Part II

Messages

Chapter 5
Comments from Chairs of Doctoral Departments

For over two years, groups of department chairs (and ex-chairs) from mathematics departments granting Ph.D. degrees met in focus groups to talk for two or three hours at a time. In a real sense these focus groups were the central accomplishment of the Task Force. They gave almost one hundred chairs of doctoral departments a chance to share experiences, to ask questions, and to offer advice. For many, the experience was both a relief and a revelation.

What did we learn in the focus groups? What advice did all those chairs have to offer? The first question is easy to answer: We learned about the problems, the concerns, and the successes of mathematics departments across the country. It was informal learning, the kind of knowledge one gains in casual discussion, but it helped chairs understand their own situations in the context of the broader mathematics community. The second question is much harder to answer, and this is the central dilemma faced by the Task Force.

We have included below samples of the many notes taken during the nine focus groups, collected into categories to show the common threads present in almost every discussion. These are indirect quotes, extracted from discussions over a two-year period.

Many Departments

Almost every participant told a story about a department: the pressures felt, the special problems in a particular university, the way in which the department grew or contracted. The central lesson of all these stories is simple: While departments face many common problems, they also differ in essential ways.

In reading the comments, however, some general trends become apparent. In a typical department the number of faculty is decreasing, majors are decreasing, the graduate program is shrinking. There are substantial decreases in upper-level undergraduate courses. The only things that seem to be increasing are the number of non-tenure-track faculty (either postdocs or part-time) and students in remedial courses. The feeling of many chairs was expressed by one person's comment that there are "too few faculty and too many students."

Many of these trends are borne out by the surveys (for example, the most recent CBMS survey, see Chapter 21), but the surveys as well as the comments of a few chairs show that the situation is neither simple nor uniform. The number of tenure-track faculty is indeed decreasing at doctoral-granting universities, but to

a large extent this decrease is offset by an increase in non-tenure-track positions (mainly postdocs). In the meantime, there has been a dramatic decrease in enrollments at these institutions. One might wonder why the situation isn't improving. The anecdotes here, along with some more refined analysis of the data, show why it is not.

Although both enrollments and faculty are decreasing in general, these trends are not uniform. Calculus enrollment in Group I private universities, for example, decreased from 1992 to 1997, but it increased in Group I public universities. In the same period, graduate student enrollments were reversed in these two groups. Many of the comments in the focus groups reinforced the vision of departments adjusting to such changes.

However, mixed with the problems were stories of success: departments that faced the future with optimism because they had found ways to secure resources or respect from the university. In differing degrees, many departments reported success even when they despaired at the problems.

There were other variations in departments. Some had many part-time graduate students (who are mainly older). Some were applied departments with no responsibilities for calculus. A few indicated a tradition of emphasizing teaching, which they felt gave them an advantage in today's climate. No matter how they varied, however, every department appeared to be under pressure.

Instruction

What are the pressures felt by departments? Over and over in the focus groups it became clear that the answer was overwhelmingly instruction: how to improve, how to create a better image, how to convince faculty to undertake time-consuming projects. The focus groups vacillated between bemoaning the sorry state of students ("they take no responsibility for learning") and castigating the community for its lack of effort ("math departments do a lousy job").

Nearly every group of chairs talked about the need for smaller classes, and many expressed an interest in gathering evidence that small classes are better. Many departments had already achieved smaller classes or planned to do so soon.

A number of chairs worried about the evaluation of teaching: whether it is good or bad and the increasing pressure to carry out a more elaborate evaluation process. There was some grumbling about treating students as customers, and the comment was made frequently that good evaluations are not necessarily correlated with good teaching. But there was also the recognition by many that mathematics is under pressure to be more accountable.

What are the major changes in instruction? Chairs most often mentioned computers (or calculators) in the classroom. Some commented with pride that their department has computer labs for the students, nearly always followed by the comment that such labs require substantial resources. Many indicated that graphing calculators seem to be a more practical alternative.

Calculus reform was a topic brought up in every focus group, often by chairs who were apologetic that reform seemed to have passed them by. For those who indicated that their departments were engaged in reform, most talked about computers first and the particular reform text second. Group learning and other ex-

perimentation was mentioned less frequently. In many departments, reform appeared to be done in only some classes, and the problems of integrating several versions of calculus were mentioned by a number of chairs. It was clear that nationwide reform efforts had made most departments consider instructional issues, even when they were not actively engaged in reform themselves.

The instructional problem most often mentioned by chairs was college algebra, which often led to a discussion of remedial courses taught by the department. Most departments seem to accept the necessity of providing large numbers of remedial courses. Some, however, have alternative programs, either directing students into slower-paced university courses or sending them to other institutions for remediation. Only a few indicated that they were able to raise standards for admission.

The number of mathematics majors in departments was seen as closely connected to their instructional program. Overall the number of majors is decreasing, and surveys indicate that between 1992 and 1997 the number of majors has decreased by about 12 percent. That figure hides an important difference between universities, however. In Group I schools, the drop has been slightly above 20 percent; in Group II and III schools it has been closer to 5 percent. That difference was reflected in the focus groups by comments from some departments that the number of majors had actually increased in recent years. A few provided some details about programs designed to attract and to retain new majors.

Many fewer chairs mentioned problems (or successes) with teacher-training programs. Indeed, when teacher education was mentioned, it was often viewed as an outreach activity rather than as an integral part of the instructional program.

Graduate Program

Graduate programs were discussed in every focus group, and a number of departments reported downsizing their programs. This downsizing was sometimes mandated. The comments about the effect on the department were muted, however. Considering recent data, this understatement is remarkable. Surveys suggest that between 1991 and 1997, the number of full-time graduate students at Group I, II, and III universities dropped by about 20 percent. The number of first-year graduate students during the same period decreased by about 28 percent. These are dramatic decreases. But even this hides a more remarkable difference. The decrease in first-year graduate students from 1991 to 1997 for Group I universities was nearly 40 percent, while it was only 12 percent for Group II.

There were few remarks about the effects of these dramatic shifts on departments, except indirectly. It was clear that some departments are considering reinvigorating (or creating) master's programs for their students. A number of departments talked about industrial components for graduate degrees. A number of others indicated extra efforts to train graduate students as teachers, both for their work during graduate training and for their careers later. All these things are designed to provide a better graduate program, which ultimately will attract better (and more) students.

It was remarkable that almost no chair indicated that his department was considering substantial modifications to their current doctoral program, except for

adding an industrial component and teaching experience. There was virtually no discussion of curriculum, qualifying exams, or dissertation requirements. Only one or two chairs knew what the average time-to-degree was for their graduate students. Few departments tracked students after they left.

Deans

Almost every chair recognized that deans require evidence in order to be persuaded to give more resources. Often, however, chairs were unclear about what evidence to provide. There was a recurring theme in focus groups: a call to committee to provide a report that any chair could take to the dean, providing convincing evidence that the dean should give mathematics more money. This was the "magic bullet" approach towards dealing with the administration, and it was extremely appealing to everyone, including members of the Task Force.

Deans (and other administrators) were viewed by chairs with a gentle antagonism. A few commented that members of the administration held nonacademic values, but most believed that deans were other academics who merely needed more knowledge about the mathematics department and the benefit a healthy department would bring to the university.

Chairs of departments that had been successful in securing major resources from the university provided occasional advice (clearly indicate the intended use, build support from other departments, etc.). In many cases, however, these successful chairs indicated that there had been special circumstances that permitted them to compete for resources. There was some good advice, but there were no magic bullets.

Some Advice

There were other issues brought up occasionally at the focus groups: some interest in development and fundraising, as well as a general concern about library budgets and the future of subscriptions. Remarkably, however, there were few topics that compared to the discussion of instruction. It was a constant theme for every chair at every meeting.

Some chairs offered good advice:

- One of the problems of mathematics is that mathematics is invisible in the political structure of the institution.
- Mathematics does a poor job of selling itself. Our initial courses should provide a good experience for students.
- We need to show that "math is a smart major" and that math majors make more than other science majors.
- The major problem is communication between the math department and other departments. The other departments need to understand the pressures on a math department; we need to make an effort to go out to the client departments to get information and feedback.
- Mathematics is really key to what is happening in the institution. As a discipline mathematics must do more thinking than anyone else about the way it educates its students (at all levels).

- Technology is an enhancement, not a replacement.

The topics that did not arise are almost as informative as those that did. Except for one or two incidental remarks, almost no chair talked about a perceived need to reinvigorate a research program in the department. A few mentioned the problem of faculty who were unproductive in research, but only in connection with variable teaching loads. Few talked about interdisciplinary programs outside the context of instruction, and none mentioned interdisciplinary research groups. The insularity of departments was never mentioned, not once (see Chapter 6). Almost no one mentioned conflicts between pure and applied mathematics (see Chapter 6). No one mentioned an effort to change in fundamental ways the basic doctoral program: distribution requirements, qualifying exams, dissertation.

Mainly, chairs were melancholy about the prospects for mathematics. Mixed with their pessimism, however, was a belief that mathematics is important to the university and to the students. Except to point out that many administrators have someone in their family who had a bad experience with mathematics, there was an inability to explain why we are unable to explain the poor reputation for mathematics.

Chairs understand that there is a problem; they do not understand its nature, its scope, or its solution.

Comments from Chairs

Stories of Departments

♦ We have 32 tenure-track research positions, down 2 since 1990. The university has increased in size every year, and the state's projection is that the university classes will skyrocket. In addition to the tenure-track positions, we have 10 budgeted instructor positions created in the 1970s and 1980s for a very large precalculus program, started as a remedial mathematics project, and we give credit for these. We changed the way we taught calculus; it is taught by faculty and graduate students. The only support we've received for any of this has been two extra graduate students.

♦ There are too few faculty and too many students. The department has received additional funds to hire part-time faculty, but we mostly have no new faculty lines. One exception is a new line to develop applied calculus and precalculus. The department is hiring year-by-year full-time calculus teachers with higher teaching loads. People with master's degrees are hired to teach twelve hours.

♦ Our university got the downsizing bug. Essentially there have been no new people coming into the department. This seems to be happening in a lot of universities. We teach fewer classes, and of course classes get larger. Over the past fifteen years we have seen a tremendous drop in interest in mathematics among American students. We have a large number of Chinese and Russian undergraduates. We can still give courses to maybe 10 students.

♦ We have a number of tenure contract faculty, who teach far more students than regular faculty members and more sections. We are experiencing a larger and larger precalculus burden — very dramatic and significant. None of the regular faculty interacts with these courses. We are looking to make one appointment to replace three retiring

faculty. We have two faculty who have indicated they will resign. If you look at the total teaching load of the department, graduate students do a large amount of remedial teaching, and the regular faculty have only about 50 percent of the contact hours for the rest. The regular faculty teach the graduate courses; the advanced undergraduate courses are becoming smaller and smaller. I am trying to improve the latter, since a mathematics major demonstrates significant thinking skill and will improve your ability to be hired.

