty in the Department of Statistics will continue to play an important role in the Ph.D. program, but any departing Statistics faculty in the College will be replaced by faculty in the social science departments who have expertise in statistics. As a result, the Statistics major may be eliminated (but with the retention of the minor) over the next five years. Primary budget support for the Ph.D. will shift from the College to the Medical School. This shift in responsibility for the Ph.D. program from the College to the Medical School is the result of the Medical School's commitment to high quality statistical consulting, which they believe can only come from faculty who are attracted to a department with a Ph.D. program. From the perspective of the College, we believe that the investment is too great to bring the Statistics Department into the. highest rank. Its current NRC rank is 32 (49th percentile). As shown in Table B, 11 top-30 institutions have higher ranked Statistics graduate programs, 15 do not offer a Ph.D. in Statistics, and 3 have poorer ranked graduate programs.

Summary

The configuration of Ph.D. programs remaining fully in the College is as follows:

Humanities English Philosophy (reduced/focused) Visual & Cultural Studies Social Sciences Clinical & Social Sciences in Psychology Economics History (reduced/focused) Political Science Sciences Biology Brain & cognitive Sciences Chemistry Computer Science Earth & Environmental Sciences-(reduced/focused) Physics & Astronomy Engineering Electrical Engineering Materials Science Mechanical Engineering (reduced/focused) Optics

We believe that this configuration of Ph.D. programs, with some additional Master's programs, will maintain Rochester as a very strong Carnegie I Research University, with a more focused mission at the graduate level and more resources at both the graduate and undergraduate levels. As shown in Table A, the remaining 20 Ph.D. programs in the College (translated into 17 on the preceding page because of the multiple biological science classifications used in the NRC report) keep Rochester significantly above the mean of 16 for the "2nd-15" -institutions from the U.S. News & World Report list of private national research universities. In short, we will not be an "outlier" on the dimension of breadth of Ph.D. programs among a cohort of national research universities with whom we compete for undergraduates. Estimated cost savings (in 1995 dollars) once the steady-state scenario is achieved are approximately $3 million. Coupled with expenditure reductions in administrative costs, some reallocation of resources among the -Schools and the College, and anticipated growth in tuition revenues through a focus on undergraduate quality, the Renaissance Plan will reduce the structural unbalance in the College and put us on a path of excellence in our research and teaching missions.

We fully recognize the pain involved in these decisions. But to delay or assume that our financial problems will simply go away is foolhardy and unacceptable; doing so will only make the necessary readjustments worse and may also permanently lower the University's quality and reputation. We could not expect the faculty collectively to make these difficult decisions, nor do we expect that each of you will agree with them. But we cannot attain our vision of a stronger College --- which we believe to be achievable and exciting --- without the active, cooperation of the faculty. We need to get on with the task of moving the College forward, and we intend to do everything within our power to accomplish the restructuring in an orderly and timely manner.

Table A

Number of Ph.D. programs offered by the top-30 national research Universities as ranked by the '96 U.S. News & World Report.

I.	Harvard	25
2.	Princeton	27
3.	Yale	25
4.	Stanford	34
5.	MiT	19
6.	Duke	28
7.	CalTech	16
8.	Dartmouth	9
9.	Brown	25
10.	Hopkins	30
11.	Chicago	25
12.	Penn	31
13.	Cornell	31
14.	Northwestern	27
15.	Columbia	28
16.	Rice	21
17.	Emory	13
18.	Notre Dame	21
19.	Virginia	29
20.	Wash U	25
21.	Georgetown	11
22.	Vanderbilt	23
23.	Carnegie-Mellon	15
24.	Michigan	34
25.	Tufts	7
26.	UC Berkeley	34
27.	North Carolina	28
28.	UCLA	32
29.	Rochester	24
30.	Brandeis	12

Table B

Relative rankings of Rochester's Ph.D. programs.

Ph.D. Discipline	UR rank re:Table A	NRC quality (%ile)
Biology	20 of 30	32
Chemical Engineering	18 of 21	43
Chemistry	17 of 30	19
Comparative Lit.	18 of 19	70
Computer Science	17 of 25	28
Earth &- Environ. Sci.	19 of 21	73
Economics	13 of 25	13
Electrical Engineering	19 of 22	37
English	21 of 26	36
History	18 of 26	24
Linguistics	Not ranked	
Materials Science	16 of 18	56
Mathematics	26 of 27	42
Mechanical Eng.	20 of 21	53
Optics	Special category	17 in Physics
Philosophy	17 of 26	46
Physics & Astronomy	16 of 28	18
Political Science	9 of 26	11
Psychology	16 of 28	17
Statistics/BiostatiCs	12 of 15	49
Visual & Cultural Studies	Not ranked	

Appendix 2: Letter to Rochester Faculty from President Jackson, Provost Phelps, and Dean Aslin

November 16, 1995

Dear Faculty Colleague,

For much of the past year, we have been engaged in a detailed planning project to bring the future of both the College and the University into clearer focus. The forces that encouraged a period of expansion in higher education have waned, and we, along with other universities and colleges, must respond to these underlying

changes. Our Plan, which the Trustees approved unanimously at their retreat last weekend, sets us on a coherent path toward strengthening our position as a major research university.

The most central issue we confront is the quality of the College and the University. In teaching and in research, we must be first-rate in all that we set out to do. These imperatives are reflected in our plan for a "Rochester Renaissance" -- so named because it reflects, in its scope and purpose, a virtual rebirth of the College. This Plan focuses intensively on quality of all that we do, because in that quality lies our future intellectual and fiscal success. Faculty quality, now high, cannot be sustained into the future without a strong fiscal base in the College. We view it as essential to make the College and the University attractive to the very best students in the country to sustain that future for us all.

The Rochester Renaissance Plan

Summary. After extensive analysis and consultation, we have chosen a balanced program of quality improvement, coupled with prudent cost reductions, a renewed emphasis on undergraduate teaching, and a specific program to increase net revenue per student in an achievable manner. Here, with details following, the key elements of the Rochester Renaissance Plan are described in broadest terms: (a) a reduction in the undergraduate student body size from 1150 per class (last year's target) to 900 per entering class, aiming towards an equilibrium undergraduate student body of 3600 (compared with the current enrollment of 4500); (b)a major program of merit aid to attract the most talented college-bound students; (c) administrative cost reductions of $5 million or more at the University level; (d) reductions in faculty size (through attrition and consensual retirement programs) from 343 to 306; (e) suspension of enrollment in four doctoral programs within the College (Chemical Engineering, Comparative Literature, Linguistics, and Mathematics) and refocusing of four others (Earth and Environmental Sciences, History, Mechanical Engineering, and Philosophy); (f) a program of administrative decentralization to bring to the College both more fiscal and programatic autonomy, as well as more responsibility, and together, a coherence of academic program and administrative structure that the College does not now have; (g) smaller sections to teach, and greater rewards for excellence in undergraduate instruction; and (h) enhanced efforts to improve co-curricular activities for undergraduates.

With the Trustees' commitment to a horizon of five years to evaluate this Plan, we can look forward to an environment with stronger students, smaller classes, no faculty search cancellations, no salary freezes, and indeed, raises competitive with the university world in general, and a program of infrastructure investment including not only the physical plant of the River Campus but also the vital set of information resources such as the library, computer networks, and the like.

Programs to Improve Quality and Revenue

Undergraduate Class Size. We have chosen to limit the undergraduate class to 900 entering students -- the students who are academically best equipped to take advantage of a Rochester education. Reducing the student body may seem counter-intuitive, given that, from one perspective, reducing the number of students would seem to worsen, not improve, our pressing fiscal problem. However, just as the problem is not static, our solutions must also not be static, but must take a many-year perspective. We must focus on a coherent

vision for the University and the College, and provide a consistent message and experience both to prospective and enrolling students that supports that vision. A more compact student body is the only realistic way we see to improve our attractiveness to the nation's finest undergraduate applicants (and hence, net revenue) with sufficient speed, and visibility, so that we will become more selective and generate enhanced net tuition revenues. All other options we have considered would entail even deeper and more painful cuts than the one we have chosen. We believe, after extensive analysis, that this strategy, although not without risk, is indeed the most cogent and promising one to follow. The magnitude of the investment from the endowment required over the next five years stands at considerably less than was used during the recent faculty upsizing (and then downsizing), or (in equivalent buying power), the 1970s investment in the Laboratory for Laser Energetics. One important feature about this decision is that, if it works less well than we have anticipated on the basis of studies we have conducted, we can reverse the decision readily without causing major dislocation or trauma within the College and the University.

An essential consequence of reducing each entering undergraduate class to 900 is that our most gifted new students will find themselves, immediately next year, among a more even cohort. Our analysis of recent applicant pools confirms that, even without second-round quality improvements that should follow, this reduction in class size, coupled with a merit aid program described below, will immediately increase the average SAT score of the entering class to above 1200 (old scale). We as faculty will see immediately the impact of this change in our classes -- a benefit that we all can share. As important will be the "external" effect of this shift; second-round positive effects on applications and enrollments should follow. The outcomes discussed here retain our full commitment to campus diversity as an essential element of the educational environment stands at the core of a university.

To keep the enrollment stable at about 3600 students, we will continue to bring in transfer students to the College to offset departures that inevitably occur. We believe that we can continue to improve on retention of those students we admit directly from high school (as we have over recent years), and feel confident that a high quality pool of transfer applicants will ensure that we can keep the College undergraduate population stable at our target of 3600 students through this approach.

Other gains emerge from this plan. First, our selectivity increases. For an entering class of 1125 to 1150, we must admit, from our current applicant pool, a relatively high proportion of applicants (approximately 65 percent). Selectivity matters to prospective students and their parents,

Second, and perhaps less obviously, at our current undergraduate size, we have ceded what can and should be our most distinctive educational niche -- a small research university. The College is simply too close in size to that of Ivy League (and other comparable) institutions to create a perceptible distinction in the market place. By becoming more clearly differentiated from other institutions (colleges and universities alike) -- and size is an important, and visible, way to do it -- we believe that the College will further strengthen its applicant pool.

Third -- perhaps as important if less tangible -- the character of the institution has changed with its growth from 3500 to 4500 undergraduates. The consequences of the increased class size have been many, including the loss of the essential residential college nature of Rochester, and the capacity and cost pressures on

dormitories, classrooms, laboratories, dining services, recreational facilities, the student union, and campus parking, not to mention faculty and staff.

Fourth, with the planned and necessary reductions in faculty size to 306 (see below), a student body of 4500 would result in a student/faculty ratio of nearly 15:1, far higher than at any time in the history of the University, and higher than virtually every college and university with which we compete. A combination of 306 faculty and 3600 undergraduates brings the ratio of students to faculty down to 11.6:1, a significant improvement even over the current ratio of 13.1:1.

With that more compact student body size as an essential ingredient, and with other programmatic initiatives designed to build on our strengths as a residential institution, we believe we can target, not immediately but over a reasonable course of time, a 125-point increase in average SAT scores (old scale) per class from the current level of last year's entering class, and an increase of $3000 (to $12000) in average net revenues per student (in 1995 terms) over the current entering class -- goals which are set below the mid-point of a set of other relevant institutions. Many other colleges and universities, without the faculty and program quality found at Rochester, achieve those targets now, and we see no reason why they are not achievable by the College with careful planning and coordinated effort of the faculty and the administration.

Simple arithmetic will show that, upon reaching this goal, the College will have about 10 percent greater total tuition revenue than it now has with a student body of 4500 undergraduates. It is absolutely imperative that the faculty and staff work in concert to achieve this goal; the alternatives are expenditure reductions far deeper than we are implementing as a part of the Renaissance Plan.

Establishing Merit Aid Programs. From an experiment we conducted last year, we know that merit aid, offered to selected out-of-state students, doubled the yield on high-quality students. (Since this program was not advertised to the applicant pool, it did not in this case affect the number of applications. By contrast, the Meliora Grant program increased applications from New York State students by 22 percent.) We also learned that an offer of $3000 alone to an otherwise-unaided student had little effect on yield. Offers of $5000 to $8000 had dramatic effects. We have used information from that experiment to design a merit program for the class we are recruiting to enter in the fall of 1996, one which targets students with SATs above 1350 (new scale).

Timing. Reductions in class size and the awarding of merit aid will begin immediately. Since this only affects the entering class, this provides an automatic phase-in over four years -- which is neither too precipitous nor too slow. Waiting serves no purpose, and phasing in with smaller reductions (e.g., 1,000 per class) blurs the effect of our intended changes.

Dynamic Effects. Early improvements in student quality (and tuition revenues) will lead to later improvements in these areas as well. We are confident that higher average student quality will in turn attract applications and enrollments from more of the nation's best undergraduate applicants. Similarly, as we become more selective, we will have more students enrolled who made Rochester their first -- not a second or third -- choice. This will enhance student morale and engagement with the College.

We acknowledge that the course we have laid out cannot be guaranteed to work as planned, although we have good reason to believe that it will. The Trustees have offered their unqualified endorsement for this course of action over a five-year period, recognizing the immediate revenue consequences of a reduced class size. Despite the risks, we feel confident that this course offers a significantly better prospect for a greatly renewed and improved College and University than other courses open to us (as discussed subsequently). It also contains the promise of a true renaissance of the College, a promise that we believe stands a high chance of fulfillment.

Cost Controlling Measures

We cannot stake the University's future entirely on the revenue and quality increases discussed above; they must be coupled with serious steps toward reduction of the costs of operating the College and the University. The Plan, as adopted, includes the following measures.

A. Administrative Costs Imposed on the College and Other Academic Units

We believe that it would be irresponsible to consider significant reductions in faculty and academic programs without first seeking every opportunity to reduce other cost components of the University. To this end, we continue a major administrative review of every facet of the University, from telecommunications to purchasing services to the organizational structure of student services, designed to eliminate duplication and, where possible, both increase service and reduce costs.

We have identified a series of administrative cost reductions that we believe can be achieved, without harming the nature of service provided, reductions of at least $5 million annually for the University, approximately $2 million of which will directly help to resolve the financial problems of the College. Some of these reductions will be obtained through outsourcing of services currently provided directly by the University, in part following upon recommendations from the Administrative Cost Review Task Force's report from the past spring.

B. Academic Program and Faculty Reductions

The growth of our faculty and academic program, in common with other higher educational institutions, has overtaken our ability to garner revenues, and we must responsibly seek reductions in expenditures as a part of the overall balancing of revenues and costs. Our analysis has led us to conclude that a College faculty size of approximately 306 is sustainable, given the revenue increases that we reasonably can anticipate through plans discussed above, down from our current faculty size of 343, and from an all time high of 393. To the extent that sustainable revenue growth actually hits or exceeds our long range goals, this target faculty size could be increased, but until we have proven our ability to sustain that growth, it would be irresponsible to suggest any larger faculty size than the 306 indicated here. Increasing beyond our sustainable size brings the painful necessity of a later downsizing, such as the one we have recently experienced, and we would not willingly set the College forth on such a path again.

We also strongly believe that it is necessary to focus our efforts in graduate education more carefully. The logic for choosing which programs to pursue with vigor, which to curtail, and which to suspend, is consistent with the College Vision statement distributed to you earlier this year, revised in light of your many thoughtful

comments; the revised version accompanies this letter. We can continue to support graduate education (which, in general, is not self-sustaining financially) only where it supports undergraduate education, the creation and dissemination of new knowledge, or both, with a quality of graduate education that adds luster to the University, or can be brought to such a level with reasonable investment of resources. While we do not intend to discuss in this memorandum the decisions about PhD program suspension on a case by case basis -- Dean Aslin's accompanying memorandum is designed to do that -- we believe firmly that this set of decisions, combined with the faculty reductions we have planned, creates a focused use of resources in doctoral education that serves the College mission better than any other sustainable set of programs we can envision.

Our focus on the institution's quality, in its core faculty, and -- because of its centrality in supporting all else that we wish to do -- in the undergraduate student body and the environment in which they learn and live, rests in considerable measure on the vision we hold for the College. That vision encompasses the dual teaching and research missions of the College and the University. This commitment to research stands as a central part of the very self definition of the University of Rochester, and must continue as a central feature as we reshape ourselves for the future. We wish to reemphasize here the importance of research and scholarship by all our faculty. As a part of the Rochester Renaissance Plan, we will necessarily bring to a close enrollment in some doctoral programs in the College, thereby -- without question -- altering the nature of research carried out by faculty in affected departments. We are completely convinced, however, that research and scholarship can and must continue in all cases -- those with continuing doctoral programs, those with refocused doctoral programs, and those where doctoral enrollment will be suspended. The style of research will change in some cases, and we will need to (and are committed to) providing new resources as necessary to support the research and scholarship of all faculty across the College.

For doctoral programs remaining in the College, we hold high expectations for their future success and achievement. Many of those programs now reside in the top quarter to top third of all programs in their disciplines. While our programs operate with an intrinsic handicap of small size, we set forth an admittedly ambitious goal of seeing most, if not all, of our doctoral programs achieve that stature in the future. Careful faculty recruiting, stronger doctoral stipends, and thoughtful consideration of new opportunities we will face in the future, can all help support our success in this part of our quality-related endeavors.

We have paid special attention to the question of whether we can maintain (and enhance) our reputation as a national research university with somewhat fewer PhD programs. The companion memorandum from Dean Aslin outlines why we believe that our plan, which includes a more focused set of PhD programs, will not jeopardize our overall reputation as a first-rate private research university.

Dean Aslin's memorandum discusses the specific doctoral program decisions more fully. In brief, programs that will have enrollment suspended immediately are: Chemical Engineering; Comparative Literature; Linguistics; and Mathematics. Four other doctoral programs (Earth and Environmental Sciences, History, Mechanical Engineering, and Philosophy) will be retained in a more focused form, subject to approval of a strategic plan developed by each department's faculty.

Some Interactions Between Proposed Changes. Although we have highlighted some of the interactions between these proposed changes, several deserve special mention. We have noted the improvement in student/faculty ratio through these changes, despite the reduction in faculty size. We will also see effects as

a consequence of the shift from graduate to undergraduate teaching. These changes, combined, reduce the average size of each course section (a "class") from the current level of 35 students per section to under 30 per section. This will greatly increase the number of small classes available for undergraduates, including most importantly for student retention, first-year Quest courses. Thus, the faculty downsizing, doctoral program enrollment suspension, and curricular reform all come together to achieve the goal of improved undergraduate teaching, and hence, improved outcomes in student quality and revenue.

Process Used in Formulating the Plan

The process of analysis, evaluation, and deliberation for possible courses of action included a number of discrete steps:

A conscious effort of self-def@tion, including development of a College vision that, in significant part, rests on the new curriculum adopted by you, the College faculty, this past spring.

An historical analysis of our past successes and failures, exploring relevant causes.

A comparison of financial status and student quality with actual and "aspirational" peers.

A delineation of available options, and careful analysis of their consequences for student quality and financial outcomes.

The development of measures of quality of our teaching and research programs, both internally and by use of the recently-issued National Research Council study of graduate programs.

A rigorous understanding of the productivity in teaching and research of each department in the College, through a process initiated by President O'Brien, that provided data on each department's teaching efforts, space use, costs, and research output.

More than 75 one-on-one discussions with College faculty about their departments' quality, interrelationships with other programs, and consequences to them of having their department size reduced (or increased) and (if necessary) having enrollments in their doctoral program suspended. This process also involved discussions with all deans in the University, to make certain that programmatic changes would not affect them in unanticipated ways, as well as discussions of the general directions and goals with the Cabinet of Department Chairs in the College and the steering committee of the Faculty Council of the College.

An extensive series of written communications with yoi4 initiated by memoranda from us to help illuminate the problems we confront (January, 1995), the process we initiated to bring your input into the decision making process (March, 1995), and the general outlines of the conclusions we had reached (September, 1995). In each case, we have received significant and valuable input from many members of the faculty of the College to help guide our thinking.

Discussions of directions, assumptions, and details with individual Trustees.

No change from the status quo is painless, and no reasonable course of action is without risk. Nonetheless, we believe there is a way to emphasize and build upon our strengths, while at the same time recognizing the fiscal realities that press upon all institutions of higher education. Some within the College will, at least in the

short term, see themselves as adversely affected by the reduction in size or suspension of enrollment in graduate programs, by the reduction in faculty size, or both. We hope it will be clear to all, however, that we must proceed with the changes that are necessary to the long-term success of the College.

We believe, based in part on extensive discussions with you over the past year (including the 75 visits between your representatives and Dean Aslin and Provost Phelps) that there is a broad consensus among the faculty on the need both to focus our resources and to favor quality over quantity of programs or current program size. We also believe that there is equally strong consensus that we should not reduce programs across the board. One cannot act from this premise without a concrete subset of departments that would be affected more than others (although all departments and their faculties indisputably contribute to the shaping of the overall College program). The relevant question is whether the path chosen is the most promising for the institution as a whole. We believe that it is.

Alternatives Considered and Rejected

In comparison to the Plan presented here, we think it useful for you to understand other approaches we considered, some obviously stronger than others, but all listed here for completeness. The choices we faced included the following (omitting here, for reasons of space, the full arguments for and against each alternative):

A. Follow the current path of continual cost cutting and budget squeezing, leaving unchanged the general nature of the College, its programs, and its overall size. We viewed this option as completely unacceptable, on the grounds that it would worsen, not improve our revenue potential, and simply continue to magnify existing problems as time passes.

B. Cut faculty size sufficiently so that current revenues would sustain the remaining expenditures. Such cuts could be made either uniformly across departments, or selectively, but in either case, the target faculty size that we could sustain with current revenues (something on the order of 250-275 overall faculty in the College, compared with the current level of 343) would without question cripple our ability to deliver an educational product that would meet the market test of quality and desirability. This path, too, ultimately diminishes our quality as an institution, and is likely to lead to reduced revenue in the future, putting us again out of balance. For these reasons, we firmly rejected this approach.

