Beyond Rochester:
Mathematics Departments Come to Grips with University Downsizing

Whether it comes in the form of the axe or the whittle-knife, fiscal pressure has forced most mathematics departments across the nation to take a new look at their role in the university. Adding to the sense of urgency is the situation at the University of Rochester, where the administration instituted a downsizing plan that entails closing its mathematics Ph.D. program, cutting the mathematics faculty to half its current size, and covering teaching with adjuncts and nonmathematics faculty.

This article discusses what has happened in some other institutions facing problems and pressures similar to those at Rochester. Interviews with faculty in several departments around the country do not turn up reports of downsizing moves as drastic as Rochester's, where the mathematics department was targeted for especially deep cuts. Far more common, though almost as painful, is gradual but unplanned deterioration due to yearly budget cuts. Many departments are struggling to keep some sense of cohesion under these strains. Others have seen the shadow of the budget axe and have been able to act before it cut too deeply.

Departments Suffer from Attrition

The University of Massachusetts at Lowell is experiencing now what has been ordained for Rochester: By the end of this academic year, its mathematics faculty will be about half the size it was five years ago. As the department shrank through attrition, the university, pressed by state budget problems and declining enrollments, did not hire replacements. In addition, according to Mary Beth Ruskai, a mathematics professor at Lowell, when resources became available, they were not put into mathematics. Unlike Rochester, Lowell does not have a mathematics Ph.D. program. Still, she says that just a few years ago her department was talking about the establishment of a graduate program "as if it were a fait accompli."

The budget problems have also hampered efforts to improve how mathematics is taught at Lowell. To manage the teaching load, nonmathematics faculty from departments with declining enrollments are routinely brought in to teach mathematics courses. As might be expected, this arrangement is far from ideal, though Ruskai says some of the faculty have worked out reasonably well. One of the biggest problems is that these faculty are not in a position to work on improvements in mathematics curriculum or teaching. And "if you get assigned to a mathematics course a month before the start of classes," there is little prospect of making changes, Ruskai notes. "This discourages the kind of interdisciplinary collaboration in teaching that could be very productive in the long run."

Ruskai also points out that most university regulations stipulate that if there is retrenchment, faculty must be given the opportunity to teach outside their own departments. "This is something that many institutions will have to deal with in the future," she says. The combination of circumstances at Lowell—overstaffing in certain departments, budget cuts, and retrenchment rules—is cropping up on other campuses, and administrators might look to Lowell's approach as a way out of their headaches.

Recently the Lowell mathematics department convinced the administration to allow the department to review outside faculty before they teach mathematics courses. This way the department can at least ensure that only those faculty with genuine interdisciplinary expertise teach mathematics. "Mathematics departments should not be used as 'dumping grounds' by beleagured administrators," Ruskai states.

At the University of California, Santa Barbara, about one-third of the mathematics faculty retired over the last five years, many of them taking early retirement incentives. The department has patched together a teaching staff using regular faculty, graduate students, retirees, one- and two-year appointees, and instructors hired by the quarter. On top of this, the department is trying to implement calculus reform. "We're scrambling like hell just to survive," says de-

partment chair Michael Crandall. "The campus community has the impression that we teach worse than we do. But we've done massive innovation with few resources." His dean believes the department is doing a good job under difficult circumstances and has given them more funds to fill temporary positions and TAships. However, in the vast bureaucracy of the UC system, the dean has limited clout to make lasting improvements, like hiring more permanent faculty.

Recently UCSB's chemical engineering department, stating they are unhappy with the instruction its majors are getting in mathematics, decided to teach its own second-year calculus courses. The mathematics department is arguing against this move. Only a small proportion of students would be affected—there are only about twenty chemical engineering majors a year, compared to the hundreds who take calculus. But, says Crandall, "it's a bad precedent." Historically mathematicians have linked engineers' dissatisfaction with mathematics instruction to the economics of engineering schools: When the number of engineering majors has dropped, the faculty of engineering schools, swelled by research funds that are now in decline, need to justify their paychecks by teaching more courses.

Despite these problems, Crandall believes that, unlike at Rochester, his graduate program is not in jeopardy. Indeed, the structure of the UC system is such that what happened at Rochester, where a small group of administrators decided to cut four Ph.D. programs, could not happen at UCSB. In addition, the balance sheet at UCSB is quite different. At Rochester mathematics classes are small enough that the university can save money by hiring adjuncts instead of running a graduate program in which the students teach. UCSB uses large lectures for introductory mathematics courses, and without TAs to conduct discussion sections, classes would have to be smaller and more adjuncts hired, so costs would likely rise. This setup protects the graduate program to a certain degree, but still, Crandall says, within the UC system, "the idea is present to eliminate some graduate programs."