♦ We just went through a large number of retirements: of 17 faculty, 6 took early retirement with eight years' service credits. We recruited for 2 faculty, and for many years we have had temporary faculty. One-third of our calculus is taught by permanent lecturers who eventually are made full time. We also use itinerant lecturers, but we need a critical mass of people in order to be viewed as a research university. The administration is most concerned about costs per course.

♦ We have lost a lot of the senior faculty members, having gone from 70 to 50 senior faculty. The number of junior faculty that we are allowed to hire is dropping very fast; grants for national needs no longer exist. Our computer labs are being closed and/or are threatened. It is hard to staff courses, since they try to insist that junior- and senior-level courses have at least 35 students in the classroom.

♦ We have a new president, and he came in with a big problem of recruitment and retention. He identified college algebra as one of our biggest problems, and he put in place a policy of no rookies on rookies in the classrooms. We have four new faculty positions, and we have gotten extremely positive responses on the campus. We have had a tremendous shift in recent years, and almost all the departments require these elementary courses. We are running faculty workshops in the summer, and for one week the faculty have to learn how to teach these classes. Faculty are preparing the material, and the first one is being done in summer of 1997. The workshops will be developed by the people that are teaching the courses.

♦ There have been lots of small problems in the last ten years, and several big mistakes. The business school created a quantitative reasoning department, and the math department was opposed. All this might have worked, but they started to look more and more like a math department, and they are now teaching calculus and engineering. We are trying to come up with some resolution for our problems. We need to resolve all these applied-math-versus-math issues.

♦ Our department is less traumatized by recent events because we have been a department with a strong commitment to teaching. All the courses above precalculus are taught by regular faculty, and it has stood us in good stead. For us, teaching qualifications have always been important; it is well understood that our teaching mission is a major part of our sustenance. We all teach two courses per semester. We had a period of confrontation between engineering and mathematics. They claimed that they could teach calculus equally well for their students. We made the case that the university had a strong investment in the mathematics department and that its viability depended on retaining our instructional mission. This case was won, but it resurfaces frequently, and math departments need to be vigilant about the threats that this presents. This is an important lesson for people to keep in mind. We are a traditional core mathematics department; we don't have good industrial contacts. One thing that has always struck me is that when mathematicians look at the life of a department like ours, they see something very different from administrators. There is a tremendous amount of mathematics that goes on in seminars in which we invest a large amount of time. None of these show up in our teaching loads, but they take up an incredible amount of time.

♦ Our department is nontraditional in several ways. We have a very broad-based core that resembles a kind of 1960s mathematics department. But we also require everyone to take computational mathematics and probability and statistics. We also have a required applications component, which requires of the students a semester of student work. We also have students who come back and participate in instruction. And we have a couple of on-campus internships with departments such as engineering. We have had a student in math education working in a school district on curricular matters. The students we have been graduating—every one of them—have gotten jobs. A couple of our students were made offers at the places where they had the internships. Most of our students who want academic careers are interested in teaching careers, and the application component helps them quite a bit. Internships are set up by a single person (almost like a director of graduate studies), and the hard part of the job is to keep up the contacts with industries. It's not easy to get someone to take on the job and do it with enthusiasm.

♦ Our environment is that of an urban university. We have been absorbing two to three cuts each year. We used to have 75 faculty, but the Institute must shrink by 30 faculty members. We now have 70 faculty and 100 graduate students, which is down 30 percent. We have about 6 to 10 graduate students finishing each year. The morale of beginning graduate students is very low.

♦ Our situation and programs are different from what I hear. We are a large urban comprehensive research university. We have some unique features: a large part-time graduate student body, a large master's component, including a master's in applied mathematics, and a program designed for part-time study and for people whose undergraduate degree is not mathematics. There are advantages and disadvantages. Many Ph.D. students are employed while pursuing their degree. Our programs satisfy a need for people who want intellectual stimulation; this is also true for people working in industry. This mission of a graduate program needs to be recognized. We have some ties to local industries, and we have a couple of interdisciplinary centers working on nonlinear analysis. The department has attracted good to excellent faculty, and we've seen a dramatic increase in the quality and accomplishments of students. There are new directions in areas of sciences, especially areas that are good for interdisciplinary work. Our greatest difficulty is that our course load has gone from 6,000 to 10,000 students, and this has put a severe strain on our resources. We cannot afford to experiment.

♦ The department has 32 faculty, 27 tenure-track, and 5 visiting/temporary positions in research. There are 35 graduate students, 30 of whom are TA's. About 5–6 Ph.D.'s finish each year: about 3 find research jobs, and 2 teaching jobs. TA's teach fewer than 7 credit hours and handle sections of fewer than 25 students. There is a successful training program for TA's. First-year students don't teach; they're attached to a senior teaching assistant to help with tests and grading. Second-year students teach and are monitored by a committee that helps them. There is a center for teaching at the university and a lecture series on great teaching. Graduate students are provided with small group analysis and discussion. Lectures are videotaped. Similar help is given to new faculty. Since good teaching is expected, graduate students do not have difficulty with these expectations. There is a $500 award each year to a TA for excellence in teaching. Since good teaching is expected of faculty at all times, at promotion, faculty can be judged on their research.

♦ The mathematics program is only about twenty-five years old. There has been recent work on the graduate program, and there are now 85 full-time TA's. The department graduates about 12 Ph.D.'s each year, all of whom (except those with personal reasons) get jobs. Most get academic jobs at both teaching and research institutions, and about 1 or 2 go into business per year.

♦ There are 35 Ph.D. students, with 3 or 4 finishing per year. Given the present job market, more will not be supported. A large number of students work outside part time, and courses must be adapted to work schedules. Students come with very wide backgrounds and preparation. Large numbers of students begin at levels below calculus. The university is held to a standard set by the state and is underfunded. Large numbers of part-time faculty are teaching. The department must live with its tight budget. Researchers teach a 2-2 load and others a 3-3.

♦ We are organized differently from most departments. There is a core math department and an umbrella math department that picks up most other things. The two departments cooperate in ways that are productive. We have programs that capture traditional math majors, and then we have the professional terminal math major for a master's. This is a first step: many students are not ready to go into a traditional math major, and they enjoy something more applied. For them we have a professional B.S. program in math with no proofs. In many ways, this is equivalent to an engineering degree.

♦ We have 10 tenure-line faculty. Our graduate program is dominated by service; we are essentially a technical university. This means we get lots of students in our courses. That's bad because we have large financial pressures, and we're forced to put much more effort into service teaching and don't have much left for research. We have reduced the size of calculus classes, have introduced Maple, and switched to the Harvard curriculum, all this due to the efforts of one faculty member without funding.

♦ We have 27 tenure-track faculty. We have some new instructorships, funded by a former member of our department. Two of them are labeled research, and one is labeled teaching with a scholarly agenda. These instructorships have a reduced teaching load so they can do curriculum development and research. This effort has just started, so there is still room for growth.

♦ We have 4 semipermanent instructors. The regular FTE's have stayed flat for the last few years. We are down to 26 FTE's after some people retired; there is only temporary money. The deans look at this temporary money as the only thing that is flexible in their budget. You should know that the budget in the math department is determined by the number of FTE's, so with the retired faculty our budget has gone way down. Yet we must still teach the same number of students. We are under pressure to increase class size. We are trying a calculus class of over 300 for the first time.

♦ We have math and computer science in the same department. There was no computer science department, and in 1976 we built a computer program within mathematics. We give the only Ph.D. in computer science in the state. We created an institute of computational mathematics to take advantage of the applied mathematics in our department. We share research colloquia with physics and computer science. We have about 65 supported graduate students, one half are in computer science.

♦ We have variable teaching for research and scholarship reasons. We have a significantly sized department with full professors, and some have slacked off in their research. Every math course we teach is no larger than 35 students. We decided to look at the faculty we would like to give reduced loads to and then make changes. We have reallocated our loads to help the research efforts.

♦ We lost some faculty to retirement, and we have had to concentrate our research in fewer areas: applied math, differential equations, and analysis. We have been forced to limit the areas. We have not decreased the program; we have simply become more efficient.

♦ We started out as a university with very few pretensions. There is a clash of values, and this varies from department to department. We have a large number of positions at a time when the market is not good. We have added 15 positions since early 1991. Our department has undergone a number of changes. Because we have responsibility for center management, and the math department is usually the cash cow, we are in a good position. When the center management model came into effect, they said that our income would be determined by the number of students and our overhead on grants. In theory, 72 percent of the money comes back to the department, but of course the real amount still depends on the dean.

♦ Applied mathematics has different instructional demands: we teach no calculus; we have large undergraduate courses in differential equations; and we serve students across the sciences, especially in engineering. Applied mathematics emphasizes graduate programs: 60 percent of our enrollment is at the graduate level. We have a number of undergraduate majors in applied math (operations research, statistics, applied math, and economics, regarded as a great path to business school). We also have a very large visitor program, which is related to the mission of the department. The visitors outnumber the faculty in some years. The university does not contribute to this; it is done entirely from grants. The structure is good for both departments, and there are joint appointments. But our department is very different from a typical mathematics department.

Instruction

♦ Our university has been retrenching for several years. Research support has been time honored on campus, and there is a feeling that if you show an interest in teaching, you are not interested in research. We need to encourage and to acknowledge teaching, and we need to try to say that teaching does make a difference. There is a problem in balancing teaching and research. If NSF had more programs supporting teaching and the K–12 interaction, then you could say, "look, this person has a grant." We started a young scholars program for minority students in the state, hoping that national groups and companies would continue. This did not happen, and they decided it was too expensive to turn it into a recruitment device. It now is more remedial than academic.

♦ I have found that we don't instill in our students a responsibility for learning. The attitude of our students has really deteriorated, and they are not very responsible. This is a part of the equation that is never mentioned. We have to figure out how to do this. George Cobb at Holyoke has pointed out that there has been a great effort by faculty members to make students happy. Students and faculty are supposed to be working together, using the methods of TQM to get the students to do their work. That's the problem.

♦ The committee had better go beyond proving that calculus is better taught in small sections. Proof that it's better in small sections isn't enough; we need to know how to implement smaller sections.

♦ We have been very good at denigrating ourselves publicly and privately. We also need to show off some of the good things we do. We have not done enough to show off some of our successes, the ways in which we have improved our teaching. When we ask other departments how we can best help them, the focus tends to be on the negative.

♦ To be truthful, most math departments do a lousy job. I have looked at it from the point of view of the engineers as well as of the mathematicians, and I find that most mathematicians have no idea how to create a syllabus for a course. They have no idea how to prepare the kids and make sure that they can do homework on a regular basis.

Stand at the back of a lecture and take a look around the room; you may realize that the majority of the people are not paying attention. Mathematicians are not doing their job.

♦ We emphasize good teaching. We have always had a program in which we emphasize good teaching. We give awards to the best undergraduate teachers, and we show in many ways that we recognize good teaching.

♦ We teach many service courses in which we are teaching people who are not happy about being there. We need to educate people, to teach those who don't want to learn what we are teaching. For that reason, it is important to teach communication skills to teachers, promoting more active learning.

♦ Are the same people who are asking for assessment also asking you to measure student learning? There is not a perfect correlation between attitude and learning. You cannot infer that if students feel good about their experience, then they have necessarily learned more.