C. Eliminate all graduate programs in the College. This choice -- which essentially sees the University as having an undergraduate college with several professional schools -- significantly alters the nature of the University, casting away an important feature of both our self-image and external reputation. Even if it could succeed in solving our financial problems, it would place us more directly in competition with a very well-established group of liberal arts colleges throughout the Northeast and the country where we would have little comparative advantage. We rejected this option as well.

D. Eliminate "severable" portions of the College -- i.e., those disciplines not "central" to a basic undergraduate education. In reality, this would have meant -- and this was suggested to us by a number of serious commentators both within and without the College -- completely disbanding the engineering and applied sciences departments of the College. This choice, too, would have thrown away valuable and

prestigious elements of the College, and perhaps more important, would not have helped solve some of the fundamental problems we confront. Since its students are, on average, neither better nor worse than others we admit to the College, eliminating engineering risks decaying the student body quality for any given undergraduate student body size, where improving that quality has been a highest priority. We did not choose this path.

E. Grow ourselves into greater excellence. This approach, at its essence, relies upon the well known relationships between size and reputation, arguing that, if we only could increase our size by x Percent (often 10-20 percent, or perhaps 50-100 percent) we would gain the national stature that would bring us students and revenue to help solve our problem. This approach suffers from several flaws. First, we would likely have to increase the size of our faculty enormously to succeed in this approach, and even then there would be no guarantee of success. We note that this essentially was the approach sought in 1986 when the endowment spending increased from 5 percent to 7.5 percent, and the faculty size from 340 to 383, without succeeding in attracting the students and revenue that we need to sustain such a strategy. In addition, this approach is very difficult to back out of (as our past five years have provided ample demonstration). We seriously doubt that we could have convinced the Board of Trustees to go down this path again, even if we believed it to be the proper choice (which we do not).

F. Continue to expand the student body to increase revenue to support the College. This approach, in some sense, mirrors the defacto strategy taken over the last 15 years, during which time the undergraduate population has increased by I 000 students. Several obvious problems come with this approach. First and foremost, added students inevitably bring with them added costs, not only of instruction, but dormitory capacity, classroom capacity, laboratories, space in the student union, dining facilities, and other areas of the campus. But most important, this approach would make us less rather than more competitive in student quality, eroding the essential nature of the College. We cannot go down this path again with any confidence that it will succeed.

G. Add new programs to attract new undergraduate students, e.g., an undergraduate business major. Particularly with a business major (discussed frequently and intensively about five years ago), we have several major concerns. First, only a few other top schools (Pennsylvania and Washington University are examples) have found this an attractive program to mount. Second, the number of intended majors in undergraduate business has plummeted steadily in recent years, now to half its peak scale, and this pool of majors has significantly lower quality than the remaining pool of college prospects. Heading in this direction would dilute our effort to increase the student body quality (see below). And finally, such a program would require expenditure of significant new resources and expand the scope of activities we undertake, conflicting with our overall desire to bring an increased focus and coherence to our undergraduate experience here. We reject this alternative as well.

H. "National Meliom." We considered as an alternative a national extension of the Meliora program implemented last year in New York State. That program was in fact quite successful in its own right; applications and enrollments increased from New York, and the combination of a stronger applicant pool from within state and our ability to substitute into that pool to replace weaker students from out of state, were in significant part responsible for an increase of 34 SAT points in the most recent entering class

compared with a year ago. The program was also responsible for a modest increase in the financial outcomes of the College, compared with (to our best judgement) the alternative of doing nothing. Taking this program nationally, however, would likely lead to quite different and less favorable outcomes, and we have chosen not to do this. First, the financial consequences differ, because the mix of full-tuition and financially aided students differs greatly between in-state and out-of-state pools. This is in significant part due, we believe, to the particular competition we face from the SUNY system in New York. This and other facets of the program we learned while conducting the NY "experiment" have led us to conclude that, for outside of New York, a program focused more specifically on very high quality students would best serve the College, and we have in fact implemented such a merit aid program already for the coming class.

The Future

Our Common Task. We must all work together to bring this plan to fruition -- the future of the College depends upon successful cooperation by all. Faculty across all departments must work to enhance the undergraduate experience of our students, for our success in this arena absolutely and irretrievably defines our ability to carry out other missions of the College, including graduate education, research, and other scholarly activity, and co-curricular activities within the College. Departments that continue their graduate programs will need to focus more on undergraduate education, through innovative additions to the Quest Program and thoughtful response to the new curriculum as approved by the College Faculty Council this past spring. Departments that have had their doctoral programs suspended will need to develop their new roles in a positive and supportive fashion. Departments whose programs are scheduled for further review will have to responsibly examine the nature of operating a more focused PhD program.

Commitment to Scholarship. The change in the scope of doctoral programs in the College does not mean that we have abandoned in any way the intent that these departments and their faculty will vigorously pursue research and scholarship in their respective disciplines. Indeed, we will continue to expect and require research productivity from these faculty colleagues. We recognize that, in every discipline, there are crucial elements necessary to pursue scholarly activities. We have set aside modest funds to support the scholarly efforts of faculty in departments who will no longer carry out doctoral training, to assist in their continued intellectual activity in scholarship and research,

In programs where doctoral studies continue, we have programmed an investment in doctoral stipend levels for a number of them, in order to enhance the attractiveness of Rochester for the very best students. This step, we view, is essential to continue to attract the strongest students to our strongest programs, and it is a step we cannot afford to take while attempting to operate our current range of doctoral programs.

Rewards for Success. As the Rochester Renaissance is successful, new resources will be created to reward those departments that have been most successful in supporting the new endeavor of the College. Departments successful in attracting majors, minors, students to clusters, and high quality "service" functions (a necessary part of any college curriculum) will find new rewards in the future, in terms of higher compensation, enhanced support for departmental activities, and ultimately, in enhanced faculty positions allocated to departments. We wish to make clear that, in the new College environment, resources will flow more generously to those departments which succeed best in supporting the overall goals of the Renaissance Plan, relating both to undergraduate teaching outcomes and to the production and dissemination of new

knowledge. We understand that the processes by which these goals can be accomplished vary across departments who have (and do not have) active doctoral programs, but we wish to emphasize here the primacy of the goals in both teaching and scholarship.

Other Investments. The fiscal plans we have developed include vital investment in the infrastructure of our University, both physical plant and new intellectual resources. This Plan contains a program to add (incremental over time and building to) approximately $1.5 million per year to River Campus physical plant replacement and renovation beyond current spending, to be used, for example, for classroom improvement and modernization (including computing in the classrooms), and general improvement of the campus appearance. In addition, we have set aside $.3 million per year to improve our "information" resources, including the library, computer networking capability, and related investments. (These funds are not intended to provide "end user" computing capability, which remains a responsibility of the College and individual departments, but rather for central resources that affect all faculty and students.)

Organizational Structure. To help support the new College, we will analyze the opportunities for a substantially more independent, free-standing administrative entity, in parallel with the considerable independence of the major professional schools of the University (which all have school-based admissions, marketing, and development functions, as well as dedicated separate endowments). The current College structure cannot yet support such independence, but we will move steadily towards a reorganization of functions that will lead directly to this goal. This degree of independence from central administration is a natural follow-on to the previous recombination of the Colleges of Arts and Science and Engineering and Applied Science that we introduced a year ago.

Evaluation Time Frame. We have asked the Board of Trustees for -- and they have agreed to -- a five-year horizon to evaluate the shift from the current environment to the new College, smaller in scale, more compact in its focus of graduate programs, much more residential in its nature, and with a dramatically enhanced quality of the student body. The transition will assuredly require excessive use (i.e., more than the target 5.5 percent annual draw) of the University's unrestricted endowment, but we cannot set forth on this course and then reverse it within a few years because of nervousness over whether the ultimate financial goals can be met. Thus, the Trustees have agreed to allow this Plan to proceed for five full years, allowing a full year of operation with all four classes at the newly-sized College undergraduate population, before re-evaluating the plan. As of now, the College no longer operates on a year-to-year basis, but rather on a five-year plan, so that programmatic and related objectives can be pursued clearly, consistently, and with a reasonable time horizon.

If these plans prove successful, implementation and refinement can continue apace, If the revenue gains anticipated from these changes do not emerge, several alternatives are available at that time, including (as a first step) a reversal of the decision to downsize the undergraduate class. This approach, unlike previous strategies to increase the faculty size, is readily reversible without major financial or organizational trauma to the College and the University. Together we can succeed with this plan, if all faculty and staff work to achieve it. It will require change and adaptation from many, but the potential rewards are great -- a highly focused and coherent undergraduate educational program, a significantly stronger student body, smaller classes, excellence in our graduate programs, and perhaps best of all, a stable and positive financial future for the

College that we can all look forward to and depend upon. The alternatives, as outlined earlier, present a bleak picture for the College. Thus, we set forth the Rochester Renaissance Plan as the path along which we move together. We look forward with the strongest possible enthusiasm to proceeding together with you towards these new goals.

Sincerely, Thomas H. Jackson
Charles E. Phelps
Richard N. Aslin

Appendix 3: Report from the Mathematics Department at the University of Rochester

Section 1: Introduction

On November 16, the University of Rochester administration announced its decision to terminate the graduate program in mathematics immediately, and to reduce the full time mathematics faculty from 21 to 10 "over time". There was absolutely no attempt to obtain outside evaluations of our program. The Mathematics Department was informed of this decision one hour before the formal public announcement. The story had already been "preplanted" with the *New York Times*.

This document is a detailed report on the current situation of the Mathematics Department at the University of Rochester. The purpose of this report is to address the specific charges for this decision which were stated in the Dean's "Rationale for the restructuring plan" and which is quoted in Appendix A8.

This department has a solid core of distinguished senior faculty together with a group of young people who are contributing to the strength and prestige of the department. Some of the evidence for this is as follows: Approximately 60% of the faculty receive some form of Federal grant support. Four have received Sloan Fellowships. Two have given invited talks at the International Congress of Mathematicians. Two others have given invited addresses at the Annual National Meeting of the American Mathematical Society. Short biographical sketches for all current faculty of the department are included in Appendix A7. We list (1) fields of interest, (2) selected publications, (3) grant support, and (4) invited addresses. We feel that these biographies paint a strong picture of research quality.

Undergraduate teaching is taken seriously. Two-thirds of the calculus courses are taught by the faculty. The other third is taught by our graduate students. These students are selected carefully and have performed well. The summary of student evaluations given in section 3 corroborates this claim. (We stress this point because some of the harshest criticism of the administration is directed at our calculus teaching.)

During the last 6 years, our graduate program had a student body varying from 31 to 40. We produced 37 Ph.D.s during this period. More details are included in section 4. The quality of the applicants has been steadily increasing. In addition, we have tried to exercise the highest feasible mathematical standards for admission of our graduate students.

One of the justifications given by the Dean for the severity of the suggested cuts is the NRC ranking for the Mathematics Department. Although we have serious concerns about the validity of the NRC rankings of mathematics departments, upon closer inspection they give evidence of the strength for our department. The NRC ranked 139 departments as follows: (i) "distinguished" means 4.01 to 5 points, (ii) "strong" means 3.01 to 4 points, and (iii) "good" means 2.51 to 3.00 points. The precise NRC ranking for the University of Rochester Mathematics Department is 2.9. It is stated explicitly in the NRC report that there is a strong positive correlation coefficient (of .5) between size of department and ranking; namely larger sized departments tend to do better in these rankings. There is an admitted statistical error in these rankings. In addition, there are ONLY 27 departments in the top half of the NRC rankings which receive Federal support at a rate greater than the 60% rate here.

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Appendicies

Section 2. Fact Sheet

Number of faculty: 22 (1 untenured) Number of graduate students: presently 31 Average number of undergraduate mathematics degrees: 32 per year for the last 5 years. Number of students in mathematics courses: Fall '95: 1,271 students, 4,936 credit hours (almost all of those are in 4 credit courses) Spring '95: 976 students, 3,920 credit hours (almost all in 4 credit courses)

Graduate students: From 1989 to 1995,37 Ph.D. degrees in mathematics were granted. Of these 37 students, 29 found employment at academic institutions, 6 found employment in the private or public sector, and 2 are yet to be employed. Of those who found academic employment, 21 are at research universities and 8 are at colleges which concentrate entirely on teaching.

Total grant income budget:

6/91.....$768,714
5/92.....$916,414
6/93...$1,151,635
6/94...$1,203,136
6/95...$1,475,671

Thirteen members of the department currently have grants. Overhead charged by the university for National Science Foundation Grants was negotiated at 57%. The overhead charged for the academic year ending on June 1995 was $206,889.

Cost of the stipends for the graduate program in the academic year ending June 1995: $182,844

Remarks: Every member of the department teaches four courses per year with the exception of one member who teaches three.

Every member of the department holds a Ph.D. in mathematics and every member of the department has a respectable publication record.

Section 3. Some Aspects of Undergraduate Teaching

The Mathematics Department makes a strong effort to maintain quality in the teaching of undergraduates. Performance in this area is monitored by two kinds of teaching evaluations. Those who teach a course or sections of a course are evaluated by students using a form designed and compiled by the University Administration.

Graduate students (and the very few undergraduates) who are teaching assistants are evaluated by students using a TA evaluation designed and compiled by the Mathematics Department. It is our view that the statistics so collected confirm that we have maintained a high level of quality in undergraduate teaching.

The data collected by the university allows for two categories of evaluation, student satisfaction with the instructor and student satisfaction with the course. Since this information is collected over the whole College, comparisons can be made between the evaluations of the Mathematics Department and the evaluations of the entire Natural Sciences Division. (In the Spring of 1994 the classification of departments was changed and mathematics fits into what is now called Formal Reasoning which includes Mathematics, Statistics, and Computer Science.) The data indicates that, in the period from Fall 1992 to Spring 1995, there is no significant difference between the student evaluations of teaching in the Mathematics Department and the student evaluations of teaching in Formal Reasoning (1995) and in the Natural Sciences Division.

For example, the ratings for Spring 1995 are stated with 5 being the highest possible rating. In smaller courses with no more than 20 students, instructor approval was rated 4.43 for mathematics and 4.33 for Formal Reasoning. The corresponding numbers for course approval were 4.15 for mathematics and 4.15 for Formal Reasoning as a whole. In middle sized courses between 21 and 40 students, instructor approval was 3.70 for mathematics and 4.14 for Formal Reasoning while corresponding course approval was 3.56 for mathematics and 3.71 for Formal Reasoning. In the largest courses with 41 to 100 students, instructor approval was 4.49 for mathematics and 4.23 for Formal Reasoning, while course approval was 3.79 for mathematics and 3.66 for Formal Reasoning.

We find the following particularly instructive: During the years >of 1992 to 1995, the category of courses with 41 to 100 students (which includes first and second year calculus courses), the student evaluation of mathematics instruction and mathematics courses has been consistently higher than the average for Natural Sciences or Formal Reasoning as a whole.

In middle sized and smaller courses, the comparative ratings of mathematics and natural sciences (or Formal Reasoning) oscillate from year to year. Sometimes, mathematics is rated higher and sometimes it is the other way around.

Each semester approximately one third of our calculus courses are taught by graduate students. Their performance has been outstanding. Seventy five percent of them were rated better than the average rating in Formal Reasoning as a whole. We pick these graduate students carefully on the basis of their previous performance as TA's.

The TA's who teach recitations are evaluated via an evaluation form which is scaled from a low of 1 to a high of 5. The data indicates that there is a high level of student satisfaction with the performance of these graduate students. For example, in Spring 1995 and Fall 1994, 11 out of 16 received an overall evaluation of at least 4. In Spring 1994, 7 out of 15 received an evaluation of at least 4, and in Fall 1993, 12 out of 15 received an evaluation of at least 4. During this entire period precisely one evaluation was below 3.

Three other undergraduate activities supported by the Mathematics Department should be mentioned. The first is an undergraduate mathematics society. The second was the development of a summer mathematics camp for the Pew Midwest Science Cluster. Members of the Mathematics Department conducted this summer math camp. Finally, each year, members of the department help students to prepare for the Putnam Mathematical Competition.

Section 4: Some Aspects of the Graduate Program

From 1989 to 1995, the University of Rochester granted 37 Ph.D. degrees in Mathematics, an average of roughly 6 per year. Upon the completion of their degrees, 29 found employment at academic institutions, 6 found employment in the private or public sector, and 2 are yet to be employed. Of those who found academic employment, 21 are at research universities and 8 are at colleges which concentrate entirely on teaching.

We feel that our students from this period have done well. Among the schools which employ them are Duke University, Northwestern University, Queens College, University of Lille, University of Minnesota, University

of Georgia, Centro de Investigacion del I.P.N., and Berea College. Among the private companies which employ them are Xerox and I.T.T..

Students from earlier periods are presently on the faculty of Dartmouth and Notre Dame.

The quality of the applicants to the graduate program has been steadily increasing. Although some of the admitted students chose to go elsewhere (e.g. Princeton, MIT, and Berkeley) , there are currently three students who have used fellowships which could be used anywhere.

Section 5: The NRC Data

The following information can be extracted from the National Research Council evaluation of graduate programs.

(1) Is the level of grant support in the University of Rochester Mathematics Department "minimal," as described by the Dean in his "Rationale for restructuring" ?

No, in fact the level of outside grant support here has been very strong when compared with departments which have similar rankings, and is respectable even when compared with departments in the first quartile.

The NRC figures state that 60% of our faculty (of 25 at the time) had federal support at some time between 1986 and 1992, and this agrees with our own numbers.

Of the 33 mathematics departments in the top quartile in the NRC ratings,18 have less than or equal to this level of support. Of the 34 departments (excluding us) in the second quarter, 25 have less than or equal to this level of support. Of the 13 departments which are tied with us or which are immediately ahead of us in the rankings (namely, those places with numerical ratings of 2.9 to 3.06), 10 of them have less than or equal to this level of support. The 60% support figure for the Mathematics Department indicates the high level of respect which our faculty commands nationally.

(2) How is the U of R math department doing, given its modest size?

The NRC report notes, on p.3, that there is a sizable correlation between rankings and departmental size. In departments of mathematics the correlation coefficient is .5 (as noted in the table on p.453). The size of the U of R Mathematics Department's was 25 at the time of the NRC survey. (The size is currently 21 regular and one temporary faculty.) This puts it substantially below the mean for departments in the first and second quartiles, which are 46 and 34 faculty, respectively. The thirteen departments with which it is tied or which are immediately ahead of it in the rankings have a mean size of 32.

Thus, the U of R Mathematics Department is doing well for its size.

Furthermore, there is a smaller, but significant, positive correlation between faculty size and percent of faculty with federal grant support; for mathematics departments, this is .18. Again, given the relatively small size of the Mathematics Department here, the level of support is very good.

(3) How good can a research university be without a doctoral program in mathematics? We can look at the success that other such universities have had.

Notice that 29 of the top 30 research universities cited in the US News and World Report have doctoral programs in mathematics. Also, 27 of them are ranked by the NRC; Emory and Tufts have unranked programs. The only one without a doctoral program in mathematics is Georgetown University, which has a graduate program in chemistry, but not in engineering or in other physical sciences.

The following information is taken from the 1995 NRC report. We looked at disciplines (other than mathematics) in the physical sciences, engineering, and some social sciences in which U of R currently has doctoral programs. Consider 10 such fields, namely

CHEMICAL ENGINEERING (93 schools ranked)
CHEMISTRY (168 schools ranked)
COMPUTER SCIENCE (44 schools ranked)
EARTH SCIENCES (100 schools ranked)
ECONOMICS(107 schools ranked)
ELECTRICAL ENGINEERING (126 schools ranked)
MATERIALS SCIENCE (65 schools ranked)
MECHANICAL ENGINEERING (110 schools ranked)
PHYSICS (147 schools ranked)
POLITICAL SCIENCE (97 schools ranked)

In each field one can look for the schools ranked in the top half which do NOT have doctoral programs in mathematics. We found only five schools that fit this description. Three of them (UC San Francisco, Oregon Graduate Inst. Sci & Tech, and Rockefeller U) do not have undergraduate programs of any kind, and the other two (U of Kansas, and U of Akron) have doctoral mathematics programs (according to their WWW pages) not ranked by the NRC.

The conclusion is that **there is no competing university ranked in the top half of any of these 10 disciplines which does not have a doctoral program in mathematics.**

APPENDICES:

A1. Brief report on Graduate Recruitment 1994, 1995

For the Fall class of 1994, we successfully recruited our two top candidates with two Sproull Fellowships. The yield with the remaining candidates was not good. One feature is that we offered a stipend of $8,500 which was very low compared to other institutions.

Here are some examples which were taken from the AMS publication "Assistantships and Graduate Fellowships in the Mathematical Sciences". These appear to be typical amounts for departments at our level.

Berkeley.....$10,818
Cornell.....$10,212

MIT..... .....$12,510
Northwestern University.....$10,530
University of Minnesota.....$10,800

The stipend offered here was far from competitive.

In 1995 we saw the continuance of a trend toward higher quality applicants to the mathematics department. Our goal was to recruit six new graduate students. We typically overbook by double that amount. Our yield was five. Two of our candidates won Sproull Fellowships in a university wide competition.That is two years in a row for which candidates from the Mathematics Department won Sproull fellowships. This fact gives more substance to the view that the quality of our applicants is improving.

In addition, we offered a higher stipend of $12,500 to six of our candidates. These candidates were identified as having potential for both excellent scholarship and teaching. One of these six offers was accepted. The other 5 went elsewhere: MIT, Cornell, UC San Diego, and two to Berkeley.

A2. Retention of Students in the Calculus Sequence

Since the undergraduate tuition revenue stream is enhanced by higher retention rates, it is a legitimate concern that students finish taking the calculus which they set out to learn.

Although we have not seen the data, it has been asserted that one third of those who start calculus do not finish it. While we do not have precise statistics on the rate at which students fail a calculus course, we believe that this rate is not very high and is, in fact, lower than corresponding rates at comparable insitutions.