Elite Departments Not Immune

While the elite mathematics departments have largely been insulated from the kinds of pressures that one finds at Rochester, they are not immune to them. The Stanford mathematics department does not spend all of August scraping together money to cover precalculus teaching; there, fiscal pressures take a different form. According to Stanford mathematician Ralph Cohen, one dean there would point to UC Berkeley, just across the bay, and ask what makes Stanford worth the enormous difference in tuition between the two schools. One answer, faculty and administrators agree, is that Stanford offers the opportunity for undergraduates to be involved in research or to work directly with top researchers, something most small liberal arts colleges and big state universities cannot do.

This conclusion has led to a move on the Stanford campus to get senior faculty more involved with undergraduates. In response, the mathematics department has rearranged the teaching of its introductory mathematics courses so that a faculty member, not a graduate student, is in charge. In addition, the department is developing ways of getting undergraduates involved in mathematical research. This is where Cohen believes the Rochester administration "is missing the boat." It's better "to get research faculty more involved with undergraduates rather than hiring outside adjunct teachers for undergraduates," he says.

Like others all over the country, the Stanford mathematics department struggles with the problem of offering courses that meet the needs of other departments and are sound mathematically. In particular, there is pressure from other departments, especially economics and engineering, to start teaching their own mathematics courses, a trend Cohen decries. "This flies in the face of what a liberal education is meant to be," he declares. "This principle is really threatened all over the country." Despite the friction, he says, "we are listening to" the other departments, and some mathematics courses will be redesigned to better meet their needs.

Departments Focus on Teaching

One of the downfalls of the mathematics department at Rochester was the perception that the department did a poor job teaching calculus and other introductory courses. Even before all of the publicity about Rochester, some departments were beginning to believe that how well they taught calculus was important to how they were perceived and treated by their administrations. As John B. Conway puts it, "Not to pay enough attention to the way calculus is taught is probably asking for trouble." Conway, hired in 1990 as the head of the mathematics department at the University of Tennessee, has instituted a number of changes in his department to ensure that calculus gets the attention it needs.

First, the department set out to reduce the size of calculus classes: at the start of this effort the average class size was sixty and now it is thirty-two. In addition, all calculus classes are now taught by regular faculty or by graduate stu-

dents who have passed their preliminary examinations. Adjuncts are not used for calculus but only for remedial courses, and their use has declined in the past five years. In fact, these people are now dubbed "continuing instructors" because they are hired on long-term contracts. They also work on curricular reforms in the courses they teach.

For the past year and a half the department has been conducting a study of which flavor of calculus reform, if any, it should adopt. The department tried out four different reform schemes. At the start of the study, Conway says, the faculty were split on whether even to adopt calculus reform. By the end of the study, when the department voted on the question, it was nearly unanimous in favor. This process "got the faculty united and also helped us in our communications with other departments," Conway says. In addition, "it made us look good to the deans and convinced them we are paying attention to business." The administration has been supportive and even added a couple of extra positions to the department.

In these kinds of introductory courses, mathematics departments face special difficulties matched by few others. They get students from an enormous variety of majors, many of whom are just trying to get through a requirement as quickly and painlessly as possible. And many mathematics faculty claim their courses are just plain harder than those in other areas, and they have data on grades to back up the claim. As a result, it is very common to have the mathematics department at the bottom of the heap in campuswide student evaluations.

However, it seems that departments that have been able to capitalize on their teaching strength do not let these kinds of problems hold them back. "Even if you have demanding standards and high expectations, you can do it in such a way that is supportive of students, that shows you want to help them succeed," says William James Lewis, chair of the Department of Mathematics and Statistics at the University of Nebraska. This outlook has paid off: After a year-long budget planning exercise, fourteen out of seventeen departments in their College of Arts and Sciences had their TA budgets reduced, but not Lewis's department. In fact, they got funds for an additional faculty member because of the demands placed on them and the perception that they were doing a good job. Says Lewis, "It's very important to be out in front of issues and make sure your department is meeting the needs of the university, as perceived by people outside your department."

Lewis attributes his department's success in undergraduate teaching to a departmental culture that sets high value on good teaching. When new faculty are hired, they are immediately inculcated in this part of the departmental mission. Sometimes new faculty are paired with a senior faculty mentor who is a good teacher. The department always makes sure it nominates its members for campus teaching awards, and now one-third of the mathematics faculty have won them. The department also instituted a $500 award for outstanding TA.

In addition, the Nebraska mathematics department has activities that draw the campus together around mathematics. Each fall the department organizes "Math Day" for approximately 1,000 students who visit from area high schools. The activities include a mathematical "College Bowl" and a written competitive exam; scholarships are awarded to the top students. Other departments put on displays showing how mathematics is used in other subjects. The goal, says Lewis, is to show that mathematics is important to a wide range of majors. In addition, it helps students to see Nebraska as a lively, interesting place to attend college.

Shifting Research Focus

Many universities are going through "strategic planning" exercises to decide how best to utilize dwindling resources. At two such institutions—Virginia Polytechnic Institute and State University, which recently completed such an exercise, and the University of North Carolina at Chapel Hill, which is just starting—the process seems to be quite different from what was done at Rochester. At Virginia Tech final decisions were made by a high-level advisory committee, but those decisions were based on reports departments wrote about their plans for the coming five years. A similar process will be followed at North Carolina, and faculty will have input at every stage. At Rochester, most observers agree, departments had too few opportunities to contribute their views.