♦ One reason people (including me) are so quick to criticize mathematics is very simple: Anyone in engineering or the hard sciences will tell you that without a good mathematics program they are in trouble. I am very critical because some faculty think it is not difficult to teach. It is hard work, and it takes lots of preparation, regardless of our training. Think about how it ties in with other disciplines and what students need to know. I have realized that I ought to teach the people in front of me the way I would like to have my own children taught.

♦ The real issue is about the intellectual case, the problem we face when going to the dean to hire. The dean wants us to use anyone to teach mathematics and thinks faculty is interchangeable. Other professors would never teach a course if it isn't their research specialty.

♦ We changed from large-section to small-section calculus about twelve years ago. This required many more faculty, and the chair then worked out a very ingenious method of getting them: small college teachers would come and teach some of those sections, which represented for them a small teaching load for which they got compensation while they were on sabbatical from their institution. They contributed a lot to the life of the department. Once the foundation support disappeared, the college picked it up, but they have become increasingly critical of the large number of visitors. In order to maintain the program we need a dozen or so faculty more than we actually have. We have met our needs in the last few years by increasing the number of other visitors.

♦ We have interdisciplinary grants at our school and a grant for interdisciplinary work with the engineering school. The math department is under a lot of pressure to become the Baskin-Robbins of calculus —to provide all the flavors. Engineering would be just as happy to hire mathematicians to work directly in the engineering department to teach mathematics.

♦ The idea of treating the students as customers has led to a lowering of standards.

♦ We have two different calculus classes, and I am concerned that the department seems to be marching in different directions. The students would like to have more technology put into use, and I think that the faculty would like it also. Freshman love chemistry and other sciences, but they don't like mathematics. The reason is that the other sciences pay more attention to their beginning students. We have a placement exam — pretty boring. Their chemistry homework is hard, but they spend a lot of time doing it anyway.

♦ There is a tension between undergraduate teaching and graduate training. We must balance the need to cover courses, to have assistants for teaching, and to mentor our graduate students. An administrative survey showed that math scored lowest on the number of undergraduates seen by a typical faculty member per year.

♦ Americans are really in the minority at my school; the problem I find is not the language but a culture gap. A prime example is an eminent mathematician I recently appointed. I was actually blocked when I first tried to appoint him. I promised to teach his courses if this person failed in the classroom. On that basis he was appointed. Although he has a tremendous problem with his English, he was nominated for a teaching award.

♦ It is assumed that if someone gets good teaching evaluations that they are good teachers. I would like to have something to show that teaching evaluations by students should not be used as the only measurement of good teaching.

♦ Teaching evaluations are largely done by students, and we are now starting to do faculty evaluation of teaching. Mentoring in the last five or six years has been more successful with Ph.D. students. We give them the opportunity to teach over the summer, and this usually helps the students to find employment.

♦ The school of engineering and physics has recently threatened to teach their own version of calculus. After much discussion, mathematics finally has the course back, but only after swearing up and down that they were going to do a good job.

♦ One way to measure success is to track the performance of the teachers. It is important to look at things other than student evaluations; you need to look at the performance of the continuing students and see how successful the students are after having had a particular teacher. It is important to realize that "you cannot fatten the hog by weighing it". English departments give the impression that they are doing assessment; mathematics departments don't.

♦ Our college decided that research was going to be very important, but teaching is considered sacrosanct. Teacher evaluation is done by writing to alumni (about 100) along with department recommendations. Teaching and research are being weighed equally these days; if you are not outstanding in both, you will not be promoted.

♦ We have been using our own homegrown calculus book. The book gets very low ratings by the students, and it has affected our student evaluations. They want a real book that they can use for reference.

♦ We talk about quality, yet we don't define what we mean by quality in teaching. We also need to say what defines success and what is the success of the student relative to this cost analysis.

♦ College algebra is a problem. It would be nice to know what general math requirements are in other universities and what works with these students. A study was done to predict performance in college algebra. A combination of high school GPA, admissions test scores, and a couple other factors are used to predict student placement. This method is used, since funding for tests has not always been available.

♦ Remedial and precalculus is where we have most of the problems. The administration insists that we have faculty — professors — teaching them.

♦ The university has a quantitative reasoning graduation requirement, which increases the load in mathematics. The college algebra course is being rethought to serve better as a terminal mathematics course. Collaborative learning is being used. TA's are being prepared better for these courses.

♦ The importance of mathematics courses to other departments varies tremendously from university to university. Who in the other department are you trying to convince? We ought to listen to other people and gather information. We need to listen to what they need and then respond. But we also should remember that we are the mathematicians, and we are the ones who know how to teach mathematics.

♦ We had a series of lucky occurrences about five years ago. There was a task force on undergraduate education, and it met for two years and produced a report. We did an experiment, taking students who were predicted to be at the bottom of our calculus classes and teaching them in small sections. They performed above average on the exams. We ran a few more pilot sections, and we made a proposal to teach all entry-level calculus in small sections. We had only a little data, but it worked. The next thing that happened was that there was some reallocation, and we moved from big calculus to small calculus. The sections of 35 and under are taught by Ph.D.'s, although we have a few large sections left. We copied some of what Michigan has done, hiring people on two- or three-year appointments, not on tenure track. We have gotten rid of a lot of stuff in our curriculum, things like integration formulas. We didn't get flack from other departments because we invited them to share in the discussion when we changed. The students are clawing over each other to get into the small sections. And we give them first-come first-served classes, with the exception of one dean who has insisted that all his students attend small sections.

♦ We have what is called a college algebra course, and this course (or something higher) has to be taken by all students. We have a nonengineering calculus sequence and an engineering calculus sequence — all these are taught in small sections. They are almost all taught by part-time instructors or second-year-and-above teaching assistants. The lectures consist of two groups of 35 students. There is no placement: the students can assert their rights to take anything they want. We have successes in recruiting minority students from rural backgrounds who have demonstrated potential to excel in mathematics. They are recruited primarily due to the energy of one individual in the department. These students attend ordinary lectures and an additional six hours of recitation. They learn how to learn, and they do well. It is expensive, but these students are getting better grades consistently, and they seem to be doing okay in engineering, etc.

♦ In working with engineering departments we are told we are not using enough computers. They would like to take over these courses. We have downsized our department, and we are downsizing our graduate program even more.

♦ The college has just implemented a policy for promotion from associate to full professor, requiring documented efforts in the area of instruction. Somehow candidates need to have in their portfolio of activities something that reflects the quality of their teaching. On the other side, we work very aggressively with people who are having trouble with teacher evaluations. We "penalize" bad teachers by splitting their classes, making them smaller. That way fewer students are subjected to a bad teacher, but it is not much of a penalty.

♦ There are no changes at our university; we teach as always. Teaching is what we are there for, and classes are all small. Students get constant feedback, and faculty are always available in their offices, waiting for students to drop in. This is the liberal arts tradition. A large number of math majors go on to get Ph.D.'s. There is nothing revolutionary in our department: we have not made any changes, we have not looked for additional resources. We have tried technology: for example, computing in modern algebra. But this has not seemed to make any difference.

♦ We teach some sections using Mathematica; we need a computer lab, but this is financially burdensome. I hope that the College of Arts and Sciences will see fit to create a computer lab for us instead of the math department trying to do it alone. Regular faculty members are very reluctant to go into new approaches to calculus. All our regular calculus classes use a calculator-based class, thereby removing the burden of having a computer lab.

♦ Five years ago the university instituted a 55-credit general education program. One of the requirements of this program is a mathematics course, and we have started some new courses: math appreciation and business calculus. They both now have 400 students each semester. General education courses are supposed to be taught by tenure-track professors, and all of our classes are taught to 45 students or less, but there are no resources to help us with this. I've noticed that the majority of faculty wants to teach behind closed doors; the most time they spend is researching what they are going to teach. People need to read journals on improving their classroom techniques; we don't have seminars about teaching.

Reform

♦ In calculus reform we have done nothing, except for individuals that have done their own thing. We have a large number of faculty looking at reform from the interdisciplinary point of view. Group learning, more interactive classrooms — there have been changes in the upper division that don't involve a lot of students.

♦ The issue of what we are trying to teach in calculus has to be addressed. Should we try to teach skills? That's what the students believe we should teach. We are not able to teach beyond skills when we have to teach classes that are too large.

♦ Calculus reform has bypassed us. Most things depend on the chair. We have tried to bring in some interesting mathematics from industry, and we got NSF support to do that. We did get a grant to do theory and to do some computation — this was our one venture into education.

♦ We are doing quite a bit toward instructional reform in the calculus sequence, running some experimental sections alongside the traditional sections. Only senior faculty are teaching the experimental sections. Two are math education specialists, and three are mathematicians. They have weekly meetings on how this is all going. The final aim is to have all small sections, but this isn't possible with the number of faculty available. We need to do more in the direction of technology and with the number of math education specialists.

♦ We are not making dramatic changes, just trying to keep abreast of what is happening. We teach a lot of calculus in sections of 40, and it is taught by regular faculty. We have done sections with Maple and extra hours in a Mac lab, but we don't have the resources to do this with everyone who takes calculus. We ran Harvard consortium materials and used graphing calculators. We have had a large section of calculus with about 120 students and a common final examination of all sections. We kept statistics to compare, and the results were that the people in large sections did better. Also, those who teach in large sections tend to be better teachers and the students tend to self-select, so that those who select the large classes feel comfortable with calculus already. Those students were taught by regular professors except for the one hour a week with a TA. We teach in one large section, and the other sections are 40.

♦ We are now using the new Harvard calculus. In first-semester calculus 73 percent of the students passed calculus with a C or better, and in the next semester with the old method 53 percent of the students passed second-semester calculus with a C or better. We put an incredible amount of resources into this.

♦ We are somewhat behind here. We use Maple throughout the upper-level curriculum. We teach many sections of two large courses at the lower level, and we started introducing graphing calculators into some. The problem is that we teach those courses to seven thousand students a year. Some faculty are happy while others are not at all; it is a big job to introduce calculators. We are changing the way we teach the courses, and we will try to phase in those changes during the next two years. We are formulating a fairly radical proposal for teaching calculus in small sections and bringing down the credit hours of each course. Students have to be ready to take the next set of courses, so the courses need structure and faculty need constraints. But you have to give people freedom to teach in order to make them creative; people will be better teachers if they are creative.

♦ When we implemented the new calculus, we decided to do all the sections the same way. The reaction of the students was immediately intense and negative, since they had no other place to go. The program included using Maple and group work, mostly focused on working together in computer groups. They had trouble getting together.

♦ Three years ago we changed the general structure of our courses. We have special sections for business and honors. We also have a special section in which computers are used, although we have used things less complicated than Mathematica. We introduced graphing calculators in a weak calculus class and it didn't work, so we backed out. This fall we are going to make using calculators optional. In the fall this course is large, with about 500 students. All in all we have been very conservative. Strangely enough the engineering school has also not been interested in this kind of technology.

♦ The department is using a traditional curriculum while beginning the process of reform. The dean is pushing, while there is concern about how to bring the faculty on board.