We assume that it has been taken into account that many students drop from the faster paced Math161-162 sequence to the slower paced Math141-142-143 sequence. If these "drops" have not been accounted for, the figures regarding drop-outs and failures are misleading.

The claim that 1/3 of the students who start a course do not complete it with a passing grade is not supported by our enrollment data. We have the raw data from the registrar giving the enrollment figures for the beginning and the end of a term. The figures below are a sample for the academic year 94/95 and are typical for the last 5 years. See Table 3 in Appendix A6.

These figures are presented in the following format:

```
 Course       141    142     143  (Fall,Sept/Jan) 254/243  99/91    41/38  Course       161    162     163     164  (F
all,Sept/Jan) 313/293  150/130  119/105   74/64  Course       141    142     143  (Sprng,Jan/June)124/115  170/17
9   22/20  Course       161    162     163     164  (Sprng,Jan/June)47/35    272/233   115/95    81/68
```

For example, 254 students enrolled in Math 141 at the beginning of the Fall term and 243 were enrolled in January at the end of the Fall term.

Freshman calculus is taught in 2 sequences, 141-143, and 161-162. Students switch between the sequences. Sophomore courses are Differential Equations (Math 163) and Multi-variable calculus (Math 164).

There is another source of error in interpreting the completion rate for the calculus sequence, namely, the fact that many majors do not require or evenly strongly encourage their students to complete an entire calculus sequence. Frequently, one course suffices.

Here is a summary of minimum mathematics requirements for B.A. programs with any mathematics requirements at all. The first four programs are among the most popular in the college and none of them require or even strongly encourage a full sequence of calculus.

Biology requires 161-162 or 141-142 (not including 143) with the B.S. requiring in addition 163 or Statistics 201, 212, or a computer science course.

Economics requires 141 and recommends additional mathematics.

Environmental Studies requires 161 or 141-142.

Certificate in Management Studies requires 141.

Chemistry requires 161-162 (or 141-143) with the B.S. requiring in addition 163 plus one additional course in mathematics, computer science, or statistics.

A3. Mathematics Being Taught by Engineering at Rochester

The Mechanical Engineering Department teaches four courses which are essentially equivalent to courses taught by the Mathematics Department.These courses and their history (as recalled by Segal and Pizer) are as follows:

1. Differential Equations (Math 163 and ME 163). The ME department taught this for a short time in the 1970's. They stopped teaching it prior to 1975. They began teaching it again about 5 years ago.

2. Vector Calculus (Math 164 and ME 164). ME taught this for a while in the 1970's. They stopped teaching it in 1978. They began teaching it again about 5 years ago.

3. Boundary Value Problems (Math 281 and ME 202). ME started teaching this about 10 years ago.

Note:

(i) At the time ME started teaching these courses, ME was in a school of engineering was separate from the school of arts and sciences in which mathematics resided. Each school had a separate dean.

(ii) ME began teaching ME 201 and 202 because (as they admitted at the time or at least some of their faculty did) that they were losing students and they wished to "capture" them. Their students were not quitting because of mathematics courses rather they were quitting because they were interested in different subjects.

(iii) Nationally, enrollments in engineering are cyclical. Also it seems that nationally that the interests of engineering departments in teaching mathematics courses is also cyclical. These cycles may not be unrelated.

A4. Summary of Some Teaching Innovations

(1) Numerical analysis: Math 280, (1987-1990)

Over several years the Mathematics Department developed this course from a cookbook survey of algorithms to a course centered around a small number of principles for developing algorithms and analyzing errors. In particular, the use of Peano's theorem as a basis for analyzing "theoretical" errors is emphasized. Among the myriad of elementary textbooks with "numerical analysis" titles, very few share this philosophy--we are now using a book by Kincaid and Cheney which is reasonably attuned to this philosphy. Even though this is a computationally intensive course, it has seemed useful to keep the technology from overwhelming the content of the course--we have used in succession Xgraph (developed, then abandoned at the U of R), graphing calculators, and this next term we will use the freeware programs Xfunctions and mathPAd in the classroom. Students are encouraged to use any calculating tools with which they are comfortable in doing the homework.

The Mathematics Department used Hypercard for advising student majors in mathematics. This project began in 1990, was greatly improved in 1992, and recently converted to world wide web (seehttp://www.math.rochester.edu for the current incarnation.)

The Mathematics Department also uses the Academic File Server to distribute some homework answers, practice tests, etc.. This has been expanded to include delivery via world wide web.

(2) Concrete mathematics: Math 220, (1993)

This course was converted from the standard smorgasbord-like discrete mathematics course (a little logic, a little set theory, some combinatorics, and proof by induction) to a more focused study of recursive relations and sums using Knuth's book Concrete Mathematics. The new course MTH 200 (Transition to higher mathematics) covers some of the original smorgasbord topics for those interested. (3) Qualitative ODE: Math 173 (1994)

The department experimented with Math 171-174 by teaching the differential equations section emphasizing nonlinear techniques. While this has been considered more advanced material in the past, Hubbard and West's book on the subject and the existence of computer programs for doing phase plane analysis now makes it possible to successfully include this information in the initial introduction to differential equations. The resulting emphasis on qualitative behavior is both more interesting, and in these days of symbolic differential equation solvers, more useful, than the traditional approach.

(4) Using Xfunctions and mathPad in Math 163: (Spring 1991 and following)

These freeware programs are smaller and less obtrusive than Mathematica or Maple, but allow cover us to cover what were previously considered "advanced" topics such as phase plane analysis and in the general geometric aspects of differential equations. This benefits non-majors as much as or more than majors. Mechanical Engineering also adopted the use of Xfunctions.

(5) Using Xfunctions in Math 141: (Spring 1993)

This is very useful in the early weeks of the course.

(6) Using Mathematica in Differential Geometry: (Fall 1994)

Mathematica turned out to be very effective in the differential geometry course even though it was only used in a few classes. Several student questionnaires suggested (without prompting) ways in which its use could be expanded in future classes. Next time attempts will be made to use computer displays even more during the course.

(7) Geometer's sketchpad in Projective Geometry (Spring 1994)

Geometer's sketchpad software was used to good advantage in the first part of the course. This gives a great visual feel for the material which is usually lacking in this course. Some of the material was tied to applications in computer graphics in addition to the usual theoretical results.

(8) Physics 121/ Math161Q(1995)

This pair of courses loosely couples the first semester of physics with the first semester of differential calculus. Several experiments are taking place at once: (i) Coordination of material between math and physics, (ii) development of more substantial problems,and (iii) use of computers in delivering and grading homework.

(9) Math 141-143, Math 161-164 (1994)

After extensive meetings with a Math Task Force consisting of the Dean of Undergraduates, with members of the Mathematics, Engineering, and Physics Departments, the Mathematics Department revised the pace of the calculus sequence. This pace was slowed down so as to allow for more time to discuss applications, to practice technique, and to explain ideas. (10) Math 200

A new course was introduced, Transition to Higher mathematics, to ease the passage of majors from calculus to more abstract courses.

(11) Math 325

This course was in Problem Solving, designed for majors at the Junior and Senior level. This course also drew students from Mathematics Education.

(12) Math 238

The course in Combinatorial Analysis was modernized to include some design theory and some coding theory.

(13) Math 285

In Spring 1996, a new course, Methods in Applied Mathematics is being introduced.

(14) Math 215, Fractals and Computer Graphics (cross listed with Computer Science)

This course was introduced in 1992 and is offered on a yearly basis. Topics include the Mandelbrot set, Julia sets, dynamical sytems, and iterated functions systems. The fractal utility program Fractint is used to

illustrate (with the help of an overhead luminator) many examples. The coursework consists of various programming projects and experiments with fractals.

A5. Report on Linkages

Since the issue of linkages has been raised by the administration, we have prepared this report for the AMS fact finding delegation. It is based on a questionnaire sent to the members of the Mathematics faculty.

To the extent that the term linkage, as used by the administration, makes any sense to us, we have identified the following activities that can be so construed. Before presenting our summary, we raise the question whether this novel parameter of linkage is an appropriate measure of the legitimate activity of any Mathematics Department.

I. Transfer of information

------There have been at least five collaborations with faculty in other departments resulting in joint papers or successful grant applications.

------There have been at least ten instances of consultations resulting in acknowledgements in published papers.

------Most of us have answered technical questions raised by faculty and graduate students from other departments. It is our view that the average adjunct, expert in calculus pedagogy, would not have been very helpful for providing answers.

II. Institutional linkages

------Bridging Fellowships

Three of our faculty have bridged to Electrical Engineering, Chemical Engineering, and Computer Science. In each case, these bridges have led to further collaboration or consultations. In contrast to the three successful applications there was a distressing failed application. One faculty proposed to bridge to computer science with the aim of a substantial upgrade of of the course in discrete mathematics, especially under the impact of Mathematica, and Maple. It was turned down by the Dean as lacking intellectual content. How does this auger for the future of undergraduate instruction in mathematics at Rochester ?

------Cross-listed courses with Statistics--there are 5. In the past, there were cross-listings with Computer Science, but these have been dropped in the current catalog.

-----Math Physics Seminar, presently dormant for lack of funds. It has been operating for over twenty years.

III. Instructional Linkages

-----Upper level mathematics courses are prerequisites or strongly recommended for other undergraduate degree programs, e.g. Computer Science, Economics, all 4 Engineering programs, Chemistry, Physics, Statistics. These include Math 201, 220,235,280,281, and 282.

-----Three of our faculty have served as contributing outside members of Ph.D. theses committees.

-----All the respondents to the questionnaire have taught courses attended by graduate students or faculty from other departments: Economics, Physics, Computer Science, Business, Biology, Statistics, Chemical Engineering, Mechanical Engineering, Optics, and the Medical School. Some faculty have given reading courses tailored to the individual requirements of the non-mathematics students taking the course.

A6. Tables

Table Number 1

Summary Of The Mathematics Department Teaching Evaluations

Comparison of the Mathematics Department's means with means for the division of natural science (Fall 1990-Spring 1994) and with means for the division of formal reasoning (Fall 1994-Spring 1995)

Overall Student Rating of Instructor and Course

Class Size =* * <= 20 21 <= * <=40 41 <= * Math Div Math Div Math Div Sp 95 Inst 4.43 4.33 3.70 4.14 4.49 4.23 Crse 4.15 4.15 3.56 3.71 3.79 3.66 Fl 94 Inst 4.00 4.21 4.20 4.14 3.67 3.50 Crse 3.71 3.87 3.61 3.60 3.45 3.37 Sp 94 Inst 4.17 4.09 4.10 4.08 2.93 3.94 Crse 3.95 3.93 3.66 3.85 3.19 3.78 Class Size =* * <= 20 21 <= * <=40 41 <= * Fl 93 Inst 3.9 4.1 3.7 3.8 4.2 3.7 Crse 3.7 4.0 3.5 3.7 4.1 3.6 Sp 93 Inst 4.0 4.1 4.1 4.0 4.1 3.9 Crse 3.8 4.0 3.6 3.8 3.7 3.7 Fl 92 Inst 3.9 4.2 3.6 3.9 4.0 4.0 Crse 3.7 4.1 3.5 3.8 3.4 3.8 Sp 92 Inst 4.0 4.1 4.0 3.9 4.0 3.7 Crse 3.7 4.0 3.6 3.7 3.5 3.5 Fl 91 DATA NOT AVAILABLE Sp 91 Inst 4.1 4.1 3.9 3.8 4.0 3.9 Crse 3.9 4.0 3.7 3.7 3.7 3.7 Fl 90 Inst 4.3 4.2 3.6 3.7 4.0 3.9 Crse 4.0 4.0 3.6 3.7 3.7 3.7 CUMMULATIVE MEANS Inst 4.08 4.16 3.88 3.94 3.93 3.75 Crse 3.84 3.98 3.60 3.70 3.61 3.58

Table Number 2

Summary of Mathematics Department Teaching Evaulations for Calculus Courses, MTH 141-164

Spring 1994- Spring 1995

Comparison of the Mathematics Department's means with means for the division of natural science (Spring 1994) and with means for the division of formal reasoning (Fall 1994-Spring 1995)

Overall Student Rating of Instructor and Course

Class Size =* * <= 20 21 <= * <=40 41 <= * Math Div Math Div Math Div Sp 95 Inst 4.22 4.33 4.04 4.14 4.28 4.23 Crse 3.80 4.15 3.69 3.71 3.71 3.66 Fl 94 Inst 2.96 4.21 4.18 4.14 3.63 3.50 Crse 2.66 3.87 3.58 3.60 3.65 3.37 Sp 94 Inst 4.55 4.09 3.79 4.08 3.20 3.94 Crse 4.18 3.93 3.45 3.85 3.12 3.78

Table 3

Math Course Enrollments

COURSE Fall 94 Fall 93 Fall 92 Fall 91 Fall 90 NUM Spr 95 Spr 94 Spr 93 Spr 92 Spr 91 MTH 141 Sep/Jan 297/310 287/243 274/264 340/320 319/320 Jan/Jun 124/115 91/126 132/128 117/96 115/91 MTH 142 Sep/Jan 78/78 91/76 82/50 57/41 69/61 Jan/Jun 230/220 170/175 170/173 230/209 221/219 MTH 143 Sep/Jan 39/37 38/34 35/28 87/70 93/69 Jan/Jun 22/20 7/21 19/15 24/15 56/54 MTH 161 Sep/Jan 334/320 371/293 398/317 428/323 383/280 Jan/Jun 34/31 37/49 40/32 n/o n/o MTH 162 Sep/Jan 150/130 141/130 134/133 120/104 122/97 Jan/Jun 242/233 272/233 274/238 280/220 204/184 MTH 163 Sep/Jan 119/105 128/103 178/142 170/128 181/143 Jan/Jun 126/128 115/95 133/122 128/115 142/121 MTH 164 Sep/Jan 62/60 69/74 92/75 111/85 83/62 Jan/Jun 55/40 90/64 131/118 138/130 143/119

Sep/Jan and Jan/Jun are the dates of the enrollment figures gathered. The numbers e.g. 297/310 are the figures reported by the registrar when classes began and when classes ended.

n/o: course not offered

A7. Short Biographies

1. Carol Bezuidenhout: Ph.D. 1985, University of Minnesota
Field: probability
Articles: 7 research articles including [The critical contact process dies out (with G. Grimmett), Annals of Probability, 18(1990), 1462-1482].
Other activities: Van Vleck Assistant
Professor, University of Wisconsin, Madison, 1985-1987.

2. Frederick R. Cohen: Ph.D. 1972, University of Chicago
Field: algebraic topology
Articles: Over 60 research articles including (1) [Torsion in homotopy theory, Annals of Math., 109(1979), 121-168 (with J. C. Moore and J. A. Neisendorfer)], and (2) [The homology of Cn-spaces , Springer-Verlag Lecture Notes in Math., v. 533, 208-353]. Grant support: (1) Alfred P. Sloan Fellowship 1979-1983, (2) NSF 1975-present, (3) Member, Insitute for Advanced Study, 1975-77 Other activities: (1) Editorial board of Proceeding of the AMS 1987-1991, (2) editorial board of Forum Mathematicum, DeGruyter (1987-present...), (3) invited address at the International Congress of Mathematicians (1983), and (4) Journees de topologie of the Swiss Mathematical Society,Lausanne, June 1996.
Student theses: five currently supervising two

3. Michael Cranston: Ph.D. 1980, University of Minnesota
Field: probability
Articles: 35 research articles including (1) [The strong law of large numbers for a Brownian polymer, (with T.S. Mountford), Ann. of Probability, to appear], and (2) [Gradient estimates on manifolds using coupling, Journal of Functional Analysis, v99, no.1,110-124, 1991]. Grant support: National Security Agency, National Science Foundation (1985-88, 90-present), and Army Research Office MRI at Cornell (1990-1994). Other activities:(1)Invited scholar ETH (Zurich, June 1994), (2) Universite de Paris VI, (June 1990), and (3) Hour invited address at American Math. Soc. Central Section , Kansas, March 1994, and (4) Co-organizer AMS

Summer Research Insitute, July 1993.
Student theses: two

4. Michael E. Gage: Ph.D. 1978, Stanford Unversity
Field: differential geometry, nonlinear differential equations, integral geometry
Articles: 15 research articles including (1) [Curve shortening on surfaces, Annales Scientifiques de l'Ecole Normal Superieur 2(1990), 229-256], and (2)[A proof of Gehring's linked sphere conjecture, Duke Math J., v. 47, No3, (1980), 615-620]. Grant support: (1) NSF grants: 1986-1990 NSF, and (2) Visiting professor, Institute des Hautes Etudes Scientifiques, Paris, France, Fall 1986 Other activities: (1) Invited hour address Conference on Motion by Mean curvature and Its Applications -- Levico, Italy, June,1994, (2) Micro-program in Riemannian Geometry, Fields Institute, August, 1993, and (3) Invited to speak at Cleveland Symposium (1995) of TMS--The Minerals, Metals & Materials Society.
Student theses: three and one currently finishing

5. Samuel Gitler: Ph.D. 1960, Princeton University
Field: algebraic topology
Articles: Over 40 articles together with 7 monographs, books, and edited conference proceedings including [A spectrum whose cohomology is a certain cyclic module over the Steenrod algebra (with E.H. Brown Jr.), Topology 12(1973)]. Grant support: (1) Rockefeller Foundation,1957-1959, (2) Institute for Advanced Study 1964-1965 and 1985-1986, and (3) National Science Foundation 1989-present.
Other activities: Invited hour address at the annual AMS meeting 1972, member of the Colegio Nacional from Mexico, recipient of the National Prize in Science from Mexico in 1976.
Students: two in Rochester

6. Steven Gonek: Ph.D. 1982, University of Michigan
Field: Analytic number theory, theory of the zeta function
Articles: 20 articles including (1) [Mean values of the Riemann zeta-function and its derivatives, Inventiones. Math. 75(1984), 123-141], and (2) [Simple zeroes of the zeta function of a quadratic number field II (with B. Conrey and A. Ghosh), Analytic Number Theory and Diophantine Problems, Proceedings of a Conference at Oklahoma State Univ., Birkhauser, Basel, 1987]. Grant support: NSF 1985-86, 1988-90 Other activities: Invited lectures at (i) International conference on Analytic Number Theory, Kyoto, Japan, May 1996, and (ii) University of Toronto, October 1994.
Student theses: currently supervising four

7. Allan Greenleaf : Ph.D. 1981, Princeton University
Field: Harmonic analysis
Articles: 12 articles including (1)[Determining singularities of a potential from the singularities of back scattering (with G. Uhlmann), Comm. in Mathematical Physics, 1993] and (2) [Non-local inversion formulas for the x-ray transform (with G. Uhlmann), Duke J. Math. 1989] Grant support: (1) Alfred P. Sloan Fellowship 1990-1992, (2) NSF support for 9 out of the last 10 years
Other activities: Review 2-3 NSF proposals per year and member of NSF Review Panel
Student theses: five currently supervising one

8. Martin A. Guest: Ph.D. 1981, Oxford University
Field: geometry and topology
Articles: 27 research articles including (1) [Group actions and deformations for harmonic maps (with Y. Ohnita), Jour. Math. Soc. Japan 45 (1993) 671-704], and (2) [Configuration spaces and the space of rational curves on a toric variety, BAMS 31 (1994), 191-196] Grant support: (1) NSF grants (1984-86, 1991-93), (2) MSRI Fellowship 1984, (3) Humboldt Fellowship (Max Planck Inst., Bonn, 1986-87), (4) NSF/JSPS Fellowship to visit Tokyo Metropolitan University, 1989/90, and (5) NSF/CGP Fellowship to visit Tokyo Institute of Technology, 1994. Other activities: Hour Invited address, Mathematical Society of Japan meeting, Kobe, Japan, 4/1994.
Student theses: two currently supervising two

9. John R. Harper: Ph.D. 1967, University of Chicago
Field: algebraic topology
Articles: 34 articles including (1) [Co-H-maps to spheres, Israel J. Math., 66(1989)223-237], (2) [H-spaces with torsion, Memoirs AMS, 22(223) 1979]
Grant support: NSF support 1970-1987
Other activities: Two books: (1) Algebraic Topology: A first Course, Addison-Wesley / Benjamin -Cummings (1981), (2) Secondary Cohomology Operations (book in preparation), and (3) Midwest Topology Seminar invited speaker,
Student theses: five currently supervising one

10. Naomi Jochnowitz: Ph.D. 1976, Harvard University
Field: Algebraic number theory, modular forms
Articles: Eight including (1) [Congruences between modular forms of half integral weights and implications for class numbers and elliptic curves, Inventiones. Math, 126 pages, to appear], and (2) [A p-adic conjecture about derivatives attached to modular forms", Proceedings of the Boston conference on p-adic Monodromy and the Birch and Swinnerton-Dyer Conjecture, (Barry Mazur and Glenn Stevens, editors), Contemporary Mathematics, 165. Grant support: NSF 1991-1995
Other activities:(1)Lady Davis Postdoctoral Fellowship (1976-1977), (2) Science Scholar of the Mary Ingraham Bunting Institute of Radcliffe College (1983-1985), (2) Tamarkin Assistant Professor of Mathematics, Brown University, 1979-1982, (3) Mathematical Sciences Research Institute, Spring 1995, and (4) New Vistas in Automorphic Forms, Harvard, 1995, invited talk, and (5) invited talk in the conference on p-adic Monodromy and the Birch and Swinnerton-Dyer Conjecture that was jointly sponsored by Harvard and Boston University.
Student theses: one

11. Richard B. Lavine: Ph.D. 1965, MIT
Field: Mathematical physics, Schrodinger operators
Most influential work: Introduced commutators into quantum scattering theory [See Reed &Simon, Methods of Modern Mathematical Physics IV, p.p 157-163]
Main research goal: Understand resonances (without asymptotics) [Comm. Math. Phys. 128(1990), 263-284]
Articles:24 including [On the inverse scattering transform for the n-dimensional Schrodinger operator, Topics in Soliton Theory and Exactly Solvable Non-linear equations, World Scientific (with A. Nachman), 1987].
Student theses: eight