Virginia Tech mathematics department chair Robert Olin says that throughout the process he was "extremely worried" about the mathematics graduate program. In the end, two graduate programs were eliminated, but mathematics survived. The key, according to Olin, was sharpening the focus of the department on only four mathematical areas: algebra (particularly representation theory), numerical analysis, applied partial differential equations, and applied and computational control. What this means is that in the next few years, hiring in the department will concentrate on these four areas.

Initially, this move caused some turmoil in the department, especially among those not in the four chosen areas. Olin also took heat from some leading mathematicians outside Virginia Tech, who questioned the department's ability

to predict what in the next few years would be the four best areas to invest in. He responds that if in a couple of years it looks like the department made a wrong move, the department can always change directions. The strategy was "really a plus for the department", Olin maintains, and he says that most faculty now support the plan. He points out that when the Rochester department was cut, "mathematicians said, 'How dare they do that to mathematics?' But they are not paying attention to the signals" from university administrations. "We listened to the signals from up above, and we responded." In fact, the administration gave the department an exemplary award of $5,000 this past fall, partly in recognition of the focusing of their research mission.

Olin also credits his department's success in avoiding cuts to the attention paid to undergraduate teaching. The mathematics department regularly consults with other departments about their needs in mathematics courses. In fact, in the strategic planning process, every college outside of the College of Arts and Sciences signed a statement about the importance of the service teaching in the mathematics department and the need to avoid major cuts in mathematics.

In its downsizing plan, the Rochester administration faulted the mathematics department for having few linkages to other departments. Although not a panacea, having some expertise in applied areas can strengthen a mathematics department's position on campus. At the University of North Carolina, mathematics chair Patrick Eberlein says that his department has been trying for a number of years, with moderate success, to build an applied mathematics program. This year they hired Greg Forest, an applied mathematician from Ohio State University, whom Eberlein says will lead the faculty in building up the department in applied areas. Eberlein also believes the additional strength in applied mathematics will bolster the department's position in the upcoming strategic planning exercise. "Just hiring [Forest] has made a difference to our image," he notes.

In a fortuitous decision last year Eberlein arranged to have an outside evaluation team visit the department in February. The team's report will help the department prepare for the strategic planning exercise and give their plan added weight. Among the team's recommendations were the establishment of three-year rotating postdoctoral positions to replace some of the adjunct positions, closer supervision of calculus and precalculus courses, and a reduction in the teaching load of graduate students. With the new hire and the site visit report, Eberlein believes the department will "hold its own" in the strategic planning exercise. And unlike at Rochester, where everything was on the table, North Carolina explicitly recognizes in the guidelines for the exercise the importance of ensuring appropriate funding for "core" academic areas.

Conway, the chair in the Tennessee mathematics department, says that he would be upset if he were on the Rochester faculty. He calls Rochester's plans for increasing the use of adjuncts a "grave mistake" and says that their reliance on *U.S. News and World Report* in making decisions on what graduate programs to cut "strikes me as especially crazy." Nevertheless, he believes universities have the right to take a hard look at which programs should be maintained. "If income is constant and expenses go up, it's natural to take a close look at academic programs," he notes. "It's what we pay deans to do. Lots of things are changing in universities," he declares, "and we've got to realize that we have to be prepared to examine our own programs and make a lot of changes. Otherwise, it's not inconceivable that others could have the same fate as Rochester."

—Allyn Jackson

What is the AMS Doing?

Under the leadership of Morton Lowengrub, professor of mathematics and dean of the College of Arts & Sciences at Indiana University, the AMS Task Force on Excellence in Mathematics Scholarship has been working since summer 1994 on issues raised in the accompanying article and related concerns. The project was funded last fall by grants from the National Science Foundation and the Exxon Education Foundation. Carl Cowen, professor of mathematics at Purdue University, serves as the project director.

The goals of the Task Force are to identify critical issues related to providing quality undergraduate and graduate programs in doctoral institutions, highlight successful activities, engage faculty and administrators in dialogues about programs and resource needs, and give departments the information they need to replicate or adapt successful programs. In the past 18 months the Task Force has hosted eleven focus groups for mathematics faculty and administrators. More such discussions and visits to exemplary programs are planned to gather information. The Task Force will prepare a preliminary report later this year, with the full report planned for 1997.

Departments at many doctoral institutions are struggling to provide introductory mathematics courses for large numbers of students. Departments and administrations recognize that strong mathematics instruction is critical to student retention. At the same time, mathematics faculties are striving to improve programs for undergraduate majors and graduate students. A number of departments, including some mentioned in the article—as well as the University of Michigan, Oklahoma State University, and the University of Chicago—have found innovative ways to improve their programs which other departments can adapt. The reports of the Task Force will provide examples of successful strategies and the data necessary for implementing workable programs.

—Carl Cowen and Morton Lowengrub