♦ The significant change from the point of view of education has been the Calculus Reform project. The essence of our program is that we have turned calculus into a laboratory course — the ideal science course. We actually expect students to work and think more among themselves rather than with us. By the end of the freshman year we have students writing significant reports, and we have abandoned the idea that if we don't tell it to them, they will not know it.

♦ We come from a conservative background. We have a secondary school associated with the university, and they were using graphing calculators. We were told that if we didn't get our act together and do something reasonably modern, they would cease to recommend their students to us. There are faculty members who refuse to use technology. All sections of calculus are not taught with calculators, but the students are very responsive. We now have two sections, but I guess that four to five years from now almost all the teaching will be done with graphing calculators. It's largely been a positive experience.

♦ We started with students who were beginning calculus, experimenting with graphing calculators. We don't have enough computer labs to deal with high-level software in calculus, but we have started using Mathematica and have been successful. We would like to experiment more with it. That was the extent of our department's efforts; we put in a request for more resources, and while we have not changed the curriculum, we will add some special sections.

♦ We have undergraduate math counselors in the dorms providing tutorials. We have consultation rooms and about four different support systems for students. When we went to using Harvard calculus, we used a project approach. We assigned projects to students and had the students work on the projects in groups. It seems to have had a big effect on retention: the students don't disappear anymore.

♦ Five years ago we got a lab and workstations and began using Mathematica and Maple. We now have a lab fee. We got a campus site license, and all students have projects to do. We now have more small learning groups using graphing calculators and are experimenting with graphing calculators in calculus. The nature of instruction is changing dramatically: we are renovating a classroom to use two or three different kinds of computers to create a high-tech environment. This one classroom is primarily dedicated to our department.

♦ Calculus has diversified and comes in many flavors. Biology is one new version of calculus. We have outreach programs using Mathematica, and some of those programs don't require the students to come to campus. This is labor intensive, but undergraduates are used in part of the program.

♦ For six years we have been experimenting using Mathematica. Our faculty is too small to do it in many sections, but we did it in a couple of sections. We tried to offer small sections, but the students voted against it: they perceived this as being more work. We decided to do something different in order to incorporate technology into teaching, and so we decided to go with HP graphing calculators in all calculus sections. Then we decided to introduce them in precalculus courses, and the students thought this was a reasonable thing to do. They would like to see us go to laptop computers. It really is nice for all the students to have the same machine and to have it with them everywhere they go. The most complaints are from the transfer students. We are running a $40 ten-hour workshop for transfer students to get them up to speed on the graphing calculators.

♦ Our dean feels that we need to convince the other departments that reform is a good idea. We have been on the reserve system for the last ten years; the business and engineering schools have incentives to teach calculus themselves. They have their own agenda and are not worried about the best way to teach mathematics.

♦ Over the past five years there have been big changes in the attitudes of the faculty members toward the importance and involvement of student learning. We started out with involvement in the Calculus Reform project viewed as a technology thing. As we got into the project the central focus became getting more student involvement and more cooperative learning. We have instituted a large training program to train faculty in how to do this. The faculty has been very receptive, which has had an impact throughout the curriculum, and we have more people interested in getting involved in these projects than ever before. The major effect has been a shift in the way faculty members think about their job. There has been a lot of emphasis given to how students receive the courses, and in response we have been able to cut class size down to about twenty-four in 30 percent of our calculus classes.

♦ The university has good technological resources. Most upper undergraduate courses have Mathematica available. There is a state-of-the-art classroom with thirty-five workstations. The university has a PEW grant to train faculty to incorporate technology into their teaching. A large quantity of materials had to be developed to support this. These materials are available to all participants. It is difficult to use technology. Few calculus sections use computers. The cost of labs is high. One solution might be networked classrooms with students owning laptop computers.

♦ Undergraduate courses are being reformed. There is a new interdisciplinary course being written by sixteen writing teams; it will use team teaching. The issue of granting teaching credit has not yet been addressed, as this program is still being planned. The department has funds to support faculty outside mathematics in this effort, and modules are being created for science courses where mathematics is needed. Work is being done to create a more problem-oriented core for the undergraduate major. Mathematical modeling is becoming more the focus. The department is asking what it means to think rigorously and is trying to put more mathematics earlier in the curriculum. This is part of the effort under a preliminary NSF grant for undergraduate curriculum development.

♦ We have been involved in a number of reform movements. Three years ago we did calculus reform with an NSF grant, and we developed a new calculus course with short-term projects. We use Maple. We had laboratory reports for projects as well as traditional kinds of instruction, and we received NSF grants to reform those courses as well.

♦ We have many credit hours in experimental courses. Our philosophy has been to emphasize concepts, introduce technology, and do a lot of modeling. The applications in calculus and differential equations are done through projects that take a few weeks to do; they are open-ended. We use Maple throughout the campus and we are getting the support of engineering and physics. We are hoping that it will begin to take off through the curriculum. The professors like it. In differential equations we have large sections and use peer learning assistants.

Remediation

♦ We have problems with remedial classes. Fifty percent of our students take a series of computer-generated exams through the semester. All students are required to attend classes, with a maximum of 20 students per class. We provide a room full of tutors at all times (this is due to a very talented director). They just published a book with all the information an undergraduate student should know about mathematics.

♦ We offer no remedial courses. We have a problem with engineering calculus students who are ill prepared, so we have a slow-paced calculus course, which is both popular and successful. There has been a lot of pressure on the retention issue and on the issue of students failing calculus. Obtaining data on these issues is important to people like me. We are interested in whether we should go to smaller-size calculus sections. We have a very small number of math majors.

♦ In our state we talked to the regents and the department of education to let them know that students in those kinds of courses (eighth- and ninth-grade algebra) were not going to get college-level credit. This filtered down to the high schools.

♦ Placement examinations are used for all freshmen. A Treisman model program was created to address some of these problems. It has been very successful. Random interviews were held to assess success, and these show that if students put effort into learning, then they succeed. There need to be such efforts in order to get more people into science, especially for minority students.

♦ We are a private school, structured differently. We have a junior college on campus, and students who need remedial help go there. When they come out they tend to be ready for calculus. There are a lot of students who are weak in math, and we are faced with them if they are strong in English and the humanities. As of September there will be an increased requirement for two math courses (which can be any math or computer science courses above algebra and trig). This is going to create a large influx into the program,

and we are trying to cope. In this institution, with the tuition so high, they actually count tuition as real money. As it is, I have approximately thirty classes a year taught by part-time people. After reading "You Are the Professor. What Next?", we got together to discuss teaching issues, technology in the classroom, and videotaping classes.

Majors

♦ The number of math majors is down. It would be nice to reverse this trend. It should be natural to choose mathematics as a liberal arts major. There are obstacles. The beginning courses require five instead of three contact hours.

♦ Retention of math majors is also a big problem. Part of it is the anonymity of the large department: we don't have a sense of community.

♦ The department is looking at the undergraduate major. The number (50–60 graduates per year) of math majors has not declined, but GPA's have. There is an undergraduate differential geometry course. Students take a two-year sequence in a core subject like topology, algebra, or analysis. This two-year sequence has had some unexpected consequences. It may explain the lower GPA's. The department is waiting to see. There is some data on high school performance versus college performance in mathematics.

♦ The numbers of math majors has increased, and we also allow people to take math majors from other departments.

♦ There are 130 majors, about half of whom are teachers. A database is kept on these students. There is an undergraduate room. The department teaches about 3,500 students per semester in freshman courses. The university has recently moved from a quarter to a semester system.

♦ We are mainly an undergraduate school. All students do two projects. The junior project is an interactive qualifying project; the senior is more major specific. In math we instituted an industrial project that students could do for the senior-year project. We developed teams, and there are three or four students working on these projects, with companies willing to pay for the work. Three companies gave us projects, and with this we are able to give release time to the faculty members because we have a deliverable project to a company. Some of these projects have turned into master's degree projects.

♦ We have the fear that our higher administration is not geared toward scholarship. We started a senior research experience that we hope will become a requirement. You could do an industrial side, or you could participate with a professor in a project. A number of students are getting together to work on something. Most undergraduate math majors do not know what research is all about.

♦ We have a very successful mathematics program: 8 percent of our undergraduates are mathematics majors. We have an REU program and bring in about 24 students each summer (one fourth from outside). The local ones are very successful in doing research and in getting research papers published. We have a tremendous number of activities all the time: math dinners, two undergraduate talks a week, ice cream socials. All senior math majors have to give talks as part of their senior year in order to graduate. We don't have a problem with calculus. Our calculus courses are the reason why we have so many majors, primarily because we have teachers who are extremely enthusiastic.

Teacher Education

♦ The department is concerned about its teacher education program in mathematics. Teachers are being produced who do not know and do not like mathematics.

♦ We are trying to do teacher preparation. We have 450 math majors overall, but the largest contingent of those are preservice high school math teachers. We teach two classes in the department to all preservice elementary teachers. All these students are seeing computing in their math courses. The elementary teachers are seeing it as an essential part of their exposure to math. We have a program that affects a small number of prospective teachers. They teach a couple of algebra and trigonometry courses for money, and they are required to take a course about their experiences in the classroom. This is an opportunity to work under the guidance of a mathematician and to think about the meaning of the math they are teaching to their fellow students. We insist that they take about one half classroom load outside of the program.

♦ We have been involved in several attempts at this kind of outreach, investigating the role of university faculty in mathematics education. With some private funds we are sponsoring three university faculty who are spending time at a local school. They set up and made available an Internet program for the students and teachers who are in the workshop.

Graduate Students

♦ We are under pressure to downsize the whole graduate program, and I will have to make the case for maintaining it. I don't really have good information about retention of graduate students. Most are there to get a Ph.D., but we often have students for six years before they leave (without a degree). We don't have exit interviews; they don't tell us they are leaving, let alone why they leave.

♦ Some data about graduate programs around the country would be very helpful. We have only about ninety Ph.D. students, and there is an amazing variation in the average time to completion, the workloads, sources of support, ultimate career goals, etc.

♦ After a year of lobbying we are starting our industrial master's degree. We made initial contact with over one hundred firms, mostly with our alumni, and they are anxious to have our students go into the program.

♦ We are currently reexamining our graduate degree, and we are trying to strengthen our master's degree, with an eye towards employment outside academia. The state cancelled a number of our courses because the enrollment was too low. We graduate 25 students each year.

♦ We are examining our master's program. While we are traditionally a Ph.D. department with very few master's students, there is a need to develop a strong master's program in conjunction with other departments.

♦ We developed a Ph.D. program with a substantial industrial component. By making connections to these companies, all of our students have some industrial component to their education.

♦ The university has decreed that first-year graduate students will no longer teach. They will be involved in learning how to teach. The central administration gave us the money to do this, which shows a commitment on the part of administration to improve the climate of the department.

♦ There is a very good sense of community between the faculty and graduate students. First-year graduate students do not teach, but second-year students participate in lecture/lab courses. The best senior graduate students run their own courses just like the faculty. There are some very good minority students.

♦ We have a very good TA training program. In their first year they only do grading. In the spring they work with a mentor in first-year calculus; they have conferences and watch. Then they are assigned one lecture, are criticized, and taped.