12. Yi Li : Ph.D. 1988, University of Minnesota
Field: Non-linear partial differential equations Articles: 28 articles including [Travelling fronts in cylinders, preprint (with C. Li)]
Grant support: NSF grants 1988-present
Other activities: (1) L.E. Dickson Instructor, University of Chicago, and (2) Excellent Ph.D. Thesis Award, May 26, 1988 , School of Mathematics, University of Minnesota

13.Saul Lubkin: Ph.D. 1963, Harvard University
Field: algebraic geometry and homological algebra
Articles: 13 articles including [A p-adic proof of Weil's Conjecture, Ann. of Math., 97(1968), 105-255] and [On a Conjecture of Andre Weil, Amer. J. of Math., 89 (1967), 443-458].
Grant support: (1) Alfred Sloan fellowship 1968-1970, (2) NSF Postdoctoral Fellow, Oxford (64-65) and Stanford (65-66), and (3) NSF grants.
Other activities: (1) Invited Colloquia at Harvard, IAS, Princeton, Berkeley, Toronto, Oxford, Oslo, Copenhagen, (2) Senior Visiting Fellow of the Science Research Council of the U.K., (3) a principal speaker at the Barsotti Memorial Symposium, University of Padua, Abano Terme, Italy, June 24-27, 1991, (4) Book, Cohomology of completions, North Holland (1971) (5)Book, Lifted p-Adic Cohomology, contracted, being proofread. (6)Sole Editor, Mathematical Studies series of books, Elsevier Press, the Netherlands, 1994-present.
Students: four currently supervising one

14. Carl Mueller: Ph.D. 1979, University of California at Berkeley
Field: probability
Articles: 29 articles including (1) [Coupling and invariant measures for the heat equation with a noise term, Annals of Probability, 21(1993), 2189-2199], and (2) [On the extinction of measure-valued critical branching Brownian motion, Annals of Probability 17, (1989)].
Grant support: NSF (1982-88, 1991-95), and NSA (1991-95, 1995-98).
Students: one

15. Adrian Nachman: Ph.D. 1980, Princeton University
Field: Inverse scattering problems
Articles: 20 including [Reconstructions from boundary measurements, Ann. of Math. 128(1988), 531-576], and (2)[Global uniqueness for a two dimensional inverse boundary value problem, Annals of Math., to appear]
Grant support: (1) 1990-1997 ONR Nonlinear Aspects of Multidimensional Inverse Scattering Problems, P.I., (2)1986-1989 NSF Inverse Problems in Potential Scattering, Co-principal Investigator with R. Lavine (3)1994-1996 U.S. Army New Methods for Quantitative, High Resolution Ultrasonic Imaging of the Breast, Co-investigator with R. C. Waag, P.I., and (4) 1992-1996 NIH Ultrasound Imaging and Tissue Characterization, Co-investigator, with R. C. Waag, P.I. Other activities: (1) Keynote speaker at the AMS/SIAM Conference on Impedance Tomography, University of Washington, 1995,, and (2) Editorial Board of Inverse Problems, 1991-1994. Collaborators: Emil Wolf (optics), Martin Feinberg (engineering), Robert Waag (electrical engineering and radiodology)
Students: one

16. Joseph A. Neisendorfer: Ph.D. 1972, Princeton University
Field: algebraic topology
Articles: 29 papers, 1 Memoir [Primary homotopy theory, Memoirs of the AMS, 232] including (1) [The double suspension and exponents of the homotopy groups of spheres, Ann. of Math., 110(1979), 549-565], and (2) [On the homotopy groups of a finite dimensional space, Comm. Math. Helv., 59(1984), 253-257].
Grant support: NSF grant support 1979-present.
Other activities: (1) Invited hour address, American Mathematical Society, Annual Meeting, 1983, and (2) Finalist teacher of the year award 1989
Students: four

17. Arnold K. Pizer: Ph.D. 1971, Yale University
Field: algebraic number theory
Articles: 22 articles including (1) [Ramanujan Graphs and Hecke Operators, Bulletin of AMS (New Series) 23 (1990), 127-137], and (2) [Orders in Quaternion Algebras (with H. Hijikata and T. Shemanske), J. Reine angew. Math. 394 (1989), 59-106].
Grant support: (1) NSF Grant (1972-83, 1991-1996), and (2)NSF SCREMS (1993-1996) (co-PI with D. Ravenel)
Other activities: (1) "Ramanujan Graphs" at Computational Perspectives on Number Theory, A Conference in Honor of A.O.L. Atkin, September 14-16, 1995 Chicago, Ill., and (2) Member of the 1988 NSF panel for evaluating curriculum development in Mathematics/Calculus in the 21-st century
Students: four

18: David Prill: Ph.D. 1965, Princeton University
Field: Several complex variables
Outside support: (1) University of Munich, Verwalter einer Assistentenstelle, 1966-67, (2) Eidgenossische Technische Hochschule, Zurich Switzerland, 1970-71, and (3) University of Bonn, Germany, under aegis of SFB 40, 1977-78.
Articles: 7 including [The fundamental Group of the Complement of an Algebraic Curve, Manuscipta Math. 14(1974), 163-172].
Ph. D. Students: Five

19. Douglas C. Ravenel: Ph.D. 1972, Brandeis University
Field: algebraic topology
Articles: 50 articles including (1) [Localization with respect to certain periodic homology theories, Amer. J. Math., 106(1984), 351-414], and (2) [The nilpotence and periodicity theorems in stable homotopy theory, Seminaire Bourbaki, Expose' 728, Asterisque 189-190(1990), 399-428]
Grant support:(1) NSF 1972- present, (2) Alfred Sloan Foundation fellowship 1977-81, and (3)Troisieme Siecle(Switzerland), 1980
Other activities: (1) invited address, International Congress of Mathematicians, 1978, (2) Seminaire Bourbaki, Paris, 1990, (3) Holiday Symposium, New Mexico State Univ. 1989. Books: (4) Complex cobordism and stable homotopy grpups of spheres, Academic Press, 1986, and (5) Nilpotence and Periodicity in Stable Homotopy Theory, Ann. of Math. Studies, 128, Princeton, 1992
Students: two here and four while at the University of Washington

20. Sanford Segal : Ph.D. 1963, University of Colorado
Field: complex variables, history of science, and math education
Articles: 45 articles including [Iterative characterization of powers and exponentials, Aequationes Mathematicae, 37(1989), 201-218]
Grant support: Alexander von Humboldt Foundation (Germany), Spring 1988
Other activities: (1) member, Advisory Board for NSF grant (PMSA) to Rochester City School District, and (2) Nine Introductions in Complex Analysis, North Holland, 1981
Students: five

21. Barbara Shipman: Ph.D. 1995, Arizona
Field: Geometry, moment mappings, representations of Lie algebras, and their applications to integrable systems
Articles: On the geometry of certain isospectral sets in the full Konstant-Toda lattice, to appear
Other activities: A series of talks in the geometry seminar of the University of Rochester.

22. Norman Stein: Ph.D. 1957, Cornell University
Field: algebraic topology
Articles: 9 including [Secondary characteristic classes, Ann. of Math., 76(1962), 510-523, (with F.P.Peterson)]
Grants: Various grants over the years (NSF and Air Force)
Students: five

The Dean's Rationale for the Restructuring Plan

"Effective teaching of calculus is an essential ingredient of a quality undergraduate educational experience at Rochester, particularly given the large proportion (over 70%) of first year students who enroll in the calculus sequences. Although arguments could be made that graduate students in Math play a key role in calculus instruction, much like the role that graduate students in English play in basic-level writing courses, the dwindling numbers of Math graduate students undercut one rationale for retaining a Ph.D. program in Math. There are other ways to service our need for calculus instruction, including the hiring of non-research (adjunct) faculty and/or the redirection of other qualified faculty from other disciplines. "Coupled with these concerns is a Ph.D. program in Math that is of modest distinction (though certain subgroups of faculty are nationally prominent). Its NRC ranking is 58.5 (42 percentile). As shown in Table B, 25 of the top 30 institutions have higher ranked Math graduate programs, 3 do not offer a Ph.D. in Math, and only 1 has a poorer ranked graduate program. Despite good intentions by several faculty in Math, undergraduate instruction is less than optimal, the best graduate students are going to other programs, and no reasonable investment in the department would push our ranking to a level commensurate with the overall institution.

"For these reasons, we do not believe that continuation of the Ph.D. program in Math is justified. Linkages with other departments and programs are minimal, as is grant income (generally true of Math departments). We believe that a refocused department that emphasizes quality calculus instruction (to a smaller undergraduate student body), attention to majors and minors, and individual research excellence, will best serve the overall needs of the College. A reduction in steady-state faculty size over time from 21 to 10 FTEs, with additional non-tenure-track teaching faculty who staff much of the elementary calculus sequences, can achieve these goals."


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Friends of the University of Rochester

The following individuals have written letters of support for the University of Rochester Mathematics Program. The * after a name denotes a member of the National Academy of Sciences. For a sample of individuals, the name is linked to the text of the letter. Additional names and letters will be posted.

Andreas Arvanitoyeorgos
Ph.D, British Counsil - Greece

Edward F. Assmus, Jr.
Professor of Mathematics, Lehigh University

Sir Michael Atiyah *
Director, Isaac Newton Institute for Mathematical Sciences, Cambridge, England; Master of Trinity College, Cambridge; Past President - Royal Society of Sciences

George E. Backus *
Research Professor of Geophysics, Institute of Geophysics and Planetary Physics, University of California at San Diego

Robert S. Boyer
Professor of Computer Science, University of Texas at Austin

William Browder *
Professor of Mathematics, Princeton University; Past President of the American Mathematical Society

Daniel E. Bump
Professor of Mathematics, Stanford University

Jin-Yi Cai
Professor of Computer Science, University of Buffalo

Octav Cornea
Associate Professor of Mathematics, University of Lille, France

James B. Coykendall
C.C. Hsiung Visiting Associate Professor of Mathematics, Lehigh University

Donald M. Davis
Professor and Chair, Department of Mathematics, Lehigh University

Tom Davis
Principal Scientist and Co-founder, Silicon Graphics

William G. Dwyer
Hank Professor of Mathematics, University of Notre Dame

James Eells
Professor Emeritus, Cambridge, England

Richard R. Ernst *
Professor, Swiss Federal Institute of Technology, Zurich; Nobel Laureate, Chemistry

Herman Feshbach *
Institute Professor Emeritus, Massachusetts Institute of Technology; Past President, American Physical Society; Past President, American Academy of Arts and Sciences

Michael H. Freedman *
Charles Lee Powell Chair, Mathematics, University of California at San Diego; Fields Medal recipient

Donald Girod
Associate Professor of Mathematics, Canisius College

Sheldon Lee Glashow *
Mellon Professor of Science, Harvard University; Nobel Laureate, Physics

Marvin L. Goldberger *
Dean, Division of Natural Sciences, University of California at San Diego; President Emeritus, California Institute of Technology; Former Director, Institute for Advanced Study, Princeton; Co-chair of the 1995 National Research Council study on Research-Doctorate Programs in the United States

David M. Goldschmidt
Director, Center for Communications Research

Allan Gottlieb
Professor of Computer Science, New York University

James Lin
Professor of Mathematics, University of California at San Diego

Saunders Mac Lane *
Max Mason Distinguished Professor, Emeritus, University of Chicago; Past President of the American Mathematical Society; National Medal of Science recipient; Past Vice-President of the National Academy of Sciences

Mario C. Matos
Professor of Mathematics, State University of Campinas, Brasil

Barry Mazur *
Professor of Mathematics, Harvard University

Ken McMurdy
Professor of Mathematics, University of California at Berkeley

Jerrold Meinwald *
Goldwin Smith Professor of Chemistry, Cornell University

Michal Misiurewicz
Professor of Mathematics, Indiana University - Purdue University, Indianapolis

Cathleen Synge Morawetz *
Professor of Mathematics, Courant Institute of Mathematical Sciences; President, American Mathematical Society; Member, American Academy of Arts and Sciences

Joel Moses
Provost of Massachusetts Institute of Technology and D.C. Jackson Professor of Computer Science and Engineering

Mutsuo Oka
Professor of Mathematics, Tokyo Institute of Technology, Tokyo, Japan

Hiram Paley
Associate Professor of Mathematics, University of Illinois, Urbana

Jean M. Parks
Research Fellow, Xerox Corporation

David Pengelley
Professor, New Mexico State University

Lee Rainwater
Professor of Sociology, Harvard University

Murray Rosenblatt *
Professor of Mathematics, University of California at San Diego

Kenneth A. Ross
Professor of Mathematics, University of Oregon

Hugo Rossi
Professor of Mathematics, University of Utah; Editor, NOTICES of the American Mathematical Society

Ernesto Schirmacher
PhD candidate, University of Minnesota; 1992 graduate, University of Rochester

Alan H. Schoenfeld
Elizabeth and Edward Connor Professor of Education and Mathematics, University of California at Berkeley

George B. Seligman
Professor of Mathematics, Yale University

Howard Stein
Professor in the Department of Philosophy, the Committee on the Conceptual Foundations of Science, and the College, The University of Chicago; Fellow, American Academy of Arts and Sciences

Jean-Claude Thomas
Chair, Department of Mathematics, University of Lille, Franc

Edward C. Turner
Professor, Department of Mathematics and Statistics, State University of New York at Albany

Steven Weinberg *
Professor of Physics, University of Texas at Austin; Nobel Laureate in Physics

W. Dexter Whitehead Jr.
Alumni Professor of Physics Emeritus, University of Virginia

Robert Williamson
Associate Professor and Chair, Department of Mathematics, Claremont Graduate School, California

W. Stephen Wilson
Professor and Chair, Department of Mathematics, The Johns Hopkins University

Friend of the University of Rochester

15th January 1996

President Thomas Jackson
Administration 240
University of Rochester
Rochester
NY 14627
USA

Dear President,

I understand that you are contemplating major changes in the Mathematics Department at the University of Rochester. The American Mathematical Society, of which I am a member, has expressed its concern and is setting up a task force under Professor Arthur Jaffe of Harvard University to investigate the matter.

I hesitate to interfere in the internal affairs of another university and I can quite understand that universities have to respond to financial pressures by reassessing their activities. However, I am concerned that the role of Mathematics may not be fully appreciated and I hope you will allow me to address the matter from that viewpoint.

Perhaps I should explain that, as the recently retired President of the Royal Society (the UK equivalent of the US National Academy of Sciences). I have had responsibilities across the whole of science. In addition I currently direct the Isaac Newton Institute for Mathematical Sciences in Cambridge, where we run programmes that involve the interaction of mathematics with other fields.

From all this experience I am firmly of the view that Mathematics still occupies a central role in both the Natural and Social Sciences. Increasingly the complex problems that scientists now face require more sophisticated mathematical understanding. The advent of more powerful computers has in no way decreased the fundamental relevance of mathematics.

I can illustrate the scope of mathematical interaction with other fields by listing just a few of the interdisciplinary programmes that we have run at the Newton Institute in the past few years:

(i) Computer Vision (Robotics etc)
(ii) Epidemics (Measles, Aids)
(iii) Geometry and Physics (Elementary particles)
(iv) Cryptology (Security of codes)
(v) Financial Mathematics (Derivatives)
(vi) Meteorology (Weather forecasting)

I hope that in assessing the role of Mathematics at Rochester, you will bear in mind the scope and opportunity for interaction with other disciplines.

Yours sincerely,

Michael Atiyah

Friend of the University of Rochester

February 27, 1996

President Thomas H. Jackson
University of Rochester
Rochester, NY 14627-0011

Dear President Jackson:

I write to protest the planned closing of your graduate mathematics program.

In my view, a graduate program in mathematics is the very last graduate program that a university ought to contemplate closing. Mathematics, as the oldest branch of science, as both the queen and servant of the other branches of science, is quite simply the very deepest and most important of subjects. The singular status of mathematics can perhaps be most clearly seen by observing that it is through mathematics that all scientific knowledge is expressed.

Research in mathematics has often paved the way for major developments in other branches of science and of technology. For example, the history of computing was influenced in the most profound ways by the previous mathematical research of such figures as von Neumann, Turing, Post, Godel, Skolem, and Herbrand. The concept of formal language, of which programming language is a prime example, arose from mathematical research of the purest variety, long before electronic computers could be built. In our own day, the greatest living computer scientists, people such as McCarthy, Minsky, Knuth, Karp, Dijkstra, and so forth, are, as a rule, mathematicians of the first rank, and the majority of them were trained in graduate mathematics programs. The history of science and technology is replete with stories of the most profound results flowing from mathematical research.

I predict that killing the mathematics graduate program at Rochester will result in the departure from Rochester of all your finest mathematicians. First rate mathematicians are unlikely to be retained merely by the prospect of teaching rudimentary courses. Teaching and research at rather advanced levels is essential to the life of the mathematical mind. The departure from your faculty of its best mathematicians will result in a considerable reduction in the international standing of your university.

I can easily understand that cost reductions at Rochester are necessary. But I could not have been more shocked had I learned that you had decided to close your library. Surely, far more sensible cost reductions can be found than the elimination of your graduate program in mathematics.

Sincerely,

Robert S. Boyer
Professor
Department of Computer Sciences

College of Natural Sciences
The University of Texas at Austin

Friend of the University of Rochester

December 12, 1995

Thomas H. Jackson
Administration 240
University of Rochester
Rochester, New York 14627

Dear Dr. Jackson,

I am very disturbed to hear of your plan to eliminate the graduate program in mathematics at the University of Rochester, and to replace many of the full time faulty members with adjunct faculty to teach your calculus and other undergraduate mathematics courses.

No matter how much time you spend trying to convince yourselves otherwise, this will certainly hurt the quality of your undergraduate mathematics education (and hence their education in all the engineering and scientific fields). The adjunct faculty will have less passion for the subject, less understanding of how it fits together, and since their contracts will presumably be renewed year-to-year, they'll tend to come and go, and hence will have less idea of the mathematical requirements of your other departments.

In the 13 years since I helped to found the company Silicon Graphics, I've noticed that it is becoming more and more difficult for us to hire students with a sufficient background in mathematics. Every year, we require more, and the students seem to have less.

To do computer graphics, calculus is not enough -- we require a strong background in linear algebra, and people who are interested in making computer-generated dinosaurs for "Jurassic Park" or a liquid metal man in "Terminator II" or want to have Forrest Gump shake hands with Richard Nixon had better have a solid grounding in advanced calculus, differential geometry, and projective geometry.

Computer graphics is clearly a rapidly growing field, and it is now possible to do very effective 3 dimensional renderings on modestly priced personal computers. Hence, the job market is rapidly expanding, but the mathematics is not getting any easier. In fact, techniques like morphing (making one face or shape change to another smoothly), texture-mapping, physically-based modelling, virtual reality, robot motion and control, et cetera, are all becoming affordable for the general public, so those who hope to deliver products based on these technologies had better understand calculations in phase space, Fourier and discrete cosine transformations, mathematical physics, and be very comfortable with 3 dimensional geometry, including differential geometry.

There is a big push these days to make World-Wide-Web pages on the Internet support three-dimensional objects with motion, shading, and the other usual bells and whistles, and we're only one company of many that is hiring lots of engineers to work on these projects.

So if you're interested in producing students who can compete in these rapidly-growing job markets, you should be thinking about how to increase the amount and quality of mathematics they learn. I checked the records for the last couple of years and we've hired 4 University of Rochester graduates. I hope we'll be able to continue to find the sorts of people we need from there.

Sincerely,

Tom Davis
Principal Scientist, Silicon Graphics

Friend of the University of Rochester

Zurich, December 19, 1995

Dr. Robert B. Goergen
Chairman, Board of Trustees
University of Rochester
Blyth Industries
Two Greenwich Plaza
Greenwich, CT 06830-6353
U.S.A.

Re: Reduction of Faculty in the Mathematics Department

Dear Dr. Goergen,

I have heard of the plans to reduce the faculty in the mathematics department of the University of Rochester from 21 to 10 and to terminate the graduate program in mathematics. I have studied the Report of the Rochester Fact Finding ad hoc Committee of December 11, 1995, and the related documentary papers.

With this letter, I would like to tell you frankly my opinion as a physical chemist who would not have won a Nobel Prize without a very thorough training in basic mathematics, in addition to my principal studies in chemistry. Fortunately, the Swiss Federal Institute of Technology (ETH) in Zurich had since many decades and still has the foresight to know that mathematics is the basis for all natural sciences and mathematics is becoming more and more important as science becomes more advanced and more quantitative. Advances in chemistry are no longer possible without the most sophisticated mathematical tools and with the best training possible by experts in pure and applied mathematics.

Reducing mathematics to a mere service operation for other scientists will remove the firm basis from the University of Rochester and start its decline towards a provincial school that sooner or later has to be closed due to its irrelevance. I cannot imagine that this is your intent. If you would like to maintain a school with an international recognition, you have to try to find other ways to reduce expenditures. I am convinced it would be much better to close entire departments of specialization and to concentrate the limited means of the university to a subset of selected disciplines. However, I do not know of any discipline that would not need a strong foundation in mathematics.

I am convinced that the only possibility to teach mathematics for non-mathematicians is by very first class mathematicians. Only they are capable of fertilizing applied fields of science by novel mathematical concepts. The natural scientists and engineers at ETH would very violently reject a proposal that the courses in mathematics should be given by members of their own applied departments or by mathematics teachers who are not at the same time active at the research front.

When the American society can no longer maintain the present level of science support, that was essential for its present standard of living, I am convinced it is far better to reduce the number of Universities and to

concentrate the means on the remaining ones, keeping them internationally competitive. I expect that the Universities with a weak or non-existing mathematics department will be the first ones to disappear. I am sure you do not want the University of Rochester to belong to those institutions.

Sincerely yours,

Richard R. Ernst
Nobel Prize in Chemistry 1991

Friend of the University of Rochester

Dr. Thomas Jackson, President
Administration 240
The University of Rochester
Rochester, NY 14627

Dear Dr. Jackson:

I am astonished and dismayed by actions recently taken with respect to the Mathematics Department at the University of Rochester: to dismantle its graduate program and to reduce it to a mere service facility. The Department, although relatively small, is more distinguished and highly regarded than may be gleaned from NRC statistics. Our great Universities---the University of Rochester very much among them---are a source of pride to all Americans. And yet, the study of Mathematics (including graduate education, undergraduate concentration, and research) has aways been, and will always remain, an essential component to any entity purporting to be a University.

I recognize that your University may be experiencing severe financial difficulties. A closely related and more severe problem is that Americans, whether college educated or not, often lack the critical quantitative skills fostered by the study of mathematics. The proposed restructuring at the U of R may address the first problem (at great cost to the University), but exascerbates the second. You are sending to society a clear signal that mathematics (whose teaching may be relegated to hirelings) should be studied as a prerequisite to professional schools, or at best, as a minor complement to a more truly scholarly concentration. You will confirm the view, held by all too many college students, that mathematics need play no significant role in education.

Sincerely,

Sheldon Lee Glashow
Mellon Professor of the Sciences

cc: Dr. Richard Aslin, Prof. Norman Stein

Friend of the University of Rochester

December 14, 1995

Walter A. Fallon
Arthur R. Kantrowitz
David T. Kearns
Dennis O'Brien
George E. Pake
Hugo E. Sonnenschein
Robert L. Sproull

Gentlemen:

I was absolutely appalled and dumbfounded to learn first from my colleagues at UCSD and then from friends all over the country of the University of Rochester's intention to do away with its graduate program in mathematics and to have only a service program in the field. It is hard to imagine that a first rate university with an outstanding mathematics faculty (The National Research Council survey not withstanding and as co-chair of that study I speak with some authority on the significance of those rankings) would take such an action no matter how dire financial circumstances might be.

Not only is mathematics an exciting and vital intellectual endeavor, but from a number of standpoints plays an exceptional educational role at both the undergraduate and graduate levels. Advanced mathematics is essential in all areas of applied science, economics, technological risk analysis, to an increasing extent in fundamental and applied biology (e.g., drug design), in national security issues involving communication, cryptoanalysis, satellite reconnaissance; the list is endless but one more example is particularly relevant: In recent years topology has played a central role in elementary particle physics where string theory is a candidate for a "Theory of Everything". This is another case of the remarkable and mysterious relationship between mathematics and the physical world. Topology is one of the strengths of the Rochester Mathematics Department.

The very best teachers of undergraduates are those who by virtue of their research expertise can transmit to students the importance and vitality of this field. Bringing temporary people to teach introductory courses in mathematics. is unfair to students who might otherwise be turned on to pure mathematics, the sciences or engineering.

I would urge you as members of the Board to reconsider the decision which, in my opinion, will be very damaging to the University.

Sincerely,

Marvin L. Goldberger, Dean
Division of Natural Sciences
University of California, San Diego

President Emeritus
California Institute of Technology

cc: Thomas H. Jackson

Friend of the University of Rochester

March 14, 1996
President Thomas H. Jackson
Administration 240
University of Rochester
Rochester, NY 14627-0011

Dear President Jackson:

I am writing regarding your recent decision to eliminate the graduate program in mathematics at Rochester.

I have read a good deal of the correspondence you have received, as well as your response, in effect suggesting that the matter be put to a vote of the other physical sciences departments. All of this indicates to me that there is a serious communication gap here. Let me put it this way. The problem with your decision, which you don't really seem to have appreciated, is not so much the action itself as the *message* which it sends. You are saying, in very loud and no uncertain terms:

"At Rochester, we don't care very much about mathematics. It has low priority."

Surely, you must see that such a statement strikes directly at your credibility as a major physical sciences research university. It suggests that you do not grasp the central role of mathematics in virtually all physical sciences research. The fact that your present department does or does not have particular strength in some field, or even that its overall strength may be lacking, is not at all the issue. It is rather the way in which you have chosen to deal with the problem. Coping with perceived weakness in the mathematics graduate program by abolishing it is somewhat akin to a major league manager dealing with his pitcher's sore arm by amputating it. In short, there is no way that you can make the above statement and still expect to be taken seriously by the scientific community.

If you believe that the mathematics department is weak, you must take steps to strengthen it. We all understand the problem of scarce dollars - as a manager I certainly do. If, for the sake of an example, you were to say that the graduate program in East Asian Studies was at the bottom of your priority list and was being eliminated, I think you would certainly find some unhappiness, but hardly the gaping astonishment that you have created here. When you put the queen of the sciences at the bottom of your list, your action appears absurd.

A research university lives by its reputation. That is what draws the best faculty, which in turn draws the best students, the research dollars, and so forth. But reputation and prestige are fragile commodities, and I'm afraid that yours has already suffered some damage. I don't want to be rude, but you need to know that Rochester is fast becoming the butt of some serious cocktail party humor. Unless it is reversed, this loss of credibility will ultimately cost you many times more than whatever you think you are saving in the short run.

Fortunately, I think there is still time to reconsider. Most people I know believe that you will very shortly come to your senses and correct this mistake. I, for one, certainly hope so.

Sincerely yours,

David M. Goldschmidt
Director

cc: Robert B. Goergen

Friend of the University of Rochester

Thusday, 14 December 1995

Dear President Jackson:

As member of the class of 1966 at the University of Rochester with a dual degree in history and mathematics, I am writing to express my concern about your recent actions, described to alumni as the Rochester Renaissance. This is not a rebirth, it is a Retrenchment. The need to justify your actions to alumni, to the public and to the academic community may be distracting you from a second look at the risk you are taking. You recognize that there will be an immediate and severe loss on the graduate level. But you do not seem to understand that you are damaging the undergraduate program as well.

By now you have heard from Nobel laureates, eminent scientists, distinguished representatives of the professional societies and many dozens of mathematicians and mathematics departments. They are telling you that a research university such as the U. of R. cannot remain outstanding in science without a vibrant and strong mathematics department. They are reminding you that first-rate instruction in mathematics, pure or applied, is not likely to come from temporary teachers, and guaranteed not to emanate magically from machines. They are pointing out that mathematics is central not only to research in science but also to a true liberal arts education. They are telling you this and more, and they are right. Hearing all this again from me can have, at best, a marginal effect. But my experience as a student at the U. of R. and as a professional mathematician is directly relevant to the choice you are making. By telling you about it, I hope to influence you to consider an alternative course.

While I agree with your choice to make selective changes, rather than allow the entire institution to suffer an indiscriminate loss of quality, you seem to have acted solely on the basis of a financial analysis and a questionable competitive ranking (US News and World Report). To remain in some fictional top 30, you seem to be willing to risk losing the special character of the University. Rochester is a small university in a medium-size city with an excellent research science faculty, a great medical school and a strong liberal arts tradition. Comparison makes sense with Washington University in St. Louis, not with Georgetown or MIT. One must have a great mathematics department, the other requires a first-rate history department of a certain sort; Rochester must have both departments of high quality, or else it will lose its special character and wind up competing with Hamilton, not Amherst.[1]

As an honors-program history major with a strong interest in the sciences, I took graduate courses in mathematics, hung around the math department and got to discuss math with graduate students and young faculty. I also attended many literature courses. In my senior year, I wrote a play, based on a short story by a dissident Soviet author, and helped produce it on campus. The production included rear-projection film sequences that we made with equipment loaned from Eastman Kodak. I went on to spend a year at Princeton in the graduate program in the history of science, and from there I went to Stanford where I wrote a Ph.D. in mathematics. At the University of Massachusetts, where I was on the faculty of mathematics for twenty years, I cofounded the Center for Geometry Analysis Numerics and Graphics. This laboratory supported

productive research interactions between mathematicians, graphics programmers, networking specialists, physicists, chemists, chemical engineers and polymer physicists. We aided in various ways the work of geo-scientists, landscape architects, forest conservationists and educators at all levels. There was frequent and productive interaction between senior faculty, post-docs, graduate students, undergraduates and (yes) the occasional high-school student. In one area of geometry, we pioneered the use computer graphics and animation in pure research. The use of graphics allowed us to communicate with material scientists and to collaborate with them in developing new models that were not only theoretically justifiable from a mathematical point of view, but were also testable by laboratory software (jointly developed) which compares these models to laboratory experiments. I have help create several widely-traveled museum exhibitions about mathematics and its applications. These are organized around the computer-graphics images and animation produced in the research that I have done with others. Currently, I am Head of the Scientific Graphics Initiative at the Mathematical Sciences Research Institute in Berkeley, California. Here, in the past month, I have discussed specific scientific problems with researchers in human vision, computational quantum chemistry and polymer physics; all of them involved non-trivial theoretical mathematics.

At Rochester, I was exposed to a great deal of science, first-hand, in an atmosphere that highly valued the humanities and the arts. It is evident to me and I hope it is clear to you that this has been a strong influence on my career. For me, all these things came together around mathematics. Without a strong graduate program in mathematics, I could not possibly have had this formative undergraduate experience. Such an experience will be impossible after the Rochester Retrenchment. Replacing mathematics professors by part-time and temporary workers will lower the quality of instruction at the entry level. A teaching specialist'' in calculus could never have given me the insight, challenges and encouragement I got from professional research mathematicians at the U. of R., even those who were not great classroom instructors. Terminating the graduate program without some balancing moves will make it impossible for undergraduate majors in mathematics, computer science or history to take graduate courses in mathematics and to participate in a real mathematical life.
One of your stated goals is to make the U. of R. a premiere undergraduate institution, on a par with Amherst or Williams. The University of Massachusetts, Amherst, is five minutes by bus from Amherst College. Professors at Amherst can and do teach courses at UMASS, and vice verse. Many students from Amherst College take graduate courses at UMASS. The Five College System, which includes UMASS and Amherst, supports a number of seminars and programs in mathematics (as well as other areas of the sciences and humanities) which are open to undergraduate participation. I was a coauthor of the first NSF Grant for one of them, the Valley Geometry Seminar, which still thrives. Because of this, Amherst College can attract faculty with strong research interests and they can teach and mentor graduate students. Amherst college students can and do take graduate courses in mathematics at UMASS. Amherst does not use part-time faculty to teach their courses as you are planning to do. Their students are exposed to a research environment. Termination of the graduate program in mathematics will prevent you from attracting the type of student who goes to Amherst College.

Williams College is a good hour away from Amherst, but there is still a good deal of interaction and I can offer you some more information that will give you a better view of what is going on there. The mathematics program languished there for a good many years until they sought out and hired Frank Morgan, a serious

research mathematician who is also an equally serious undergraduate educator, possessed of boundless energy. Coming from MIT, where he was largely in charge of the calculus program, among other things, Morgan instituted now-famous research seminars for undergraduates and secured funding for these seminars and for high-quality visitors to Williamstown. Given the fact that you do not plan to hire any mathematician in the foreseeable future and that you can expect your most capable mathematicians to leave, there is simply no way you will be able to match Williams in this regard.

Mathematics as a subject and a profession is in a period of enormous change, the most profound in the last two hundred years. (As someone with a life-long interest in the theater, stemming from my undergraduate days at Rochester, let me suggest you see or read Arcadia,'' by Tom Stoppard, for another view of the how mathematics is changing but remaining central to human thought.) This is due in part to the advent of modern computing machines that are, as a friend once put it, the first new laboratory instrument for mathematicians since the invention of the method of proof in Antiquity. The ability to compute symbolically and to simulate numerically has had the paradoxical effect of making theoretical understanding more important, not less so. The vastly increased speed at which mathematical ideas find use in scientific disciplines, and then bounce back to mathematics in new forms--wavelet theory is one example, modern cryptography schemes another--has accelerated the tempo and expanded the scope of mathematics. It is no wonder that there is some confusion about what should be at the core of the mathematics curriculum and much controversy about how it should be taught. These are signs of change in a period of transition; they are not indications of irrelevance or decay. Mathematics is becoming more, not less, important in the sciences and in engineering.
Rochester needs a first-class mathematics department with graduate research involvement. Perhaps the current department should be differently configured, but it should not be decapitated. I suggest that you give the mathematics department a choice similar to the one you gave to the history department: conversion of graduate lines to a smaller number of post-doctoral positions. Three-year post docs could be hired with research interests that either are compatible with those of the faculty, or lie at the intersection of mathematics and one of the strong sciences on the River Campus. They should have teaching responsibilities and the charge to have a great deal of contact with undergraduates. Research faculty could act as mentors and collaborators. At the same time, exposure to the high-quality science on the Campus and to Rochester's industies that requires highly trained scientists will allow some of them to redirect their careers, if necessary. The graduate program could be curtailed but not terminated. Why refuse to let a really good student do a Ph.D. with a world-class faculty member in the active mathematical environment I am proposing? Just set the bar very high.

This is one alternative and there surely are others. Do not mistake your dissatisfaction with the mathematics department you have--based on ratings or grant income, or some other unstated friction with current department members--for a rationale to have a weak mathematics program. You have everyone's attention and your actions are being watched worldwide. The University's reputation really is at stake here. You do have the right to demand more, but you cannot solve the problem by removing serious mathematics. Please reconsider and make a constructive change, not the swift, destructive cut from which it will take twenty years to recover.

David Hoffman
Mathematical Sciences Research Institute
1000 Centennial Drive
Berkeley CA 94720

Friend of the University of Rochester

March 21, 1996

President Thomas H. Jackson
Administration 240
University of Rochester
Rochester, NY 14627-0011

Dear President Jackson:

I am writing to express my concern over announced plans to drastically reduce the size of the University of Rochester's mathematics faculty and to rely on faculty from other departments to teach core mathematics courses for undergraduates. I write as both a university president and a mathematician.

As a president, I understand well the need for retrenchment in these economically austere times. It is regrettable that retrenchment has led to the elimination of the Ph.D. program in a discipline as central as mathematics. Without knowing more about the special circumstances at Rochester, it would be inappropriate for me to comment on what I am sure is a painful but considered decision.

As a mathematician, however, I have grave concerns over a decision that results, as I understand the matter, in non-mathematicians teaching basic mathematics courses on a regular basis. Such a practice is akin to asking non-philosophers to teach Aristotle or non-specialists to teach Shakespearean drama.

It is my sincere hope that a plan is developed that assigns the bulk of core mathematical instruction to full-time members of the Mathematics Department.

Sincerely yours,

William E. Kirwan
President
University of Maryland at College Park

Friend of the University of Rochester

December 7, 1995

President Thomas H. Jackson
Administration 240
University of Rochester
Rochester, NY 14627

Robert B. Goergen, Chairman
Blyth Industries
Two Greenwich Plaza
Greenwich, CT 06830-6353

Gentlemen,

The Princeton University Mathematics Department is greatly troubled by recent events at Rochester University, I am enclosing a resolution by the senior faculty which sets forth our concerns. In my opinion the actions taken by Rochester University concerning a department which is outstanding in its teaching, graduate program, and faculty research will have disastrous consequences. I cannot understand how a university which is a leader in Science and Engineering can turn on that tradition. In particular, I am puzzled by the rationale of retaining the English graduate program as given by Dean Aslin: "we believe it is essential to maintain a strong presence in English as a central discipline in the humanities" and at the same time dropping the Mathematics graduate program when surely Mathematics is a central discipline in Science and Technology. Under these circumstances, it seems to me, Rochester will not be able to attract good students and will no longer be on the list of the thirty top universities.

In my view, before these actions cause permanent harm it is imperative to reverse the decision concerning the Mathematics Department. If you decide to take that path I would be happy to help in any way to retain and improve your distinguished Mathematics Department.

Sincerely,

J. J. Kohn, Chair

Friend of the University of Rochester

President Thomas H. Jackson
Administration 240
University of Rochester
Rochester, New York 14627

Dear President Jackson:

I write to add my voice to the chorus of concern regarding the fate of Rochester's mathematics department. Others have written to address the centrality of mathematics to the sciences, the dangers of relying too heavily on various rankings for making internal judgments, and the anomalous status that Rochester would have were it to dismantle the mathematics graduate program - a status that will unquestionably weaken Rochester's reputation. I will not reiterate those arguments, though I believe they are powerful and correct. Rather, I want to address the issue of mathematics instruction. My considered judgment is that, despite your best intentions, your plan for restructuring will inevitably worsen the quality of undergraduate mathematics instruction at Rochester.

The current plan calls for reducing the size of the mathematics faculty to about 10, and handling the large instructional load, particularly in calculus, by means of non-research (adjunct) faculty and/or the redirection of other qualified faculty from other disciplines. This is a recipe for disaster. Here are the two main reasons why.

First, such a plan is likely to result in the complete demoralization of the department's faculty. The best researchers will leave, because they can and because the environment is clearly not hospitable to a major aspect of their professional lives. The rest will find themselves second class citizens, because - no matter what the rhetoric - the University is in effect telling them "we define your primary if not exclusive role as that of teacher, while the rest of us define ourselves as researchers and teachers. Moreover, your teaching role isn't especially valued, since we're farming out a large part of it to adjuncts and/or members of other departments." There is no way that you can hope to maintain a dedicated mathematics teaching faculty under those conditions. High quality teaching takes place only where it is a widely shared priority, and people are respected for it.

Second, there are very serious dangers in placing calculus instruction in the hands of others. After many years of stagnation the undergraduate mathematics curriculum, stimulated by "calculus reform," is undergoing a significant transformation. That reform has come from within the mathematical community, and is rapidly taking hold within it. Keeping abreast of such changes - in particular, major pedagogical and content changes in calculus - requires being connected to the mathematical community. Creating and delivering instruction consonant with reform requires both knowledge and commitment. The odds that faculty from other departments would (a) know about such reforms, (b) be willing to make the effort required to implement such changes in service courses outside their home departments, are virtually nil. Hence, even if you were to take the high road and make use of faculty from other departments, Rochester's students would almost

certainly receive mathematics instruction that is increasingly becoming obsolete and inadequate. And if you take the low road, using adjuncts and temporary faculty, the problems would be far worse. One of my responsibilities as chair of the Mathematical Association of America's Committee on the Teaching of Undergraduate Mathematics was gathering data on and trying to fix the "adjunct/temporary instruction problem" in mathematics. I'll be blunt in summary: such instruction is typically cheap, and you get what you pay for. A major instructional and administrative commitment is required to make appropriate use of such staff under the best of circumstances. Expecting temporaries and adjuncts to keep pace with a rapidly changing curriculum that requires significant effort and coordination is ridiculous. I conclude that the changes you propose are almost certain to produce a significant lowering of the quality of instruction in mathematics courses - no matter how you staff those courses. This is the direct opposite of what you intend.

I want to close on a personal note. I was a member of the Rochester faculty in the early 1980s, and I have warm feelings for the University. I was pleased to see that you have a strong plan for renewal, for it will most likely undo some of the damage done by the indecisiveness of the previous administration. I am sympathetic to the idea of prioritizing. I know such decisions are hard and that some departments must lose in order for the institution to gain. In this case, however, it is not only the department that loses - the institution does too. Hence I hope you will continue the prioritization plan, but reverse this particular decision. It's in your best interests to do so.

Sincerely,

Alan H. Schoenfeld
Professor of Education and Mathematics

Friend of the University of Rochester

December 11, 1995

Dr. Thomas H. Jackson, President
The University of Rochester
Office of the President
Admin 240
Rochester, NY 14627

Dear President Jackson,

I was proud to receive an honorary doctoral degree from the University of Rochester in 1979, for I knew Rochester as a distinguished center of research in physics, my own field. This has remained true of Rochester since then, but recent news from your university makes me fear that it will not be able to continue to maintain this high reputation.

I refer of course to the cancellation of your graduate program in mathematics. I am not a mathematician, but I regard mathematics as the core of any research program in the physical sciences. My own work as a theoretical physicist (which was honored in 1979 with a Nobel Prize) has been enriched by contacts with active researchers in mathematics at all the universities at which I have worked: Columbia, Berkeley, M.I.T., and Harvard as well as Texas. If you do not have a graduate program in mathematics then eventually you will have no research mathematicians, which will make Rochester far less attractive to theoretical physicists. Experimental physicists may not feel the loss of the mathematics program directly, but with with fewer first-rate theoretical physicists you will begin to lose your best experimentalists as well. You will also be weakened in your ability to compete for good students; both graduate and advanced undergraduate physics students need to take advanced courses in mathematics, which can only be taught well by active research mathematicians. I imagine that similar effects will eventually be felt in your chemistry and optics departments. I would not advise any prospective undergraduate or graduate student who wishes to concentrate on the physical sciences to go to a university that did not have a graduate program in mathematics.

I do not know the details of Rochester's financial problems, but I do understand that you may find it necessary to cancel some of your graduate programs. Nevertheless, it seems to me extremely unwise to eliminate your program in an area like mathematics, that stands at the intellectual center of a large part of modern science. This is especially so as the mathematics department at Rochester has real distinction in some fields, such as algebraic topology. Please forgive me for intruding on what is not really any of my business. Even though my only formal connection with Rochester is an honorary degree, I felt a responsibility to comment on what seems to me a disastrous step.

Sincerely yours,

Steven Weinberg

cc: Robert B. Goergen, Charles E. Phelps, Richard Aslin

Friend of the University of Rochester

15 March, 1996

Mr. Thomas H. Jackson, President
University of Rochester
Rochester, New York 14627

Dear Tom,

I know you have been inundated with all sorts of information, arguments, and opinions, and have been the subject of many newspaper and journal articles, and my mathematics friends have made sure I saw all of them. They have also asked me to let you know how I feel about the developments at Rochester. I won't do that, but I will share with you some thoughts.