♦ We have had success bringing in graduate students the summer before and the summer after their first year to give them a resource seminar and some knowledge of undergraduate mathematics (so they can go into a higher-level of algebra). This has cut off almost a year from the time that they are spending in our program.

♦ We have one person who puts a fair amount of attention into TA training and follows up. We have graduate students teaching a lot; they are actually responsible for their own sections, including some experimental ones. They are getting teacher training. Also, we now have a small grant that is intended to support some graduate students going to small colleges nearby to work. We view this student teaching as a component of their education, and we view it as a continuing part of their education and training.

♦ We are having trouble finding ways to teach communication. If we don't have good vehicles for providing these kinds of skills to people in Ph.D. programs, then we don't have the competence to run the program (it is like saying, "go listen to a good opera singer, then go home and sing"). The math community needs to recognize that it should seek outside help to provide these skills. We need people with experience in this area to share with other people. We discovered that there was a committee looking at the same issue, but not for mathematics. Sometimes campus-wide teaching and learning centers that provide technical skills and push for the crucial goal of getting qualified professional people and leading faculty involved to demonstrate that this is really a worthwhile activity—that engages the senior faculty as well.

♦ We have graduate students on food stamps; they don't get free tuition. The funding at the university is year by year. We cannot offer a lot of our assistantships until March or April.

♦ We have made an effort to recruit and work with American graduate students. Personally I think that it is important to have American students so that future generations of students will be taught by people who have some sense of their own culture. I have worked very hard to recruit minority and Black students, because we need to have more traditional minority people with Ph.D.'s at institutions. In the first year the graduate student's only duty is answering questions at a drop-in center. In the second year they may teach a small section of precalculus or may even teach a calculus course. We don't do a good enough job in helping to train students to become better teachers.

♦ We have a fairly good record for attracting women into the program. However, a large percentage of the women leave. The graduate students themselves don't offer any explanations. We would like help to find out how to deal with this.

Deans

♦ The idea of a document that I can use for taking to a dean, coming from a national platform, is very attractive. We tend to think that we are much more active in calculus reform than anyone is in their respective fields. If this is true, we need to have the data available. This is the kind of thing that might excite them. The math community is doing

more than everyone else. Mathematics is the key subject for lots of other things; the pervasiveness of mathematics is important. We ought to be able to show that how well our students do in mathematics makes a big difference in their later lives. We need to show the importance of mathematics.

♦ The dean was somewhat aggressive about the problem of retention and seemed to blame particularly the math department's calculus classes; he mentioned that the figures were quite alarming. We are obviously very interested in that issue, and we would like to know more about what is happening nationally.

♦ We are thinking about restructuring the curriculum. We need information, since my dean demands that we teach calculus more efficiently. The administration feels that calculus reform is cheaper, and everything comes down to dollars. We need information on what it takes to run a quality program. We need information on what it takes to teach calculus and why it is important to have calculus being taught by regular faculty. The temporary teachers and lecturers are people who couldn't make it in research careers in mathematics. These people are good at being able to get students through exams, but that's not what a university is all about.

♦ We need some evidence of what works. We proposed teaching calculus in smaller sections, but the dean reacted by saying that this is only what you guys say. We need evidence that changes will make a difference.

♦ Our dean takes essential control of vacated lines; we hire on a probability basis.

♦ Much of our ability to copy (other programs) depends on the vision and judgment of the administration. They must have a sense of the quality of the institution and its mission.

♦ We want some kind of norm. When you are talking to a dean, what does it mean for a faculty member to be productive? Our big word is assessment. We are assessing our graduate programs and found a couple of ideas in the David Report. We are trying to assess the job in teaching calculus, because the math department is being blamed for not doing a good enough job in teaching calculus to engineers.

♦ We have had increased resources. We did not make our case on the basis of teaching; it was made by candidates whose credentials glowed in the dark. We were very aggressive in pursuing joint appointments. These are nearly free if you are willing to talk to administrators at higher levels. We have gotten some outstanding people for almost no resources, and this has had the effect of enhancing our image throughout the university. You need a high-class computational system in order to do mathematics. In ten years' time you will not have a good mathematics departments if you don't have a good computational system. We made the case for this and got it.

♦ We need to find a way to convince administrations that the intellectual life of the department is extremely important and affects the way the life of the student happens.

♦ How do we respond if we are asked to justify the quality of the program? Why do we have high-quality faculty? For teaching? For research?

♦ People in senior central administrative positions are not people whose training is in the university. We spend a lot of time educating people whose view is from an MBA perspective who don't understand what a university is about. A lot of time in university committees is spent trying to educate the administration on the financial part that this is not a business, but a different kind of enterprise. It is becoming a real impediment.

♦ Money is usually gotten at the expense of someone else. Deans need to find where the money can come from.

♦ People spend a lot of time doing studies about foreign TA's, etc., but the responsibility that students have toward learning is never talked about.

♦ We are a small private university with approximately ten thousand undergraduates. We did some restructuring several years ago; we have a significantly reduced department, and we have been unable to meet our target cuts for restructuring. It appears now that there will be a second round of restructuring and that all graduate programs in the institution are going to be affected. Almost all advanced graduate courses are threatened. I would like to hear some arguments to use with my deans.

♦ Regarding a well-known chair: No one should miss the very important point that every time he sought resources he identified to the dean what he would do with them. This helps to get the resources.

Development

♦ We don't have a strong tradition of development in mathematics. All the advice we have gotten from the university I would call generic. We would like sample alumni newsletters from other departments.

♦ As soon as a student gets an award from a donor, that donor must get instant gratification. It's important to make sure a letter is written immediately.

♦ We have an awards banquet for people who are potential donors. We get them to interact with the students.

♦ For development you need to stake out your territory and decide who will work with you once you have established the contact.

Libraries

♦ We have our library in the science library, and even there we have to battle for every shelf. It might be worthwhile for the Task Force to get data showing why math departments need libraries.

♦ The hottest issue with our faculty is the issue of libraries. We have been going through the list of journals and advising which ones we can cut to allow us to bring in the journals people have asked for. This year we have to cut an increasing amount of money from our libraries. We don't have a handle on how to hold the line. We are beginning to believe that the profession needs to address the issue, since library budgets are increasing at a rate larger than the education price index. The librarians believe that if the profession addresses this at a higher level (such as boycotting certain journals that are high cost), this sort of acidity would cut down on the price of journals very quickly.

♦ We have heard cries for help for the last thirty years. Our library is not one of our biggest problems, since a former chair has put a lot of effort into our library. He started an endowment for the library, and faculty who teach an extra course can put some amount of money into the endowment — the amount that we say the course costs, or about $10,000. This impressed the administration enough that our library is in good shape.

Miscellaneous Advice and Commentary

♦ Many people are getting discouraged; there is not much interest in supporting mathematics. Something is needed to get administrations to feel that mathematics is worth it. I feel that many are downsizing.

♦ Many administrators have someone in the family who has had a bad experience in mathematics.

♦ One of the problems of mathematics is that mathematics is invisible in the political structure of the institution. Most people don't know a lot about what we do. We need to learn to speak with a common voice, and the math departments need to work to become more visible.

♦ Mathematics does a poor job of selling itself. Our initial courses should provide a good experience for students. We need to show that "math is a smart major" and that math majors make more than other science majors.

♦ The idea of a manual or training program for chairs is an excellent idea and something that will come to be. Very often chairs will come into the job without much experience; suddenly they are supposed to have a broad view.

♦ The major problem is communication between the math department and other departments. The provost has made an effort to engage the university-wide community, trying to have the math department communicate with the other departments. He is going to resurrect a committee that died in 1985 to help. The other departments need to understand the pressures on a math department; we need to make an effort to go out to the client departments to get information and feedback.

♦ Mathematics is really key to what is happening in the institution. As a discipline, mathematics is doing more thinking about the way it educates its students at all levels...than anyone else.

♦ Technology is an enhancement, not a replacement.

♦ A new faculty member in science will receive $400,000 in setup, while less than $10,000 is allocated for space for staff serving 7,000 lower-division students.

♦ It is a myth that the library expense will start to level off because of electronic journals, etc.

♦ We arranged for six of our women alumnae to meet with girls from middle schools and high schools nearby. We showed them things that you could do with mathematics, and then we had the women talk about their jobs. In this way the students really learned about mathematics.

♦ We should be concerned about our profession. There are no jobs now, but current math majors will not reach the market for many years. The number of math majors has been dropping. At every level, courses are more populated by graduate students from other disciplines like engineering and business. Undergraduates are not as well prepared as they were five years ago, yet more subjects, such as sociology, are requiring that their students understand more mathematics.

♦ We need more resources, more time, and more faculty — yes, all of them.

Chapter 6
Comments from Deans

It is a sobering experience to overhear a frank appraisal of your shortcomings. Right or wrong, the comments represent the way another person views you and interprets your behavior. When that person controls your resources and future, it is essential to understand what those views are before you can change them.

After conducting focus groups with many chairs of mathematics departments, the Task Force conducted three separate focus groups with deans of doctoral-granting institutions. There was no systematic attempt to cover all institutions or even to sample the various levels. Deans are busy people, and the focus groups were conducted in conjunction with other meetings in order to attract as many as possible. A few deans attended more than one focus group, but most came to just one. Most were anxious to express their views about mathematics, both gripes and compliments. A good many asked the Task Force for advice: How do I deal with my mathematics department? Why is mathematics different? What can I do to make mathematicians understand?

For almost every dean the corresponding chair had attended a previous focus group. While in many cases the chair and dean seemed to understand one another quite well, in some cases it was clear that the dean saw the department in vastly different ways. These were often departments in distress.

How do deans view mathematics? There isn't a simple answer, as the notes from these meetings show. Some sound exasperated, some expectant for change, some ecstatic and proud. But there are some themes that run through many of the discussions, and they are themes that are worth listening to because they represent the way administrators (and often colleagues in other departments) view mathematics and mathematicians. If they are wrong views, we need to change them; if they are right, we need to change.

The prevalent theme in every discussion was the insularity of mathematics. Mathematicians do not interact with other departments or with faculty outside mathematics, many deans claimed, and they viewed this as a problem both for research and for teaching. In many cases, deans contrasted mathematics with statistics, which they pointed out had connections everywhere. The deans spoke of a lack of "teaching dialogue" with other departments, but largely they seemed to view mathematics departments as excessively inward looking. It was viewed as a

severe defect, and many deans who heard it voiced immediately agreed that it was their problem as well.

A second theme is slightly less focused but persistent as well. Mathematicians, the deans often claimed, show little interest in undergraduate education in general and remedial courses in particular. The lack of interest in remedial work seemed to ignore one of the fundamental missions of their institutions (at least for some), and there was only a passing acknowledgment by one or two that admissions standards played a role here.

Closely connected to this theme is the view that mathematicians who are interested in education have a second-class (or worse) status in the department. A number of deans recited cases in which they perceived departments had obstructed attempts to improve instruction by bringing in new faculty. They believed that departments were unwilling to broaden either hiring or promotion criteria to accommodate faculty who would improve the instructional program.