Observation (1). Most departments in Arts and Sciences in the colleges and universities are in a discipline that transcends the boundaries of the institutions. The role the university departments play in the discipline varies from discipline to discipline. In some disciplines, a large part of the creative activity is within the department; in others, the departments are primarily concerned with interpretation. At one end I would put the science and mathematics department; on the other, the literature departments. The social sciences fall somewhere in the middle. At the two extremes are mathematics and English. Very little of the creative activity in literature takes place in English departments, most do have writers but very few of the distinguished writers and authors are faculty members. At the other extreme are the mathematics departments where the preponderance of creative activity in the field takes place in the university departments. Since mathematics is the language of science, and is continually developing, universities have a special responsibility to nurture the environment for creative activity in mathematics.

Observation (2). Some of the departments, particularly in the sciences and mathematics, have been international in characer for many years. In general, universities can only afford a minimum of specialists in any field, that is why professional meetings and conferences are so important in all disciplines. Although the advent of computer networks has alleviated this somewhat and the comunication among mathematicians has been greatly enhanced, this is no substitute for the interaction of practicing mathematicians with young colleagues and graduate students. Seminars are very important in mathematics. Without graduate students and young mathematicians, a department would jeopardize its active participation in the mathematics community and take a step towards unplugging itself and the university from the international network.

Observation (3). There are about 100 research universities in the United States, and their continued strength is absolutely essential to the economic well being of this country. I have been amazed at how little this has been appreciated by the Congress, the legislatures, and the public in general. They turn to these institutions for help in special areas or for special projects but don't seem to recognize that these institutions' general financial strength is in the best interests of the country. The institutions themselves have not been able to get together to make this case for the research universities, and as a result many of them are trying to strengthen their undergraduate programs. There are at least 2500 other institutions offering undergraduate

programs and there is no dearth of opportunities for a good undergraduate degree. What we need to do is insure the continued strength of the research universities and this means the core disciplines have to be effective, in some cases this requires encouragement and nurturing, in others it means restructuring. But the importance of the research university is such that the research in core activities cannot be dispensed with.

Observation (4). Mathematicians are mathematicians and they want to teach other mathematicians. I berated a group of mathematicians for this one time, and a very distinguished mathematician told me with a twinkle in his eye that that was a lot more fun. The fact is that mathematics education for the non-mathematically oriented is not done very well in general. The mathematicians don't seem to recognize that the language they have developed is very useful but is very difficult for people with a non-mathematical bent to assimilate. At almost every level there seems to be a strong prejudice against mathematics, a failure by the public to appreciate what an important language it is while at the same time bemoaning the fact that they cannot get technologically oriented jobs. Mathematics education needs attention, but I don't think that turning it over to the second team is going to alleviate the situation. I might add that I think there is a parallel situation with English. In this case too there seems to be a growing unconcern with grammar and the importance of conveying our thoughts and information effectively and accurately.

I must say that after reading all the reports and documents, I was taken back by the perilous financial position you find yourself in. It certainly impressed on me the importance of good investment policy and advice, and I can appreciate your concerns considering the situation you inherited. I do hope that the University of Rochester will survive, and that the approach you have taken to mathematics will in the long run not be detrimental to the institution.

Best,

W. Dexter Whitehead, Jr.
Alumni Professor of Physics Emeritus
University of Virginia

News Articles about the University of Rochester Renaissance Plan

Notices of the American Mathematical Society

- Demotion of Mathematics Meets Groundswell of Protest (March)

  by Arthur Jaffe, Salah Baouendi, and Joseph Lipman

- Downsizing at Rochester: Mathematics Ph.D. Program Cut (March)

  by Allyn Jackson

- Rochester Update (April)

  by Allyn Jackson

The Chronicle of Higher Education

- U. of Rochester to Cut Its Faculty by 10% (Nov. 24, 1995)
- U. of Rochester to Cut Programs, Faculty, and Enrollment (Dec. 15, 1995)
- U. of Rochester Plan to Abolish Math Ph.D. Draws Fire (Jan.19, 1996)
- Mathematicians at U. of Rochester Reject Deal to Save Program (Feb. 9, 1996)
- U. of Rochester Plan to Cut Mathematics Is Recipe for Disaster (Mar. 1, 1996)

Other articles available through the University of Rochester Mathematics Department, including

AMS American Mathematical Society
Advancing research. Creating connections.

From the March 1996 issue of *Notices of the American Mathematical Society*

Demotion of Mathematics Meets Groundswell of Protest

By

Arthur Jaffe, Harvard University, President-elect, American Mathematical Society

Salah Baouendi, University of California at San Diego, Past Chair, AMS Committee on the Profession

Joseph Lipman, Purdue University, Chair, AMS Committee on the Profession

The University of Rochester's plan to downgrade its mathematics program has called forth an extraordinary surge of protest not only from mathematicians but also from well-known scientists both in universities and in business. Statements have been made by at least six Nobel laureates, by dozens of members of the National Academy of Sciences, as well as by other leaders in science and industry. The outpouring comes from many fields, including biology, chemistry, computer science, economics, geology, mathematics, philosophy, physics, and sociology.

The uproar from the scientific community arose for at least two reasons. First, the Rochester plan has become a symbolic attack at the core of the American research university. Secondly, the decision was reached in an apparently arrogant manner: the president and a few intimate advisors made broad judgments in areas far from their own expertise, without the benefit of careful external review. Both these reasons mean events in Rochester are being watched carefully across the country by other universities who might follow this bad model, and by scientists who are appalled both with the methodology and with the results.

Norman Ramsey, Nobel laureate in physics, remarked on being told of the Rochester plan, "Surely you must be joking. If you had only one science department at a university, it would be mathematics, and you build from there." In scientific circles the Rochester plan has become a symbol of the wrong way to downsize.

The Rochester administration announced their controversial "Renaissance Plan", with the stated aim of improving the quality and the attractiveness of the university through downsizing (20 percent students, 10 percent faculty).

Faculty cuts are to occur through encouraged attrition in selected departments. The faculty reduction for mathematics, from twenty-one to ten, is the most severe. Four graduate programs will be terminated: mathematics, chemical engineering, comparative literature, and linguistics. It is clear that the number of graduate students in mathematics should be reduced nationally. However, the total elimination of a graduate program in a leading department, within a university that claims to remain at the forefront of science and technology, makes no sense.

Addressing the resulting teaching shortfall (over 70 percent of Rochester's undergraduates enroll in calculus courses), President Thomas H. Jackson states, "We do reject the notion that tenure-track mathematicians and mathematics Ph.D. students are the only potential groups capable of offering high-quality mathematics instruction." Vice provost and dean Richard Aslin states, "We can significantly decrease the faculty size in mathematics who are primarily devoted to delivering quality undergraduate instruction to math majors and other sophisticated science majors while seeking other avenues (technology and non-research faculty) to deliver instruction in basic calculus (typically for nonmajors)." In fact, President Jackson has acknowledged the likelihood that the best mathematics faculty will leave.

Renowned economist Lionel McKenzie, professor emeritus at Rochester, just returned from Japan, where he received the Order of the Rising Sun. He feels strongly that his university has made a major mistake with respect to mathematics and that his own work would have been impossible without a lot of cross-fertilization from Rochester mathematicians. McKenzie is working within the university to have the administration take a different path.

The collection of protest letters already received by the Rochester administration constitutes a remarkable testimonial to the place of mathematics in research and in education. Many letter writers assert that Rochester cannot maintain its research excellence in the physical sciences and in other quantitative areas---as it aspires to do---without a strong program in mathematics, which it now has. Others state that ending the graduate program in mathematics and consigning the bulk of calculus teaching to adjuncts and faculty in other departments will markedly degrade the quality of education Rochester offers to undergraduates. Hence Rochester will become less attractive both to prospective students and to prospective faculty.

Several writers criticize the reliance by the Rochester administration on rankings of their mathematics graduate program in the *U. S. News and World Report* and in the 1995 National Research Council polls rather than on careful external evaluation of each department. Not only can polls be "based largely on knowledge by hearsay and intuition, rather than hard study of programs," but, as explained by Fields Medal winner Michael Freedman, "... departments with specialized strength will be underrated".

Thirty-one professors in the Harvard Physics department (including three Nobel laureates, thirteen members of the National Academy of Sciences, and the dean of the Division of Applied Science) signed the following statement:

The Department of Physics at Harvard University is dismayed to learn of the decision by the University of Rochester administration to cut in half the size of their mathematics faculty and to discontinue their graduate program in mathematics. Rochester has a tradition of being one of the leading American universities in science and in technology. Recent history confirms the interaction between fundamental mathematical concepts and advances in science and technology. We believe that it is impossible to have a leading university in science and

technology without a leading department of mathematics. We hope that Rochester will reconsider its decision.

Members of the Harvard Chemistry department, including a Nobel laureate and eight members of the National Academy of Sciences, expressed similar sentiments:

Our department is dismayed. For centuries, mathematics has rightly been termed "the queen of the sciences," and this is just as apt today. In particular, chemistry has benefited more and more from mathematical developments and concepts. A university that aims to have a worthy program in science and technology simply must have a genuine department of mathematics pursuing original research. We urge the administration of the University of Rochester to reconsider.

Steven Weinberg, University of Texas, Nobel laureate in physics, wrote:

I was proud to receive an honorary doctoral degree from the University of Rochester in 1979, for I knew Rochester as a distinguished center of research in physics, my own field. But recent news from your university makes me fear that it will not be able to continue to maintain this high reputation.

I am not a mathematician, but I regard mathematics as the core of any research program in the physical sciences. If you do not have a graduate program in mathematics, then eventually you will have no research mathematicians, which will make Rochester far less attractive to theoretical physicists. Experimental physicists may not feel the loss of the mathematics program directly, but with fewer first-rate theoretical physicists you will begin to lose your best experimentalists as well. You will also be weakened in your ability to compete for good students; both graduate and advanced undergraduate physics students need to take advanced courses in mathematics, which can only be taught well by active research mathematicians. I imagine that similar effects will eventually be felt in your chemistry and optics departments. I would not advise any prospective undergraduate or graduate student who wishes to concentrate on the physical sciences to go to a university that did not have a graduate program in mathematics.

Co-Nobelist Sheldon Glashow adds:

The study of mathematics (including graduate education, undergraduate concentration, and research) has always been and will always remain an essential component to any entity purporting to be a university.

Joel Moses, a computer scientist and provost at MIT, wrote:

I for one cannot imagine operating a school of engineering in the absence of a strong and research-oriented mathematics department. The same can be said for a school of science. I am also dismayed at the prospect of covering a substantial portion of the teaching load in mathematics with adjunct faculty. If you carry through with it, I predict that your programs in sciences and engineering will suffer a marked decline.

The University of Rochester has a well-known program in optics. In reply to a recent solicitation for graduate applications for an optics fellowship at Rochester, Professor Peter Pershan of Harvard wrote, "I will be happy to advise prospective students about the optics program at Rochester; however, the recent budget problems that have induced the University of Rochester to propose closing their mathematics graduate program will certainly be noticed by our students. It has already been widely discussed within our physics department."

George Backus, research professor of geophysics at the University of California at San Diego and a member of the National Academy of Sciences, wrote:

At UCSD, the Institute of Geophysics and the Scripps Institute of Oceanography often recommend that our Ph.D. students take graduate courses in the UCSD Department of Mathematics. Modern theoretical geophysics and physical oceanography simply cannot be done without sophisticated modern mathematics. To teach these [advanced mathematical subjects] with sophistication and insight requires people for whom they are the primary research interest.

Expressing an industrial point of view, Neil A. Frankel, manager, Advanced Components Laboratory at the Xerox Corporation, wrote in the December 7 issue of the Rochester "Democrat and Chronicle":

It is evident that neither [Kodak nor Xerox] is well served by the elimination of two technology-related [graduate] departments [chemical engineering and mathematics] To stay ahead of the very significant competition from Japan and elsewhere, [Kodak] will need all the quality engineering talent it can find. The availability of a quality university in Rochester enhances our ability to attract the very best people to our company. If graduate mathematics is eliminated, I really don't see how UR can support first-rate programs in the sciences and in engineering, and I fear that all of these will decline.

Professor Sir Michael Atiyah is director of the Newton Institute in Cambridge, England; he is master of Trinity College (Newton's own college), and he is also the past president of the Royal Society. Sir Michael emphasized the unity of pure and applied mathematics, writing:

Increasingly the complex problems that scientists now face require more sophisticated mathematical understanding. The advent of more powerful computers has in no way decreased the fundamental relevance of mathematics. I can illustrate the scope of mathematical

interaction with other fields by listing just a few of the interdisiplinary programmes that we have run at the Newton Institute in the past few years: computer vision, epidemics, geometry and physics, cryptology, financial mathematics, and meteorology.

Edward Dougherty, editor of the Journal of Electronic Imaging, wrote in the January 1996 issue:

While at first this might appear to most people as simply one major research university deciding to restructure itself into a not-so-major university, for those of us in the imaging community there is much more at stake. Because it is home to both Kodak and Xerox, Rochester is one of the major imaging centers in the world, and therefore the future of imaging is closely tied to significant imaging events in Rochester. Suspension of graduate research and teaching in two key foundational imaging disciplines is not insignificant.

Chemical engineering plays a role in imaging materials, toners, and numerous other staples of digital imaging. The case for mathematics is even more compelling when it comes to digital imaging.

Simply put, there is no scientific phenomenology without mathematics. The kind of mathematics graduate courses necessary for contemporary research in image processing might simply cease to exist in the city of Kodak and Xerox.

One justification given by Rochester's administration for eliminating the mathematics graduate program is its perceived weakness in comparison with other programs. While acknowledging the presence of several world-class mathematicians on their faculty, the administration has been significantly influenced by rankings by U. S. News & World Report and by the National Research Council. However, many letter writers have defended the quality of the department, pointing out that its strengths are specialized. But in several subfields Rochester is extraordinarily strong, and in algebraic topology the department is among the very best in the country. Ironically, the areas of strength are subfields which have had a major impact on related disciplines (physics, economics, or engineering).

Marvin L. Goldberger, dean of the Division of Natural Sciences in the University of California at San Diego, was cochair of the recent NRC study of graduate departments. He is also president emeritus of the California Institute of Technology, former director of the Institute for Advanced Study in Princeton, and a member of the National Academy of Sciences. He wrote:

I was absolutely appalled and dumbfounded to learn ... of the University of Rochester's intention to do away with its graduate program in mathematics and to have only a service program in the field. It is hard to imagine that a first-rate university with an outstanding mathematics faculty (The National Research Council survey not withstanding, and as cochair of that study I speak with some authority on the significance of those rankings) would take such an action, no matter how dire financial circumstances might be.

Not only is mathematics an exciting and vital intellectual endeavor, but from a number of standpoints, plays an exceptional educational role at both the undergraduate and graduate levels. Advanced mathematics is essential in all areas of applied science; economics; technological risk analysis; to an increasing extent in fundamental and applied biology (e.g., drug design); in national security issues involving communication, cryptanalysis, satellite reconnaissance--the list is endless, but one more example is particularly relevant: in recent years topology has played a central role in elementary particle physics where string theory is a candidate for "Theory of Everything." This is another case of the remarkable and mysterious relationship between mathematics and the physical world. Topology is one of the strengths of the Rochester Mathematics Department.

Saunders Mac Lane, Max Mason Distinguished Professor Emeritus of Mathematics, University of Chicago, and former vice president of the National Academy of Sciences, wrote:

I am surprised and shocked to see the extent to which NRC "ratings" have figured in the decision... I am familiar with the work of the NRC. (I was chairman of the "Report Review Committee" of the NRC for eight years.) I simply do not think that these NRC ratings are serious enough to be used for administrative decisions at universities.... I do not think that the U. S. News World Report has any standing whatever as a serious source of information. In particular the device of listing the "top-15" or the "top-30" seems to me almost meaningless...The use of U. S. News (page 2 of your "Rationale for restructuring" memo) to calculate the number of Ph.D. programs needed ["to attain a national ranking higher than Rochester's as an institution attractive to undergraduates"] seems to me barren and superficial ... As you know, the Rochester Mathematics Department has chosen to specialize, in analysis and in homotopy theory (I know the latter field; Rochester is eminent there). This choice seems to me reasonable for a smaller university. However, it may have a strong effect on ratings, as, for example, for raters not familiar with homotopy there.

Barry Mazur, William Petschek Professor of Mathematics at Harvard University and a member of the National Academy of Sciences, wrote:

The University [of Rochester] is one of the not-very-numerous places in the country where active research in number theory is undertaken. But this is not the only field of mathematics in which the current program at Rochester is important. In the hard classical problems in algebraic topology, for example, Rochester is very strong. Individually (and perhaps collectively) the algebraic topologists at Rochester are responsible for some of the most productive new turns in that field, and I guarantee you that few universities (Harvard included) could boast as distinguished a faculty in this area.

Richard Kane of the University of Western Ontario wrote:

It is my strong belief that many of the students produced [there in topology] are outstanding---as good as topology students produced ANYWHERE. These students have created a very positive image of Rochester.

Dean Aslin explains what the university intends to offer its undergraduates in mathematics. " There are other ways to service our need for calculus instruction, including the hiring of non-research adjunct faculty and/or the redirection of other qualified faculty from other disciplines. ... The refocused department that emphasizes quality calculus instruction ... and individual research excellence will best serve the needs of the college. A reduction in steady-state faculty size over time from twenty-one to ten FTEs, with additional non-tenure- track teaching faculty who staff much of the elementary calculus sequences, can achieve these goals."

Kenneth A. Ross, president of the Mathematical Association of America (MAA), a professional organization with about 30,000 members concerned primarily with collegiate mathematics instruction, wrote on behalf of the Executive Committee:

Mathematics and mathematics instruction are constantly changing. Recent initiatives by the National Science Foundation have, for example, resulted in major changes in the way that calculus is taught. Advances in technology have affected not only mathematics pedagogy but also the curriculum. To attract and retain the brightest undergraduates requires that those who are responsible for instruction be active mathematicians and be aware of the ways that both the subject and its instruction are changing.

In view of this the Board of Governors of the MAA at its annual meeting in January 1995 passed a resolution that makes it clear that it is a disservice to students and to the profession to relegate the teaching of mathematics to adjuncts and faculty from other disciplines.

Alan H. Schoenfeld, professor of education and mathematics at the University of California, Berkeley, wrote:

My considered judgment is that, despite your best intentions, your plan for restructuring will inevitably worsen the quality of undergraduate mathematics instruction at Rochester. [It] is a recipe for disaster. Here are the two main reasons why. First, such a plan is likely to result in the complete demoralization of the department's faculty. The best researchers will leave, because they can and because the environment is clearly not hospitable to a major aspect of their professional lives. There is no way that you can hope to maintain a dedicated mathematics teaching faculty under those conditions. High- quality teaching takes place only where it is a widely shared priority and people are respected for it.

Second, there are very serious dangers in placing calculus instruction in the hands of others. After many years of stagnation the undergraduate mathematics curriculum, stimulated by "calculus reform", is undergoing a significant transformation. That reform has come from within the mathematical community and is rapidly taking hold within it. Keeping abreast of such change---in particular, major pedagogical and content changes in calculus---requires being connected to the mathematical community. Creating and delivering instruction consonant with reform requires both knowledge and commitment. The odds that faculty from other departments would (a) know about such reforms [and] (b) be willing to make the effort required to implement such changes in service courses outside their home departments are virtually nil. One of my responsibilities as chair of the Mathematical Association of America's Committee on the Teaching of Undergraduate Mathematics was gathering data on and trying to fix the "adjunct/temporary instruction problem" in mathematics. I'll be blunt in summary: such instruction is typically cheap, and you get what you pay for. A major instructional and administrative commitment is required to make appropriate use of such staff under the best of circumstances... I conclude that the changes you propose are almost certain to produce a significant lowering of the quality of instruction in mathematics courses---no matter how you staff those courses. This is the direct opposite of what you intend.

David Hoffman, head, Scientific Graphics Research Initiative, Mathematical Sciences Research Institute, Berkeley, recalled his undergraduate experience at Rochester:

As an honors-program history major [at Rochester] with a strong interest in the sciences, I took graduate courses in mathematics, hung around the math department, and got to discuss math with graduate students and young faculty. I also attended many literature courses. I was exposed to a great deal of science firsthand in an atmosphere that highly valued the humanities and the arts. It is evident to me, and I hope it is clear to you, that this has been a strong influence on my career. For me, all these things came together around mathematics, Without a strong graduate program in mathematics, I could not possibly have had this formative undergraduate experience. Such an experience will be impossible after the "Rochester Retrenchment". Replacing mathematics professors by part-time and temporary workers will lower the quality of instruction at the entry level. A "teaching specialist" in calculus could never have given me the insight, challenges and encouragement I got from professional research mathematicians at the U. of R., even those who were not great classroom instructors...

Tom Davis, principal scientist at Silicon Graphics, wrote:

No matter how much time you spend trying to convince yourselves otherwise, this will certainly hurt the quality of your undergraduates' mathematics education (and hence their education in all the engineering and scientific fields).

In the thirteen years since I helped to found the company Silicon Graphics, I've noticed that it is becoming more and more difficult for us to hire students with a sufficient background in mathematics. Every year we require more, and the students seem to have less. So if you're interested in producing students who can compete in these rapidly growing job markets, you should be thinking about how to increase the amount and quality of mathematics they learn.

Richard Ernst, Nobel laureate in chemistry, wrote:

The natural scientists and engineers at the ETH [Swiss Federal Institute of Technology] would very violently reject a proposal that the courses in mathematics should be given by members of their own applied departments or by mathematics teachers who are not at the same time active at the research front.

I expect that universities with a weak or non-existing mathematics department will be the first ones to disappear. I am sure that you do not want the University of Rochester to belong to those institutions.

Summing up, Herman Feshbach, the former chair of the M.I.T. Physics Department and past president of the American Physical Society, remarked, "With one action, Mr. Jackson has reduced Rochester to a second-rate university."

On December 6, 1995, the American Mathematical Society sent a fact-finding delegation to Rochester. On December 12, President Cathleen Morawetz sent the report of that committee to President Jackson, along with a letter stating in part:

Let me state firmly that in tough times tough decisions must be made and everything is on the table. I have learned this as director of the Courant Institute of Mathematical Sciences (NYU) (1984-1988) trustee of Princeton University (1972-77) director of NCR (1.978-1990) and trustee of the Sloan Foundation (1980-1995). This has also given me insight into how decisions are made and ought to and can be changed before they do irreversible damage.

She also offered the assistance of the Society in finding a way to preserve the integrity of the mathematics program consistent with the overall goals of the university.

In the absence of any change in the Rochester administration's position, the Society has appointed a task force, chaired by the President-elect.

The task force, while still being formed, consists of mathematicians and prominent scientists as well as persons from the world of business. It is a testimony to the central role of mathematics that Marvin

Goldberger and Alexander Rich have agreed to serve along with others on the task force, as have Nobel laureates Walter Gilbert (biology), Dudley Herschbach (chemistry), Robert Solow (economics), and Steven Weinberg (physics). The charge of this group is to follow developments, to inform the community, to facilitate assistance to Rochester, and to solicit support.

Every two years the American Mathematical Society invites a well-known scientist from outside mathematics to address the Society. This Gibbs Lecture is a major event, generally attracting several thousand listeners. In January 1996 Steven Weinberg ended his Gibbs Lecture with a description of the central role of mathematics in all of science and a forceful statement that the closing of the graduate program in mathematics at Rochester is a symptom of general malaise in our universities. Weinberg concluded, "I am proud to be a member of this task force."

This groundswell of protest from the scientific community demonstrates that the Rochester plan is not only bad for mathematics, but it is also bad for the University of Rochester, it is bad for American science, and it is bad for the country.

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Downsizing at Rochester: Mathematics Ph.D. Program Cut

On November 16, 1995, the mathematics faculty at the University of Rochester got what was probably the biggest shock of their professional lives. An hour before the university administration was to unveil a major restructuring plan, they learned their Ph.D. program would disappear, the department faculty would be reduced by half, and adjuncts and faculty from other departments would be called in to help teach lower-level mathematics courses.

The whole university faculty knew that the institution faced serious financial problems and that the restructuring would entail cuts in graduate programs. But no one in the Mathematics Department was prepared for such a severe blow. It was a great surprise, it came as a shock to learn, one hour before it was announced, that this was happening to the math department,'' says Samuel Gitler. Ironically, just eight years before, Gitler had been hired expressly to build up the department.
The plight of the Mathematics Department at the University of Rochester has been discussed avidly since the announcement of the cuts. The university administration and trustees have received over one hundred letters from mathematicians and scientists urging them to reconsider their decision. In December the AMS sent a fact-finding committee to the Rochester campus, and the committee has produced a report.

The AMS Council has passed a resolution, initially drafted after copious discussions within the Committee on the Profession, strongly urging the university to reconsider its decision. AMS President Cathleen S. Morawetz has appointed a task force, chaired by President-elect Arthur Jaffe, to work further on the issue. Despite all the pressure, the university administration has held its ground and shows no sign of changing its decision.

Today's tight job market together with shrinkage in university budgets have led some in the mathematical community to suggest scaling back on doctoral programs. So why the outcry when a Ph.D. program goes under? First of all, Rochester's Mathematics Department is quite distinguished--a number of internationally prominent algebraic topologists are on the faculty, and there is considerable strength in probability and analysis--and their students have fared reasonably well on the job market. Although many observers of university downsizing foresaw cuts in mathematics departments, few predicted that a department of Rochester's caliber would be hit.

But if Rochester is rather stronger than the average department in terms of research, it is similar to many departments in other ways, notably in having few programmatic linkages to other departments and in taking some heat over teaching, especially in calculus. These are two of the areas the university administration

looked at in deciding to cut the Mathematics Department. What happened at Rochester could happen elsewhere. Says Ronald G. Douglas, a member of the AMS fact-finding committee and recently appointed provost of Texas A&M University, This will catch the attention of deans, provosts, and presidents everywhere.''

The Rochester Renaissance Plan

For the past couple of decades, the University of Rochester has faced financial troubles. In 1970 it was third only to Harvard and the University of Texas in the size of its endowment. Today it ranks twenty-fifth. From the late 1970s until the late 1980s, the university engaged in highly speculative investments in small-capital stocks and venture capital. In some years the strategy paid off spectacularly, and in others the university lost a lot of money. Around 1986 the university restructured its investments, and since then the endowment has stabilized. In the late 1980s and early 1990s, Rochester struggled with a new set of problems, this time stemming from a decline in tuition dollars collected per student. The administration that was in place at the time seems to have operated in crisis-management mode, and its attempts to juggle the yearly budget gaps wore down faculty morale and induced some to leave. In 1991 one of the deans attempted to terminate several graduate programs. The president disagreed, and, after faculty outcry, the program was quashed and the dean was fired.

Into this chaotic picture comes Thomas Jackson, hired as president of the University of Rochester in 1994. Together with provost Charles Phelps and vice provost and dean Richard Aslin, Jackson worked for a year and a half developing a plan to address the university's fiscal problems. They considered a wide range of options, such as eliminating all graduate programs and becoming an undergraduate institution or closing its engineering school. In the end they devised the Rochester Renaissance Plan, which aims to improve undergraduate education and uphold Rochester's reputation as a research university with strength in science and engineering.

The centerpiece of the plan is a strategy to raise student quality and increase tuition revenue. The university aims to raise student quality by reducing future admissions by 20 percent; this should work at least in the short term, because the top 80 percent of the current class have higher SAT scores than the remaining 20 percent. But how can reducing the student body raise tuition revenue? At present much of the tuition money collected is redirected in the form of scholarships to students who pay only partial or no tuition. The university is gambling that, by emphasizing undergraduate education, it will heighten its image as an elite'' school and improve its ability to attract high-quality students who can pay full tuition. If this part of the plan fails, the university could be in worse shape than before. Despite the risk, many faculty, tired of years of financial uncertainty, are relieved to have someone firmly take the reins. Their plan entails some risks, but boy, having somebody with a plan who understands the problem is such a huge step,'' says Thomas LeBlanc, chair of the Computer Science Department. I don't know how we could have continued on the path that we were on.''
The plan also calls for cuts of various sorts. Overall, the faculty will be trimmed by 10 percent. The administration opted for selective rather than across-the-board cuts. Four graduate programs--chemical engineering, comparative literature, linguistics, and mathematics--will be eliminated. In at least one way,

mathematics suffers the most of the four: There are interdepartmental Ph.D. programs in which faculty from the first three areas can continue to participate, but there is nothing comparable for mathematics. In four other departments--earth and environmental science, history, mechanical engineering, and philosophy--the graduate programs will shrink, with reductions in faculty ranging from 12 percent to 33 percent.

Mathematics also sustains the deepest cut in faculty size: the reduction from 21 to 10 is the largest in terms both of number and percentage. All but one person in the Mathematics Department have tenure, and the university has pledged not to fire any tenured faculty. Given the present age distribution of the department, it could take twenty years to achieve the reduction. The administration has said that would be fine with them. On the other hand, this is a five-year plan they've sold to the board of trustees,'' notes Mathematics Department member Douglas C. Ravenel. And surely after five years there's going to be some kind of reckoning with the board.'' So it is clear that the administration is counting on people taking other positions or early retirement incentives.

A Research University without a Math Ph.D. Program?

The Mathematics Department was just as aware as any other of the seriousness of Rochester's financial problems and of the inevitability of painful cuts. And the department generally does not disagree with the major outlines of the Rochester Renaissance Plan. But it does disagree vehemently with the idea that Rochester can continue to be a research university with emphasis in science and engineering when it no longer has a Ph.D. program in mathematics. I really think that this administration has no sense of what higher education and research are,'' says Gitler. They are going to make Rochester a trade school, not a university.'' Says mathematics graduate student Nora Franzova, This university cannot be called a research university anymore if it doesn't offer basic research in the purest field of research there is--mathematics.''

Many of the letters protesting the cuts in the Mathematics Department reinforce this point. One of the most powerful letters came from physics Nobel Laureate Steven Weinberg. I would not advise any prospective undergraduate or graduate student who wishes to concentrate on the physical sciences to go to a university that did not have a graduate program in mathematics,'' Weinberg writes to Jackson. It seems to me extremely unwise to eliminate your program in an area like mathematics that stands at the intellectual center of a large part of modern science.''

Paul Slattery, chair of the Department of Physics and Astronomy at Rochester, says he very strongly supports'' the Renaissance Plan, even though he is not comfortable with the cuts in the Mathematics Department. He points out that there is a Ph.D. program in mathematics at every university where the physics or chemistry program is ranked in the top half of the recent National Research Council (NRC) ranking of graduate programs. That gives you a feeling that we would be strange outliers in the community of universities that have a strong focus in the physical sciences,'' he says. He notes that the lack of a doctoral program in mathematics could hinder his ability to hire good people in physics, particularly in theoretical areas.

The Rochester administration realizes that the lack of a graduate program in mathematics will make Rochester an anomaly among research universities, but they do not seem worried. Jackson points out that, unlike in the laboratory sciences, graduate students are not imperative to doing research in mathematics. The research tends to be fairly lonely work by a faculty member, maybe with colleagues who are at the same speed,'' he says. Our sense was, you can do a lot of distinguished research without the Ph.D.

program.'' But without one, will Rochester be able to attract good mathematical researchers? My own belief is that the market is thick enough that we can, in fact, get and keep people who have substantial research agendas,'' Jackson says. He notes that the university can provide incentives other than a Ph.D. program, such as research time and support for postdocs, although there is nothing written about this in the Renaissance Plan.

Linkages to Other Departments

While the Mathematics Department has garnered considerable support outside Rochester, support on campus is less definite. Slattery sees the cuts in the Mathematics Department as a weakness in an otherwise strong plan, and he says he and others on campus are quietly discussing possibilities for evolutionary changes'' to address this weakness. He feels he must take this kind of discreet, nonconfrontational approach. One of the reasons why there hasn't been a lot of public outcry [on the campus],'' he explains, is the feeling that we should support the president, because if this thing doesn't work in the aggregate, then we're really in trouble.''

In addition, the administration has made it clear that the departments that support the plan will benefit. A letter from the administration to faculty explaining the plan put it this way: We wish to make clear that, in the new college environment, resources will flow more generously to those departments which succeed best in supporting the overall goals of the Renaissance Plan.'' Such statements could discourage supporters of the Mathematics Department from speaking out. But could it also be that the Mathematics Department has few supporters on campus? To hear the administration tell it, intellectual linkages with other departments were scarce. As much as we tried to explore, we actually found very few present interactions that were taking place,'' says Jackson. That is, it might be good in theory, but it wasn't taking place in reality.''

The administration has said that one of its reasons for choosing to cut the Mathematics Department was that it had very few interactions with other departments. The question of how much interaction there has been is a matter of some dispute. The Mathematics Department has collected a number of examples of joint research between its faculty and faculty in other departments. The topics range from ultrasonic medical imaging to cryptography. In addition, students and faculty from other departments regularly attend graduate classes in the Mathematics Department.

By contrast, the picture painted by the administration is one of an isolated Mathematics Department. As part of the formulation of the Renaissance Plan, Aslin and Phelps conducted interviews with seventy-five faculty--three members from each of the twenty-seven departments on campus (in a couple of departments, fewer than three faculty were interviewed--one of these was the Mathematics Department). Aslin says they asked science and engineering faculty specifically about linkages to the Mathematics Department. To be quite frank, we found very few,'' says Aslin. The issue seems to be that the interactions were ad hoc--a single research project or a specific course rather than an institutionalized program with high visibility. The interactions were faculty A with faculty B because they had taken the initiative to form some sort of intellectual link,'' he explains. But they were not nearly as robust as the kinds of interactions we saw between other departments outside of mathematics.'' And, Aslin claims, this was not because other departments have no interest in mathematics. It turns out that they have sought those linkages external to the University of Rochester.''

Others reinforce this view and take it one step further. There is a large mathematical intellectual community on campus, and it goes well beyond the Mathematics Department,'' says computer science chair LeBlanc. He says there are a number of faculty in the engineering school who could double as applied mathematicians'' and some people in his department and in the Physics Department who are interested in certain areas of mathematics. Centrality of the discipline was one of the things the administration looked at in deciding which graduate programs to cut. One can make the abstract argument that mathematics is central,'' he says. But if you go to twenty-seven departments and every one of them tells you, `The math department is not central to our program,' then although the abstract argument of centrality of mathematics is a good argument intellectually, if the reality is different, it makes perfect sense to view that as the basis for a decision.''

Contention over Calculus Teaching

Another element that entered into the administration's decision to center cuts in the Mathematics Department was their perception that in mathematics undergraduate instruction is less than optimal.'' Aslin says his interviews with faculty revealed that some departments were dissatisfied with mathematics instruction, particularly in calculus. In addition, there were anecdotal reports from the Center for Academic Support, which provides tutoring and other services, that students were having trouble with mathematics. Although he admits that some of the students' difficulties stem from underpreparation, Aslin believes that the Mathematics Department has not stepped up to address the problems. What you look for is initiative on the part of the department ... to begin to address what are in some sense nationwide educational concerns that go beyond the problems that are local at our particular institution,'' he says. And I think we have not seen [that] kind of interest on the part of the faculty here in our Mathematics Department.''

For its part, the department contends it has heard few specific complaints about its teaching. A report prepared by the department presents data from student evaluations showing that students are just as satisfied, and in some cases more satisfied, with courses in their department as they are with courses in other departments. And mathematics has made some attempts to reach out to other departments on the issue of calculus teaching. For example, two years after he was appointed chair, Gitler conducted meetings with all the science departments to talk about what their students needed from mathematics courses. Recalls Gitler, We talked and talked ... and then when I said, `okay, now it's time for you to put it in writing,' nobody sent anything in writing.''

Three years ago, before Jackson came to Rochester, a task force on calculus was formed. The task force brought together representatives from different departments to discuss what they needed from calculus courses and what changes could be made. My understanding is that the meetings were not successful,'' says Jackson. I'm not going to blame anybody on this, but they were ships passing in the night. The math department's view of what the science departments should want, and the science departments' view of what they wanted--they weren't talking the same language.''

The Mathematics Department does not disagree that little came out of the task force. According to Mathematics Department chair Joseph Neisendorfer, The people in the biology and chemistry departments didn't think it was worth their while to participate; they were content with the situation as it was.'' At that time, the undergraduate degree in computer science was housed in the Mathematics Department (in 1994 it was moved to the Computer Science Department), so computer science did not express much interest in calculus. The only complaints that I have ever heard came from mechanical engineering, and at one time

from some people in physics,'' Neisendorfer says. And the complaints from physics have now disappeared: in cooperation with the physics faculty, Neisendorfer helped to structure a pair of courses in calculus and introductory physics that would run in close coordination. The arrangement seems to be working well. Some departments also complained that mathematical homework was not graded. The Mathematics Department does not have sufficient staff to grade all homework, but two mathematics faculty are now developing a computer program that will provide students with feedback on their homework.

The problems with mechanical engineering were not so easy to resolve. Five years ago, the Mechanical Engineering Department, dissatisfied with the instruction its students were getting in mathematics, began teaching second-year calculus courses of its own. Clearly this has led to some friction between the two departments. Some on the mathematics faculty believe that declining enrollments in mechanical engineering prompted that department to add more courses to keep their faculty busy. But mechanical engineering chair John C. Lambropoulos says his department began the courses because the preparation their students were getting in the Mathematics Department was not adequate'', and they wanted to introduce more engineering applications and material specific to later courses. There has also been talk of establishing an applied mathematics department on campus, although under the current budget constraints it seems unlikely this would happen anytime soon.

The criticism the Rochester Mathematics Department has taken about its undergraduate instruction seems to be pretty similar to that endured by many other mathematics departments. But far from proving that there was no problem with mathematics instruction at Rochester, some observers say, this simply shows that many mathematics departments have not been responsive to problems (or at least perceived problems) with the instruction they provide. Nevertheless, many believe the Rochester administration dealt with this the wrong way. Salah Baouendi of the University of California, San Diego, who chaired the AMS fact-finding committee that visited Rochester, puts it this way. Even if there are problems between departments--and it is not unusual to have different points of view--it is certainly wrong for the administration to take a core discipline such as mathematics ... and eliminate its graduate program,'' he declares. There are other ways to solve these problems.''

In fact, the central question many have been asking is: Will the measures taken by the administration improve undergraduate teaching of mathematics? Many think not. In just a few minutes' conversation, Franzova and her fellow mathematics graduate student Lisa Christman exhibited a great deal of dedication to and enthusiasm for teaching. The department will soon lose such students. Christman, a second-year student, is not sure she'll be back in the fall, and she reports that twelve to fifteen of the department's thirty-four students will be gone by the end of the academic year. Most of the first-year students are leaving. This means that already this fall the university will have to arrange new ways to staff its lower-level mathematics courses.

The administration's plan to hire adjuncts to cover lower-level teaching in the Mathematics Department has elicited winces from the mathematics community. In a letter to the Rochester administration, Alan Schoenfeld of the University of California, Berkeley, wrote, I'll be blunt in summary: such instruction is typically cheap, and you get what you pay for.'' A major commitment is needed to make appropriate use of such staff, he argues. In addition, the best faculty will leave, and those that remain will have second-class status because of the lack of a graduate program and because their teaching will be farmed out to adjuncts. [T]he changes you propose are almost certain to produce a significant lowering of the quality of

instruction in mathematics courses--no matter how you staff these courses,'' he writes. This is the direct opposite of what you intend.''

Decision Process Criticized

Throughout the formulation of the Rochester Renaissance Plan, the administration held its cards close to its chest. While they could not very well call a faculty vote on which graduate programs to cut, some say the administration could have been more open. Neisendorfer says that two weeks before the announcement of the plan, he spoke with the dean of graduate studies, who said there would be some cuts, but nothing drastic. It appears that only Aslin, Jackson, and Phelps knew anything about the details of the plan.

There have been complaints about the criteria the administration used to decide which programs to cut. The internal'' information they used came primarily from the seventy-five interviews with faculty. For external'' information, they relied on the NRC rankings of graduate programs and, to a lesser extent, the rankings published yearly in *U.S. News and World Report*. The administration has been heavily criticized for using these rankings as the basis for such decisions. In fact, one of the people who wrote to the administration to protest the cuts in the Mathematics Department wasMarvin L. Goldberger, dean of the Division of Natural Sciences at the University of San Diego and cochair of the NRC committee that produced the rankings.

Many universities obtain external information about their departments through outside site-visit teams. Asked about this suggestion, Aslin contends that it would have taken three to five years to conduct such evaluations of all twenty-seven departments at Rochester. Couldn't one bring in an outside team to evaluate just those departments that appeared questionable? The problem is,'' says Jackson, that if you ask a discipline to come in and evaluate a program that's already been identified as targeted, the response you're almost certainly going to get from the people in the discipline is a case as to why you shouldn't touch the program.''

Morton Lowengrub is not convinced. A member of the AMS fact-finding committee, Lowengrub is dean of arts and sciences at Indiana University. How do they know they couldn't trust the information'' from an outside committee? he asks. As a university administrator who has had to deal with downsizing on his own campus, Lowengrub has used outside evaluations a great deal. If you set the parameters correctly and you get respectable people, you get very good information that puts into perspective the department's role in the discipline,'' he argues. In fact, Lowengrub expresses great dismay at the entire process the university used to arrive at its decision. They did not carry on a dialogue with the Mathematics Department; they never gave them a chance to respond,'' he says. This is one of the saddest parts of the whole process.''

Politics Comes to the Fore

As protests against the cuts in the Mathematics Department have mounted, the Rochester administration has endlessly explained and justified its decision. But some, far from being reassured that the basis for the decision was reasonable, have concluded that politics was at work. My impression, the more and more I look at it, is that they felt mathematics as a group would not be able to respond to this,'' says Gitler. More and more I am convinced that it was a political decision and definitely not an academic solution.'' Many in the Mathematics Department share his view.

According to Ronald Douglas the fact that the cuts in the graduate programs were spread around--some in the social sciences, some in the humanities, some in the sciences, and some in engineering--points to a political decision. Furthermore, some of the rhetoric was clearly such that they knew what they wanted to prove and then went back and got the information they needed to support it.'' After visiting the campus as a member of the fact-finding committee and reading the various documents associated with the plan, Douglas has come up with a theory of what happened that is roughly the following.
The administration had to cut a department in the sciences, so the question was which one. It made no sense to cut biology and chemistry, because the faculty numbers are critical to staff the laboratory-based courses taken by the many pre-med students. The Physics and Astronomy Department was already facing a cut in its faculty related to the shutdown of one of its facilities funded by the National Science Foundation. Moreover, substantial outside support in biology, chemistry, and physics depended on maintaining faculty size in these disciplines. (The Mathematics Department has done very well in attracting outside support: nearly two thirds of its members have grants. However, the total dollar amount is much smaller than in other disciplines.) Earth and environmental science is such a small department that even wiping it out would not save enough money. This meant that a cut to the Mathematics Department was inescapable. Once the administration concluded this, Douglas suggests, they felt they could solve two problems at once. They could produce the necessary dollar amount of savings, and they could take steps that they felt would address the instruction problems in mathematics.