And many deans saw mathematicians constantly squabbling with one another, especially pure and applied. It was apparent that in some universities the deans had been forced to intervene, and in one or two cases had participated in dividing departments. Even when the deans merely looked on while departments argued, they viewed the divisions within mathematics as weaknesses that made hiring contentious and expansion of departments fruitless.

It is important to note that not all deans viewed their departments in these ways. One or two praised their departments for having cross-disciplinary programs. Several expressed pride in a first-rate instructional program in mathematics and commented about the exceptional reform efforts in recent years. A few believed that their pure and applied groups worked well together. But these themes—insularity, lack of interest in instruction, squabbling between factions—were present in every discussion.

There were other views expressed less often, and they show both animosity and affection for mathematics: The mathematics department is the most feared on campus. The engineers are not interested in the (reform) courses the mathematicians want to teach. Don't ask for small classes if we don't have the resources to provide them. The math faculty forget that their role in life is to teach undergraduates. The mathematics department seems to have a siege mentality (the "Rochester Syndrome"). The department feels underappreciated, under attack from students and professional colleges. There are many complaints from students, but this is because mathematics teaches more students.

And there were some deans who enthusiastically praised their mathematics departments. It is interesting to read their comments below with care to see how they measure success.

One point should be emphasized here. The comments below represent views of the deans, and they are not necessarily accurate views. But one has to deal with misunderstandings before dealing with the truth, and of course even some of the outrageous remarks capture some truth. The aim should be to understand why one dean commented angrily, "The president has said that he gets more complaints about the math courses than anything else," while another boasted, "I can't remember when I got a complaint about math!"

Comments from Deans

Insularity

♦ Concern: I worry about the insularity of the mathematics department, especially in its relationship with applied math and statistics.

♦ There seems to be a large disconnect between mathematics and other sciences, because there is very little interaction between mathematicians, physicists, and engineers.

♦ I had a mathematics department with a revolving door problem. It was very insular, with only a couple of connections to physics and no participation in the teaching dialogues going on throughout the campus. General education issues had passed them by. Our calculus classes were taught in classes of 350. Then the provost offered the mathematics department the opportunity to move from a floundering department to one of the best departments on campus. They turned around: hired different kinds of mathematicians, taught calculus in small classes, became involved in K–12 education. The department grew, and all mathematics courses are now taught by math faculty.

♦ The mathematics department does not interact well with the rest of the university. Our statistics program is all over the campus. Following an outside review, the university is moving to build a separate department of statistics whose principal focus will be on social rather than mathematical statistics.

♦ We have an outstanding statistics department, fully integrated into the university, with an interdisciplinary faculty. But the mathematics department is insular and continues to have a poor reputation with students and engineers. Some of the major complaints concern their teaching ability. The university has a president who is very concerned with student retention, but the general attitude of the department is that it is all right to have students fail mathematics. Our university pays the community college to do our remedial mathematics. Our solution was to hire a new applied computational mathematician as chair of the department. An applied mathematician makes sense for the university. He has initiated discussions with the engineering college to restructure the calculus classes for engineers.

♦ I have a very good department. They do a very good job and take their job seriously. They are trying to earn their way into general education and the idea that students should learn more than pure mathematics, and they are moving toward broadening the discipline. We have departments of statistics, bio-statistics, and agricultural statistics. There is not much interaction between the math and statistics departments, however.

♦ Our department has not been insular; they have always had cross-disciplinary interests within the department.

♦ The mathematics department is traditionally very strong, but recent evaluations have identified it as slipping from this position. The major criticism is that it is too insular and that it does not have a strong culture of support for teaching at the undergraduate level. Our department is very old, but our junior appointments have been strong, and they have produced significant efforts in reform of undergraduate teaching and education, with some calculus reform efforts. But there are continuing problems: continuing insularity, an overly inward-looking department, difficulty in the placement of graduate students. We are currently rethinking the Ph.D. program and asking for a rethinking of master's programs; in the latter there is a general resistance to dealing with math and its applications.

♦ Many of my mathematics faculty are past their prime and are mystified that the students don't identify with them. Their solution is that we must get a new kind of student. They don't value teaching or pedagogy.

♦ Problem: Mathematicians are not willing to assume responsibility for teaching enough courses to meet the needs of the college. It has not been illustrated that putting more resources into the department will fix this.

♦ We have open admission at our institution, and remedial mathematics teaching is a big part of our program. The problem is that the mathematics department does not see this as part of their mission. Our solution was to hire one teacher trained in math education, and we put in place a computer-aided instruction program, with graduate student assistants and students meeting with other students. The result was a 40 percent increase in the success rate of these students. But the mathematics department did not want to consider tenure for this position, and as a result the person was lost to another university.

♦ The mathematics department teaches some calculus courses in sections of 25 to 30. Campus-wide there is great concern about the quality of math teaching. The members of the mathematics department do not talk to each other, never mind to faculty in other departments. Insularity is very prevalent. The "pure" math faculty looks down on math educators as well as the applied mathematicians. Few of the pure mathematicians have grants. The tenure-track mathematicians don't want to teach anything below calculus, yet a third of the students have to take high school mathematics to begin. The mathematics department is the most frustrating department I have dealt with. The department is huge, and they feel they can outlast any dean, provost, or president.

♦ Concerns have surfaced that the very heavy load of calculus and precalculus is adversely affecting the major. The math major is getting the short end of the stick. We don't want to consume graduate resources in an attempt to keep up with a good calculus program. And we don't want to go from being a good mathematics program to being a good calculus school. We even teach middle school math. It is distressing to see how many new engineering students need precalculus, in spite of the fact that we are not admitting unqualified students.

♦ During the last decade our mathematics department has lost a great deal of cohesiveness. We are now working to build a sense of community back into the department. We need this in order to convince the administration to reduce the calculus sections from large enrollment to 35 students per section; we have not been able to put enough money into that effort. The teaching loads for faculty members with modest research efforts are 2 and 2. There is very little participation from the tenure-track faculty in teaching these lower-level courses, and we want all of them to participate in calculus instruction every year. Unfortunately, we find that the faculty as a whole are not interested in the undergraduate program, and at the same time the person that supervises the curriculum is a very good teacher and not such a good administrator. The mathematics department almost never considers the ability of the faculty person to teach calculus, and they never consider their effectiveness in the classroom because of language difficulties. We have a large number of low enrollment (4 to 12 students) in 90 sections over the course of the year. It seems that too many of these little special topics courses are being taught.

♦ Three-quarters of our mathematics department are pure mathematicians. The rest of the department consists of some specialists who teach only and are treated as fourth-class citizens. The mathematics educators are treated as third-class citizens. About 60 percent of the mathematicians are eligible to retire; they pay very little attention to anything below calculus, since they consider this beneath them. Many of our students have to retake

high school algebra, however, and as a result a lot of people teach these students . . . but not the professors. There needs to be a group that cares about this. (Our chemistry department faculty does teach freshman level.) The mathematics department has a precalculus committee that looked into the situation and made recommendations, but they were not approved by the department. Our provost sees the large budget of the mathematics department and wonders why they are always asking for extra money for things like a resource center, and he thinks the department should raise their own money. The biggest problem is "how to change the culture in the mathematics community so those mathematicians who are doing things like teaching do not lose stature."

♦ We have been very positively impacted by increasing our unit requirements for entering high school students. We had only six sections of remedial beginning students. All students have to have had four years of high school math, with at least college algebra preparation and the recommendation that they do precalculus. We also had a math lab for a long time; this has become much more of a resource center. We started converting our faculty to using graphing calculators, only to find out that the faculty did not know how to use them. We had to get the faculty ready for this. The math lab is doing a lot to cure math phobia and graphing calculator phobia. We have several faculty members going in different directions on calculus reform. The calculus reform that is getting the most grants is so unpopular with students that engineering discourages their students from taking it. We have several people involved in other projects. We need advice on how you evaluate projects that seem to go in different directions.

♦ Mathematics departments need to be able to teach courses that address issues that are relevant to students who are not going to go into a mathematics or an economics major.

♦ My mathematics department consists of a large group, and they just do their thing. This is a problem. We want to get into collaborative learning and do workshops. We wanted to invest in a center for science education, and we asked the mathematics department to participate. Instead of taking advantage of this, they turned it down. They voted not to accept a position for mathematics education, claiming that this would move them in the wrong direction. What they wanted were additional senior scholars to give them a quick fix. They have been a major disappointment.

♦ We need to select fewer doctoral students and accept more that have inclinations towards a master's degree. We need more involvement in "undergraduate education": the senior faculty are not very supportive, and most of this effort is coming from the newer teachers.

♦ Problem: Our math and applied departments do not get along and cannot agree on goals.

♦ Our applied mathematics group resides within the mathematics department. The typical problem of insularity in a mathematics department therefore has been helped by the applied mathematicians because they naturally interact with other departments. One of our strengths is general education courses. This was initially opposed by the mathematics department, but they have since joined the effort (although there is still not a lot of enthusiasm with this part of their work). Most students take their mathematics component in either statistics or computer science, not mathematics. We are now facing serious financial problems, which has focused our attention on doing things more efficiently. We are presently teaching calculus to 60-student classes, and I've asked whether they can get away with teaching calculus to 120-student classes.

♦ Problem: The math and applied departments cannot agree on who gets calculus.

♦ We have a relatively young Ph.D. program—12 years. I asked the department to identify one or two areas of focus, to represent enough people to form a critical mass. We want to maintain a balance between pure and applied mathematics in the curriculum. This is a real challenge. They also have statistics to deal with, but this seems to be working well. The tension between applied and pure seems to be difficult.

♦ Our mathematics program was not well supported by the previous dean. Presently we have started joint hires with the physics department in an area that is growing rapidly. Our basic and applied groups work together very well.

♦ We have a fairly large mathematics department, and there are a lot of things I could talk about. Leadership is very important. The mathematics department has no focus, particularly when it comes to teaching. It seems that the leadership and the older faculty are more concerned with teaching than the young faculty are. The department is split between having an outstanding mathematician and having an outstanding teacher. There are too many research areas and not a lot of cohesion.

General Problems and Praise

♦ Our mathematics department is the most feared department on campus. There are not a large number of math majors. Many of our faculty teach service courses, and they are discouraged that they cannot teach anything more than basic courses. But they have to try to teach the students they have, not the ones you hope to have. We are trying to have mathematics be friendlier to the students.

♦ Concern: Our universities need to react to the issues of K–12 education.

♦ Our mathematics department developed good courses for teaching calculus, but the engineers say it takes too long to take all that calculus.

♦ My department is very good. We have received grants for improving calculus and algebra, and we received grants to do the same thing in the public school. We have a very hardworking, relatively young department. The department feels they are not appreciated. They have accomplished much at the national level, yet they are under heavy attack from students and the professional colleges.

♦ On the issue of small classes, we want the faculty in the mathematics department to be committed to teaching well. The idea of small classes seems to have support from faculty, and it has been seized upon both as a way to teach better and to generate resources. When I commented that I had taught classes of 400 in chemistry three times a day in my career, the comment was that you could do that with chemistry and not with math. We teach chemistry that way because we can't afford to teach classes of 40; the message is we don't have these kinds of resources. The message I am trying to send is that it is wonderful to be able to teach the small classes, but they must also find a way, with technology or other resources. Don't turn around and say classes of 40 are good; now give us the resources to do it.