Douglas believes that the only way the administration would reverse its decision is if they were somehow convinced that the cuts in the Mathematics Department might threaten the centerpiece of the Rochester Renaissance Plan: raising student quality and increasing tuition revenue. He is not sure that part of the plan will work in any case, because in the Northeast competition for high-quality students has been heating up immensely.'' They are banking on making Rochester a hot place for undergraduates, but I'm skeptical they will succeed,'' he says.
Some in the Mathematics Department believe that the termination of the graduate program could harm the university's attractiveness to undergraduates. Rochester's main selling point for attracting students is that it has a small student body and small classes, so you can get a good undergraduate education,'' says Ravenel. At the same time, it is a research university, so as an undergraduate you have the opportunity to get some taste of what research is like... In the long run, the absence of a mathematics graduate program will, I believe, affect the intellectual tone of the university, and it will affect the university's ability to attract and recruit faculty and students in related areas.''
For now, the Mathematics Department at Rochester has to live with the administration's decision. The AMS is doing what it can to help. The AMS task force on Rochester will continue to monitor the situation and provide assistance where possible. In addition, the AMS Task Force on Excellence in Mathematical Scholarship has already been looking at these kinds of issues for about a year now, and their report could help other departments avoid a fate like Rochester's. Perhaps all of the attention will help the department, but for now it seems still to be reeling from the blow.

Resolution Passed by the Council of the American Mathematical Society, January 9, 1996

The Council of the American Mathematical Society is deeply concerned over the University of Rochester's announced intention to severely downgrade its strong mathematics program by eliminating Ph.D studies, shrinking the mathematics faculty over time'' by more than one half, and assigning the teaching of calculus to faculty in other departments and to nontenured adjuncts.
This plan displays a lack of understanding of the nature of mathematics, its role as a core discipline among the sciences, and its place in a well-rounded education.

The entire Rochester academic community is ill-served by such a strategy. Calculus students will be taught by instructors much less likely to have either the wide-ranging overview of mathematics or the involvement with the subject necessary for truly effective teaching. Nor will these instructors be likely to stay abreast of current evolution in the pedagogy and content of calculus.

The hiring of low-paid adjuncts with no long-term commitment to or from the institution will undermine educational quality. It could lead to an egregious violation of principles of nonexploitation enunciated in the January 1994 resolution adopted by the Council in the name of the Society, on Supportive Practices and Ethics in the Employment of Young Mathematicians".
Advanced undergraduates in mathematics and graduate students in other scientific disciplines will be deprived of the support that a mathematics graduate program provides to their studies. Faculty in quantitative disciplines will miss opportunities to consult and collaborate with their colleagues in mathematics. In the absence of excellence in mathematics, the attractiveness of Rochester as a first-rate research center in physical science, engineering, and economics will diminish.

On intellectual, educational, and practical grounds, Rochester's intended treatment of mathematics is incompatible with its aspirations to national distinction as a research university emphasizing quality undergraduate education.

The Council strongly urges the University of Rochester's administration to reconsider its proposed course of action with regard to mathematics.

--Allyn Jackson

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From the April 1996 issue of *Notices of the American Mathematical Society*

Rochester Update

The University of Rochester is feeling the heat of the public outcry over the elimination of its graduate program in mathematics. In a tartly worded memorandum, the administration proposed a plan whereby the graduate program would be restored, but only if other departments chipped in to pay for it. The Mathematics Department, emboldened by the strong support it has garnered outside the university, firmly rejected the proposal.

The story began last November, when Rochester unveiled a downsizing plan that called for deep cuts in the Mathematics Department. The Ph.D. program would disappear, the faculty would be reduced from 21 to 10, and adjuncts would be hired to teach lower-level courses. The university has received about one hundred letters from mathematicians, scientists, engineers, and industrialists protesting the cuts. The controversy has also sparked coverage in the popular press.

In a memorandum sent in January to selected department chairs, the administration proposed a way to test the contention, set forth in many of the letters of protest, that a mathematics Ph.D. program is essential to successful science and engineering programs at a research university. If that contention is correct,'' the memorandum says, then we believe nonmath departments should be willing to contribute financially to a Ph.D. program outside their department that will prevent their own research from becoming inferior.'' If science and engineering departments put up the funds, then the administration would agree to a focused'' Ph.D. program run by thirteen mathematics faculty.
The proposal also outlined a mini public relations plan, in case the funds were not forthcoming. First, the Mathematics Department would have to issue a joint press release with the administration conceding that the other departments did not believe that a graduate program in mathematics is essential. In addition, the department would have to agree to acknowledge this point in any external communications that it makes thereafter critical'' of the university's decision. Finally, the proposal includes a draft statement from the Mathematics Department Leadership'' that the department would have to adopt, saying that the administration had read relevant faculty sentiment more accurately than we have and that its action is consistent with a rationally held belief that, given financial constraints, this action was institutionally sound.'' In reply, the Mathematics Department flatly refused to make any such statements and rejected the entire proposal as a plan designed to fail.'' They pointed out that the original downsizing plan stated that decisions about which programs to cut had to come from the administration, not from a collective decision of the faculty. We find it inconsistent that you are now proposing that the faculty make these decisions in such a way that the deck is stacked,'' the department wrote. In addition, recognizing that other departments suffered cuts in the downsizing, the department declared, We are sympathetic with their reluctance, and in

some cases their inability, to volunteer further cuts.'' In another memorandum, this time to the entire faculty, the administration said that the department's refusal of their proposal means that this specific claim of value [of the mathematics Ph.D. program] will not be tested, but the fact that they did not wish us to test it remains valuable information.''

By mid-February, the acrimony seemed to have cooled. We are not near a solution,'' said Mathematics Department chair Joseph Neisendorfer, but now it's more civil.'' At the time of this writing, some headway had been made in the negotiations, though nothing could be made public. But one thing is clear: the off-campus outcry has given the department a powerful bargaining chip.

--Allyn Jackson

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U. of Rochester to Cut Its Faculty by 10%

Rochester, New York -- The University of Rochester is trying to make itself more attractive to top students and trim a deficit of $6-million in its operating budget at the same time.

Rochester will cut the size of its faculty 10 per cent through attrition over the next five years, offer more merit scholarships, and reduce the freshman class to 900 next fall from 1,100 this year. It is also eliminating doctoral programs in chemical engineering, comparative literature, linguistics, and mathematics.

In 1991, the college considered and then scrapped a plan to eliminate several doctoral programs.

The latest plan wasn't a surprise. Susan E. Gustafson, an associate professor of German, said, "In a sense, there was already handwriting on the wall."

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"RE-ENGINEERING"

U. of Rochester to Cut Programs, Faculty, and Enrollment

By Christopher Shea

Rochester, New York -- Robert Westbrook, chairman of the history department at the University of Rochester, ambles out of his office for a brief tour, to show what it's like to work at a financially strapped institution.

He pops his head into a colleague's office and points out a leaky radiator. It would have ruined the ceiling of the room downstairs, he says, if not for timely repair work by Christopher Lasch, the esteemed cultural historian, who taught at Rochester until he died last year.

Mr. Westbrook stops into an office used by teaching assistants and bends over a pile of early-1980s personal computers. With the help of a friendly member of the maintenance staff, the history department cannibalizes equipment that other departments discard. "These are museum pieces," he says, in a tone of mock wonder. A graduate student looks up from a book and grins.

Mr. Westbrook can joke, because he thinks good scholarship can be produced in less-than-plush accommodations. But the University of Rochester, which ranks among the top 30 or so research institutions -- but has never been a hot college among high-school applicants -- has decided that patch jobs and year-to-year fixes aren't enough anymore.

The result is a two-part plan to revamp the university that has stirred up the campus. Rochester is cutting four graduate programs and trimming several others. It wants the faculty to shrink in size to 306 from 343 members, relying on retirements and voluntary departures to get there.

That much is by-the-book "downsizing," although the departments slated for cuts are protesting hotly.

But the plan also calls for reducing the student body of 4,500 by 20 per cent over the next few years, in the hope that greater selectivity will lead to applicants with higher grades and test scores.

The part of the plan that affects undergraduates will cost money at first, but Rochester is gambling that it will have a long-term payoff. Better students will translate into more of those who can pay Rochester's $18,700 tuition.

"At the graduate level, we're trying to focus the place so that we can completely compete nationally," says Thomas H. Jackson, who has been Rochester's president for a year and a half. "At the undergraduate level, we want to jump-start the quality of the student body so that people notice."

Last year, Rochester also started offering applicants from New York State a $5,000 annual grant toward tuition, in a bid to lure good students who thought the cost was almost -- but not quite -- worth it. Rochester had been losing students to other private colleges and to the State University of New York, which charges about $9,000 a year.

Rochester's Eastman School of Music and professional schools won't be directly affected by the changes.

Other institutions, notably Bennington College and St. Bonaventure University, have gone so far in cutting back on faculty as to fire tenured professors. Many have tried to limit their tuition increases. Last month, Muskingum College announced a $4,000 cut.

"Among institutions with the highest national prominence, Rochester has probably put the most pieces on the table with its re-engineering," says David L. Warren, president of the National Association of Independent Colleges and Universities.

Rochester is making its move before a full-blown crisis strikes, although financial strain has long been evident. Pay raises have been kept at 2 per cent or lower for years. In 1993, embarrassed departments were asked to cancel searches for new faculty candidates after advertisements had been taken out and C.V.'s solicited.

Four years ago, faculty members rebelled against a plan to cut several graduate programs, and the dean who had led the effort was fired. This time, even professors in the gutted departments realize that something has to be done.

The question now is whether the new cuts will hurt the university's reputation, offsetting any gains at the undergraduate level. Completely eliminated are graduate programs in mathematics, comparative literature, chemical engineering, and linguistics. Math is the hardest hit, losing 11 of its 21 faculty positions. To help with calculus instruction, the administration says it will turn to adjunct professors, with Ph.D.s but not tenure.

"I think that may affect our standing with high-school counselors and with parents who want to send their children to a good science-oriented university," says Sanford L. Segal, a math professor and chair of the executive committee of the Faculty Senate.

In addition, history, philosophy, mechanical engineering, and an earth-and-environmental-science program have had positions cut and some Ph.D. slots closed.

The heads of the affected departments already are lining up at the dean's office to haggle over the cuts -- which are based, the administration says, on the national reputation of each department, professors' publication rates, and the potential for improvement.

Asked how much room there is for negotiation, Richard N. Aslin, vice-provost and dean of the college, forms a zero with his thumb and forefinger.

The history of Rochester's fiscal woes has some twists. The oddest is the endowment, once huge, now barely adequate. In the early 1970s, Rochester had the third-biggest endowment in the country, topped only by those of Harvard University and the University of Texas. It then rode a very aggressive investing strategy right down a hole -- losing 40 per cent of its endowment in a year. It hit another bad stretch in the early 1980s. Last year, its endowment, at $656-million, was the country's 25th-largest.

To make up the lost revenue, Rochester began admitting more students in the 1970s. It grew by about 50 students a year from 1975 until this decade, trading larger class size for greater tuition revenue. The drop from 4,500 to 3,600 students will return the college to its 1975 size.

Rochester's biggest problem, however, has been the dwindling number of students who can afford to pay full tuition, a trend at many private institutions. The university thinks the root of its problem is its unsexy reputation. "We are not as successful at getting students as institutions that I think we match, pound for pound," says Mr. Jackson, the president.

The university's name often draws blank stares outside of New York, students say. "We have a huge insecurity," says Joshua Rovner, the campus newspaper's editor in chief. "We have a lot of students who were rejected at Cornell or rejected at the Ivies. They come to Rochester and like it, but in the back of their minds, they know it's not Cornell."

The problem is more than one of wounded psyches. When the best students pass up Rochester, the university finds itself with a disproportionate number on financial aid. Eighty per cent of Rochester's students last year were on some kind of aid, a figure far higher than those of its competitors. On average, those students get $13,000 a year in aid.

Rochester's solution to the problem seems at first like voodoo economics. The thinking is that a smaller student body with better S.A.T.'s -- a money loser on paper -- will attract more students who can pay full price. By giving away $5,000 per student, the college will replace those who need even more aid.

Mr. Jackson calls the proposals for undergraduate education "the non-obvious, intricate, and fun" part of his plan.

Mr. Rovner, the student editor, has already seen a ripple effect among high-school students. "I have a friend who is thinking of applying here," he says. "She heard it was going to be harder to get into, and that made it more exciting for her."

And the tuition grant, which is already in effect, seems to be working. Last year, Rochester's applications were up 15 per cent, and now they are up 20 per cent compared with the same point last year. The average S.A.T. score is up 34 points. The proportion of students on financial aid has dropped for the first time in 20 years. Despite the $5,000 grants, Rochester took in slightly more money in 1994-95 than the year before.

Students have some misgivings about the plan. Some think that the campus, located on the fringe of the city -- between the Genesee River and a large cemetery -- will feel too small with 900 fewer students. Some are worried that the pursuit of well- heeled students will hurt some groups of applicants.

"When you start talking about raising G.P.A. averages or S.A.T. averages, I worry that minority students will be left in the dust," says Curtis Sturdivant, a junior who is black. Rochester, where 14 per cent of this year's freshmen are black or Hispanic, has promised to remain at least that diverse.

The university also is tinkering with its curriculum, replacing broad distribution requirements with "clusters" of related courses in different areas. The goal is to emerge as the small research institution of first resort for many high- school students. "What I like best about the plan is that it is not just back-pedaling to save money," says Randall L. Calvert, chairman of the political-science department.

Rochester has months of academic wrangling ahead. The American Mathematical Society last week sent a team to ask how the university could eliminate a core graduate program like math.

The comparative-literature department wonders how it is going to handle demand for language courses among undergraduates, with 15 professors and no graduate students. The history department is bitterly resisting the suggestion that its solid reputation was due overwhelmingly to Christopher Lasch's presence -- the reason given for its cuts.

Everyone on campus is waiting to see how significant the exodus of professors in the affected departments will be. "One thing you can count on is that the people who leave will be your best people," says Douglas C. Ravenel, a math professor. Deadwood, after all, has no place to go.

But Rochester's financial condition itself was driving professors away -- more slowly, but across the board. Officials now say they hope that the remaining programs, and the college's reputation, will flourish. "It's suddenly harder to get into a school I'm already in," says Mr. Rovner, the student editor. "How great is that?"

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"IN" BOX

U. of Rochester Plan to Abolish Math Ph.D. Draws Fire

Letters of protest have poured in to the University of Rochester from scholars upset about its plan to close its doctoral program in mathematics.

Administrators at Rochester decided to suspend admissions next fall to four Ph.D. programs, including mathematics, as part of a five-year plan to reduce the size of the university.

Since announcing the plan in November, the university has received about 100 letters of protest from leading scientists and mathematicians. Last week, the American Mathematical Society passed a resolution urging Rochester to reconsider. It criticized the university's plan to hire adjuncts to teach introductory math. Reducing the department's faculty through attrition, the resolution said, would diminish the opportunities for collaboration among colleagues in science, math, and engineering.

So far, university officials have not been swayed. "It's very easy for someone outside the university to say, Don't do X, when they don't have to make any of the tradeoffs," said Richard N. Aslin, vice-provost and dean of the college.

He said institutions could provide a high-quality education in mathematics for undergraduates without a Ph.D. program -- and, he noted, most do. And while interaction between mathematicians and their colleagues is important, he said, that collaboration usually happens between colleagues on different campuses.

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"IN" BOX

Mathematicians at U. of Rochester Reject Deal to Save Program

Administrators at the University of Rochester offered mathematicians on the campus a deal: They could keep their Ph.D. program open if other departments were willing to help pay for it.

But last week, members of the mathematics department decided that this was an offer they could refuse. Joseph A. Neisendorfer, the department chairman, says the proposal would have pitted departments against each other. "We didn't think it was a fair test."

The department's struggle to preserve its doctoral program has attracted support from scholars across the country. Beginning next fall, Rochester plans to suspend admissions to four Ph.D. programs, including mathematics, as part of a strategy to cut costs. The mathematics faculty will be reduced, through attrition, to 10 professors from 21.

Last month, the administration offered to allow the mathematicians to keep an extra three or more positions if other departments would permanently contribute money to pay for the jobs.

Richard N. Aslin, vice-provost and dean of the college, says the administration got the idea from letters of protest it had received. Many scholars wrote that a Ph.D. program in mathematics was essential to graduate programs in the sciences. "We said, 'Okay, if that's true, let's go back to the other departments and ask, Are you willing to share some of your resources?'"

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U. of Rochester Plan to Cut Mathematics Is Recipe for Disaster

By Arthur Jaffe, Joseph Lipman, and Morton Lowengrub

Financially beleaguered, the University of Rochester recently announced its "Renaissance Plan," designed to improve the institution's quality by reducing the student body by 20 per cent and the faculty by 10 per cent, or 37 positions. Four graduate programs are to be terminated: mathematics, chemical engineering, comparative literature, and linguistics. Four others are to be reduced. The faculty reductions will occur mostly in these eight departments, through attrition. Mathematics will be hit the hardest, shrinking from 21 to 10 faculty members.

Even though more than 70 per cent of Rochester's undergraduates enroll in calculus courses, Richard Aslin, Rochester's vice-provost and dean, says: "There are other ways to service our need for calculus instruction, including the hiring of non-research adjunct faculty and/or the redirection of other qualified faculty from other disciplines."

The plan to downgrade mathematics at Rochester has produced an extraordinary wave of protest, not only from mathematicians, but also from well-known biologists, chemists, computer scientists, economists, physicists, and others. Four Nobel laureates have agreed to serve on a 27-member task force, with representatives from the sciences and business, formed by the American Mathematical Society to try to resolve the situation at Rochester. Four other Nobel laureates and several dozen members of the National Academy of Sciences are among the leaders in science, industry, and education who have sent letters and resolutions to the Rochester administration.

The letter writers state forcefully that advances in their fields increasingly depend on sophisticated mathematical methods, which only active researchers in mathematics can teach properly. Some characterize the plan to rely heavily on adjuncts and faculty members from other departments to teach calculus as a "recipe for disaster." Accomplished scholars in mathematics can offer students inspiration, insights, and approaches that are not available from textbooks, computerized tutorials, or even from other scholars who do not devote their intellectual lives to the discipline. The overall message is that a university cannot maintain a distinguished reputation in either research or teaching in the physical sciences and other quantitative areas without nurturing mathematics at all levels.

The letter writers and members of the task force include past and present top administrators at leading universities, people who understand how limited resources require difficult choices. Like them, we are well aware that most universities are in stringent financial circumstances, and we applaud Rochester's creativity in confronting its problems by restructuring itself, to give its undergraduates a superior education while maintaining its character as a research university. But reducing a mathematics program of recognized excellence to the status of a service department is a bad choice. It cannot serve the interests of students or help the university's reputation. It is like deciding to lose weight by cutting off a foot.

Not all academic subjects are equal. Without mathematics, science and technology would be in a primitive state. Mathematical concepts underlie our view of the physical world, and they pervade our culture in many subtle ways, through disciplines such as economics, architecture, and even the fine arts.

Speculation about "mathematical truth" lies at the foundation of the philosophy of knowledge. Mathematics has been studied for more than 2,500 years, with an exponential rate of progress in the past few decades. It is a universal human language: Modern scholars can still read mathematical texts written by Babylonian, Chinese, Greek, and Indian mathematicians thousands of years ago. Through mathematics, we can understand phenomena on scales ranging from the subatomic to the structure of the universe itself -- phenomena that are otherwise unfathomable.

A shrinking job market for Ph.D.'s in the sciences and technology already has reduced the number of graduate students in mathematics and other disciplines nationwide, and more reductions will certainly take place. Paring down a graduate program in mathematics is not unreasonable, but eliminating it totally at a prominent university like Rochester makes little sense.

Severe cuts in a mathematics department, like the ones planned at Rochester, are likely to drive the best mathematics faculty members to seek other jobs. New adjunct faculty members will not have a long-term commitment to the department. This is hardly a situation conducive to high-quality instruction, or to outstanding research. Nor is such a department likely to attract talented new members with fresh ideas. Furthermore, if other universities follow the lead Rochester is proposing, the consequences for the quality of American scientific and technological research over all could be disastrous.

The University of Rochester's president, Thomas H. Jackson, has rejected "the notion that tenure-track mathematicians and mathematics Ph.D. students ... are the only potential groups capable of offering high-quality mathematics instruction." Indeed, why should it be better to have courses taught by graduate students, for example, than by adjuncts and faculty members in other departments who may even have

Ph.D.'s in mathematics? After all, at some institutions, departments such as business and engineering, which require students to take mathematics, already offer their own math courses.

We would argue that transmitting a discipline -- a mode of thinking, a "miniculture" -- to thousands of students is the task of a team, not of isolated individuals. If you needed brain surgery, would you rather go to a hospital with a stable surgical team run by crack neurosurgeons, familiar with new developments in their area and involved in training residents? Or to one with a team of dispirited surgeons -- many of them temporary employees -- with no high-level teaching program, and which saves money by assigning operations to surgeons who learned the basics of the brain when they were younger, but who now spend most of their time on orthopedics?

It is disturbing that Rochester made such a drastic decision about a department without the benefit of careful external evaluation. In fact, many of the letters sent by prominent mathematicians assert high regard for Rochester's mathematics department, and the administration acknowledges the presence of world-class mathematicians on its faculty.

Among the justifications given by the administration for its action are that "despite good intentions by several faculty in Math, undergraduate instruction is less than optimal," and that "linkages with other departments and programs are minimal." The mathematics department has refuted these charges in detail, listing teaching innovations, comparing evaluations of mathematics instruction with university-wide averages, and providing specific examples of instruction linked to other programs and collaboration with faculty members in other departments.

Whatever changes are desirable in the role played by mathematics at Rochester will not be brought about by crippling the program. The mathematics department has given the administration a plan for more contact between faculty members and students, and for further links with other departments. Even if the department were cut back by 10 per cent, in line with the proposed university average, it could effectively implement this plan, preserve its existing strengths, and support Rochester's restructuring goals.

We urge the administration at Rochester to accept a limited reduction, such as that proposed by the mathematics department. We do not believe that eliminating graduate education in mathematics makes sense for any university in the front ranks of research in science and technology.

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