♦ Our mathematics department is extremely well run, with faculty concentrating in two areas of research. They have also invested highly and are really committed to math education. We have a substantial outreach program: math day, scholarships, calculus reform, serious involvement in K–12 education. We also have a large number of American graduate students and a fair number of women. We have invested in a very big way in undergraduate education.

♦ The chair has negotiated some new resources to reduce the size of the math classes. There is a sense that the smaller classes are good, desirable, and justify the faculty necessary to keep this size. We believe in small classes to the extent that resources will allow it. When you evaluate the different departments, it isn't necessarily true that the mathematics department warrants the number of faculty and resources.

♦ The department works hard at their calculus sequence because they had dissatisfaction from physics and engineering. They do an excellent job of placement within the university so that students know where to enter the math sequence. They are inundated with students from business calculus, life science majors, pre-health professions, and it's becoming uncontrollable. There are many complaints about instruction, but this is mainly because they teach more students. Partly it is because foreign graduate students are teaching these courses. They have rigorous training for these graduate students and they are certified, but this does not make any difference if the instructor has an accent.

♦ The general success of the mathematics department is attributed to hiring quality researchers, more than average community involvement, and strong involvement in minority affairs issues.

♦ The mathematics department has just had an external review (the post-Rochester Syndrome), and most mathematicians really feel that they are potentially dealing with the issues raised there. It is very clear that the Rochester phenomenon was traumatic, and it affects a lot of our conversations. The external review was the least successful external review of my seven departments: it was a heavily proactive attempt to speak for the department on various "resource" issues, with very little criticism; the department head felt that this was somewhat cultural.

♦ We are looking at mathematics across the curriculum, and we are trying to merge calculus with other disciplines in order to have more relevance to the students taking the courses. There is extreme post-Rochester sensitivity by the faculty to the restructuring of calculus for the engineering program. Engineering is not about to provide the funds to accomplish this initiative. We finally came up with a solution: to have faculty from other departments do some teaching in mathematics, and the mathematics department review came down very strongly against this. We are dealing with some fundamental hot buttons in terms of the math faculty; everyone is stressed. The biology department had a very different reaction and accepted outside faculty. The mathematicians react against interdisciplinary compromise. Rochester has really influenced the math faculty's sense of unease and what they see as the future of mathematics—they have this siege mentality.

♦ We have a successful mathematics department. We have faculty interested in pedagogical issues, a number of middle-level faculty who are outstanding researchers and are deeply committed to pedagogy, and this has created a revolution in calculus. We never had a tradition of large classes (no more than 37 students), which made it easier to achieve. We also had a cap on the number of graduate courses that the mathematics department could offer. This meant that when we added faculty, we did not add more graduate faculty, which meant that additional hires went into undergraduate education: "the undergraduate initiative".

♦ We have a very strong mathematics department, especially on the applied side. We are very interested in supporting calculus reform. We have sections of 100, and add further support and TA's in reform sections. Classes are run through a workshop where the students work on problems. The staff helps groups working on problems, and there is a great deal of technology involved.

♦ Another major problem is foreign TA's whose English we tried to improve. In so doing, we found that it is not just the English they are missing: they need to correct the cultural differences as well. Mostly they address the problem by speaking loudly or more sternly and think the students will understand. We just had 50 percent of the chemistry students fail mathematics because they can do the mathematics but cannot transfer the knowledge to, and do, the applications in chemistry.

♦ The mathematics department needs to do a better job of screening English language skills for teaching assistants.

♦ The mathematics department needs to do a better job of training and mentoring teaching assistants before putting them in front of the class.

♦ People answer their email. Perhaps the time has come to consider things like the use of a virtual TA, where a TA is communicating by electronic means rather than sitting in a classroom. Are there ways of taking advantage of the fact that the students growing up today are really able to do this very well? Can you do this in math?

♦ Regarding the issue of having instructors—part time or otherwise—teach calculus and precalculus courses, some of these instructors are outstanding teachers, and you get more teaching for your dollars. In an ideal world we would like to have calculus in classes of 25, all taught by math faculty teaching three or four courses per year. This is never going to happen, so what do we do? Do we bring in a reasonable mix to get more teaching power per dollar?

♦ We have too many precalculus courses.

♦ A few high-powered mathematicians are constantly trying to reduce their teaching loads.

♦ The real problem in the department is a lack of community and of shared vision.

♦ The department chair often shields the faculty from reality, and in particular the faculty think that all they have to do is ask for money. They forget that their role in life is to teach undergraduates. The faculty don't understand that they have to interact with people at different levels. It is very important to awaken math faculties to the great opportunities that are available to them if they behave more like other faculties.

♦ The president has said that he gets more complaints about the math courses than anything else.

♦ Our mathematics department does a great job. By sheer force of personality and many people in the department who are really committed to mathematics education, it has become a wonderful department. Calculus reform, math across the curriculum — there is an incredible amount of stuff going on. They are getting tired, and I don't know what to do about this. Leadership has been key. I can't remember when I got a complaint about math!

Chapter 7
Comments from Liberal Arts Colleges

The Task Force held one focus group (at the Orlando Joint Meetings) for chairs of mathematics departments at colleges and universities that do not offer a Ph.D. degree in mathematics. About a dozen chairs attended the focus group. Most were from small, high-quality liberal arts colleges, but the group also included a few who had a master's program in mathematics and one who represented a two-year college.

There was also a focus group with Project NExT fellows, attempting to gain the perspective of young faculty who had recently completed their Ph.D. Most of these mathematicians are now employed in liberal arts colleges, and the Task Force specifically asked about the fit between graduate education and their current jobs. Many of their comments reinforced those of the chairs. Project NExT is a program of the Mathematical Association of America, sponsored by the Exxon Foundation. It is aimed at young mathematics faculty, helping them to build connections with the mathematics community and to develop professionally during the early stages of their careers.

The chairs reported encountering many of the same issues and problems faced by their counterparts at Ph.D. institutions. Curriculum issues in undergraduate mathematics instruction were frequently discussed, and many, but not all, were involved with some form of "calculus reform". A number discussed their efforts to incorporate technology into mathematics instruction.

Of greatest interest to the Task Force were the comments that offered insight about the differing expectations of faculty at liberal arts schools from those at a doctoral-granting department. They described what they expected from new hires, and they made consistent recommendations to doctoral programs preparing their prospective faculty. The Project NExT fellows reinforced these views, pointing out that they often received little help in teaching as graduate students.

These comments are particularly valuable to departments that are taking a close look at their graduate programs and questioning whether they could do a better job of preparing graduate students for the jobs they will most likely receive. Based on the 1996 AMS-IMS-MAA Annual Survey, for those new Ph.D.s who do find jobs, fewer than a quarter will take their first job at a Group I, II, or III department, and almost a quarter will find a job in business and industry in the U.S.

The Project NExT fellows also made recommendations about the transition from undergraduate to graduate school. There was a general feeling that universities should provide a smoother transition for students, who often are surprised at the newer (and tougher) environment in graduate school.

It is important to note that only one chair (from a two-year college) indicated that research was not required of faculty. Most of the chairs said that new faculty were expected to develop a research program, and some implied that they had very high research expectations. One chair said that faculty engaged in research mostly in the summer. From the point of view of research preparation, the chairs had no criticism of research universities, and one chair cautioned that graduate schools should not change too much.

At the same time, it was clear from listening to the chairs that teaching issues dominated the life of faculty members at their campuses and that teaching was important in making hiring decisions. Clearly these chairs were concerned that most research departments came up short both in how they prepared graduate students to become effective teachers and in how they communicated a candidate's teaching potential in a letter of recommendation.

A recurrent theme in the Project NExT comments was the need to balance research and teaching. This was something that appeared to be universal for young faculty, and while many believed they learned some lessons in graduate school, others pointed out that finding a balance was already a major obstacle for them in their careers.

The idea that successful applicants to liberal arts colleges must be prepared for a wide spectrum of teaching duties came up repeatedly. Many chairs made specific references to the importance of interdisciplinary work, often saying that faculty needed to be able to "team-teach" with a faculty member from another department or to occasionally teach seminars outside of their own discipline. It was understood by everyone that faculty at small colleges must teach a much wider variety of mathematics classes than faculty at large research institutions.

In considering job candidates these chairs looked for evidence that applicants had taught courses with complete responsibility, not just as a teaching assistant. Others looked for evidence that the applicant had experience with something other than the lecture method of teaching. The ability to articulate research to a nonspecialist and the ability to engage undergraduate students in interdisciplinary projects were cited as important. The chairs were virtually unanimous in saying that an applicant needed a thoughtful discussion of teaching issues as a part of their application if they were to be considered seriously at a liberal arts college. Chairs from liberal arts colleges stressed that at their schools the entire college is the community, not just the department. Faculty from other departments often serve on search committees, and successful applicants must be perceived as potentially good colleagues, able to get along with people in other departments, and not just good mathematicians. If there is a final point to be made about applying for jobs at liberal arts colleges or at universities that do not focus on research and graduate education, it is that successful applicants must show enthusiasm for the type of institution to which they are applying. Applicants who leave the impression that they consider a job at a liberal arts college as a consolation prize have

little chance of a job offer. Both the applicant and the faculty who write letters of recommendation can do more to help their cause by making sure that the application is responsive to the school's advertisement and that applicants understand the institution to which they have applied.

Comments from Chairs of Liberal Arts Colleges

Life in a Liberal Arts Department

♦ At our school and at other four-year colleges, the focus is not on the math department but rather on the college. Tenure anxiety is high. There is significant student input for tenure and promotion cases. For final promotion, candidates need to have served the college. Colleges do not usually expect a lot of funding from NSF; research, as well as attendance at workshops and meetings, is supported by the college.

♦ Faculty are involved in a weekly teaching seminar in which teaching issues can be discussed. Faculty may teach courses other than mathematics and will certainly teach service courses. Faculty are expected to do some research, mostly in the summer.

♦ A significant number of math majors go on to graduate school, but not necessarily in math; fields like economics are popular. Other students are moving toward a career in teaching in schools. For undergraduates to be attracted to graduate school in mathematics, they need to be convinced that there are job opportunities. Undergraduate research is an expanding area.

♦ Calculus reform got a slow start at our school. There is a growth in the use of technology in the classroom. Students need to learn to read, speak, and discuss mathematics; we require students to learn to read the text. We use small groups both in and out of the classroom to help develop these skills.

♦ A high degree of computer literacy is required of our students; all math classes use computers. The discrete math class has a separate lab class; we use this to get students excited about mathematics.

♦ In our department in a two-year college research is not required. The Ph.D. is good for a salary upgrade, but not a mathless math. ed. degree. Two-year college faculty can use distance learning for their advanced degrees. In a master's degree for two-year college teaching, you need statistics, algebra, geometry, analysis, and some work outside the math department for applications material. Two-year colleges need more people who can teach in more than one discipline. In accreditation for interdisciplinary work, "math" needs to be labeled as such in order to show up correctly.

♦ In tenure decisions, good teaching is a prerequisite.

♦ Interdisciplinary courses are very important at our university. We are looking for faculty who can engage students in interdisciplinary projects and who are willing to use computers in their classes.

♦ Our faculty are expected to stay active in research. Interviewees give a talk to researchers and students. There are research seminars each Friday, with undergraduates coming one week out of four; this helps the faculty stay active.

♦ Our department was into calculus reform early, but it is still not completely integrated into the program. The program beyond calculus is traditional, and the faculty have much individual control over courses at that level. However, undergraduate research is

very important, and there is a project, either group or individual, for every undergraduate. About half of our math majors go on to graduate school, but not necessarily in math.

♦ Research universities could do more in providing research opportunities for faculty at nonresearch institutions. Summer workshops or institutes or opportunities for sabbaticals in which faculty could teach some classes but also participate in the research life of the department would be helpful.

Hiring Faculty in Liberal Arts Colleges

♦ Applicants to our department need to show some enthusiasm for the type of institution it is. There needs to be evidence of involvement in teaching.

♦ Too many students coming from graduate school think of jobs at liberal arts colleges as consolation prizes. Changing the attitudes at research universities would be helpful. In addition, if faculty at research institutions modeled taking teaching seriously, encouraging students to come to office hours, etc., new Ph.D.'s would find the transition easier.

♦ Applications for jobs are read carefully for a discussion of teaching issues, since teaching is paramount in our department. Letters of recommendation should address teaching, and the candidate should have a thoughtful statement about teaching. We look for experience in something other than the lecture method. Calculus reform requires more of instructors; we ask "How much time do you think you will spend teaching calculus?" Tenure is an all-college decision, so collegiality is an important aspect of the job; candidates should show some interests outside mathematics.

♦ In hiring we look for applicants with independence in their teaching, for example, having taught a class as a TA in which they controlled all aspects of the course. There are significant research expectations of our faculty. Along with teaching five courses per year, faculty will be expected to make research connections outside the college. We have a significant tradition of faculty governance, so it is important to get faculty with interests that transcend their own field. Since there are no graduate students, faculty handle all aspects of the courses themselves, and the fact that we have honors students makes it important that faculty stay active while stepping into all aspects of a career at once.

♦ In looking at a job applicant, colleges look for energy, initiative, and excitement. Some schools ask interviewees to teach a section from the calculus book as part of the process.

♦ Letters of recommendation for applicants are frequently so dissertation oriented that it is impossible to judge the quality of the applicant's teaching and whether they could handle the spectrum of teaching responsibilities. We want letters that paint a picture of individuals: what are they like in and out of the classroom, how do they interact with students, how are they as a colleague?

♦ More attention needs to be paid to teaching at research universities; it appears that the pressure for specialization and research has intensified. Many postdocs are saying that they want more balance between research and teaching. Our department seeks faculty with a broader view and the ability to communicate with colleagues outside of mathematics. Applicants are asked specific questions about why they want to come to a liberal arts college and are asked to articulate their research to nonspecialists. The hiring committee has two members from outside the mathematics department. They look for research with undergraduates, involvement with DUE grants, especially as a PI, or the ability to write expository mathematics, for example, for the *Monthly*. One positive note: there is a good supply of strong applicants coming out now. Applicants need to be re-

sponsive to the advertisement and show an understanding of our department. There needs to be evidence that research will continue, a cognizance of teaching excellence, an awareness of improvement in their own teaching, and perhaps involvement in teaching in other departments.

♦ Graduate schools shouldn't change too much. We look carefully at teaching statements of candidates. Research is important for tenure, but less important than teaching. We look for versatility on the part of job candidates, a willingness to learn after getting the job, an ability to get along with people in other departments. We need real people with a realistic view of themselves.

Preparing Graduate Students

♦ Graduate students at research universities are too focused when they leave graduate school and therefore don't fit in well in a situation where breadth is highly valued. Interdisciplinary programs in graduate school would be helpful. I came from a program where a minor outside of mathematics could substitute for one of the qualifying exams.

♦ Research universities need a gentler introduction to graduate school for graduates of four-year colleges.

♦ Graduate schools are doing okay in research preparation, but the problem is how to keep up with the field when they have a job. Graduate schools need to do a better job of preparing students to articulate their research and to move from research to teaching. The mathematics community needs to foster the idea that it is okay to teach in a liberal arts college.

Comments from Project NExT Fellows

These were oral responses to a series of five questions posed to the participants by letter in advance of the focus group. The questions were:

1. Did your graduate school experience adequately prepare you for the teaching aspects of your profession?
2. Did your graduate school experience adequately prepare you for the research aspects of your profession?
3. How could your graduate study have been different to make your answers to questions 1 and 2 (even) more positive?
4. Do you feel it takes too long to get a Ph.D.? If so, can you suggest changes to shorten the time to degree?
5. Are there changes that could be made to make the transition from undergraduate school to graduate school easier?

♦ During graduate school, I had a 6-hour teaching load and spent eight years doing graduate work. Technology was very much a part of the courses, and I had access to technology with computerized calculus. The department is good about asking the graduate students what they are interested in and letting them teach it. Because you teach so much it might take you much longer to get through graduate school, but you are very well prepared to be on the job market. To make the transition easier, the university has now decreased the teaching load for the first year of graduate school. We also had tremendous interaction with the tenure-track faculty.

♦ I had a very good experience in graduate school. One program in particular prepared me for teaching; it was subject specific, met once a week, and each week a team of two or three presented a lecture. It was hard to listen to the criticism, but we had professors tell us how to improve our presentations and material. Our teaching load was one course per semester with some supervision. We did not have much instruction on calculus reform nor on the technology involved. It would have been helpful if we had been exposed to the different trends and encouraged to be more involved with the math community. Preparation for research depended mostly on the advisor that you had. It took me only four years to get a Ph.D., and I credit my advisor with this. It would be good to have a math student orientation.

♦ We watched a professor for the first quarter and then taught; a lot of students had ten hours to teach. Everyone gets a fixed number of dollars per class per month. There was no formal training for teachers — no reform effort — no one had heard about calculus reform. The teaching was comfortable, though. Research was done as a joint effort. We had seminars, which really helped to give me plenty of research experience. I would like to see the graduate students encouraged to attend conferences; I found meetings to be really helpful to the teaching experience. It took me seven years to finish the Ph.D.

♦ I was always teaching, from the first semester on. I got a lot of experience. They have a variety of teaching reform efforts, including Treisman-style workshops, the Harvard material, and the use of Mathematica. We only taught between 8 and 9 hours a year. I was very intimidated by seminars, because I did not think I knew anything. I was a mediocre student and it was easy to get lost, and I did not take advantage of the opportunities that were there. There was a lack of sufficient orientation: literally they said, "Don't worry too much about your teaching; worry about your mathematics." Initial advice to students is crucial, and peer advice is essential. It took me six years to finish.

♦ I started teaching during the first semester and then two hours every week for the duration. Most students grade papers during the first year. In the second year you start recitations. By the third year you can do some teaching, but it is mostly recitations. Most students have their own class in the last year. Preparation for research depends mainly on the student and the advisor. We had seminars every week, and we had 5 or 6 graduate students in them every semester. If there was no outside speaker, we had to give the seminars ourselves. The department gave us support to go to meetings, and if we gave talks, they would pay us. Length of time for the Ph.D.? Four years is good enough, and five years is too long. It takes a lot of people longer because of the comprehensive exams.

♦ I needed more teaching experience, although I learned a lot about teaching from being very involved in support. The system worked well to find an advisor, and that helped prepare me for research. But there weren't regular, frequent social events that induced the students and faculty to mingle, and that hurt. The university started to treat the students as a drain on the system. My graduate training did not prepare me for the job I now have. I continue to do research in the summers (since I don't teach then). My department supports travel to conferences and places emphasis on obtaining grants, but they are happy to have me publish a paper every two years or so.

♦ My graduate training prepared me well for teaching. I was in full control of the courses, teaching a 6-hour load. I taught a wide variety of courses; the chair for undergraduate teaching made sure of this. I found the training good at helping me to balance my time and to manage my course load. The training also prepared me for research, largely because of the exposure to people in my research field. Most of my time now, however, is spent teaching and doing service. In undergraduate school I had been part of

a group that had a spotless record; we all got A's without much trouble. But that group did not measure my ability to prove theorems, which is really what is needed when you go to graduate school. It is important for departments to consider designing the transition to a graduate school program more carefully, with broader, more sophisticated course work in preparation for graduate school.

♦ Undergraduate teaching did not take place in my graduate school. But I taught 6 hours each semester from my second semester on. I taught a traditional lecture class with a pretty high failure rate, which was expected. We had no teacher supervision, and there was little collaboration among the graduate students. The U.S. students were a source of cheap labor for the university. No one monitored our progress. In graduate school I got the sense that expository writing was not for young people. This turned out to be a great deficiency in my training; writing is essential to one's career.

♦ I had no training or supervision in graduate school. The seminars were very good, although most of the time I did not understand the content. What was missing most was combining of the three requirements: teaching, research, and service. We were not prepared for service. There should be some sharing of service responsibilities with graduate students, even if it is just to share the feeling that you really need to divide your time. Presently I am being told to concentrate on my research, but I am placed on so many committees that there is no time for research. I have a feeling that there is a severe lack of structure in graduate school; I needed more milestones. I did not know when I was finished. Finally, the transition to graduate school was very difficult for me. I was not prepared for it, even though I was an A+ student. I didn't know how to do a proof. In this regard, undergraduate research projects are very important.

♦ I was totally unprepared for graduate school, but because I had done a master's degree and had been teaching for some time, the experience was not as traumatic as it might have been. It took me two years to get a master's and nine years total to get the Ph.D. I embarked on the Ph.D. program in order to get tenure, but I did not want to do research. Now, however, I love it.

♦ I gave up an industry job because I knew what I wanted to do: I wanted to teach at a small liberal arts college where they expected the faculty to be scholarly and expected the students to be good. In that sense, I am very well trained for the job. It is necessary in graduate school to teach some upper-level courses and to be on a book committee. And teaching 6-8 hours each semester taught me to balance teaching and research. My research was helped by graduate student colloquiums. In my graduate school, time to completion of the Ph.D. shortened considerably when they changed the exams and began enforcing the time limits in the graduate school contract. I believe graduate schools should change their admissions policy and allow people who have been out of school for a while to enter graduate school, since they are good risks; they know where they are going. There is a need to tighten up on the time it takes to get through graduate school.

♦ I taught most of the semesters while in graduate school. There was no supervision, no introduction to teaching, no help from the faculty at all. I got help only when I asked. My research experience was fairly good. I was in a very active area in the department, and there was a seminar every week. I talked to people about research often, and I always had someone to work with and to talk to. I don't have anyone to talk to now, and it is very hard. I need to balance teaching and research in this new environment. It would be nice if there was an orientation to graduate school, giving you a chance to talk to several different professors. It took me six and a half years to finish my Ph.D.