

University of Tennessee - Knoxville

Mathematics Department Strategic Plan, 2012

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I. INTRODUCTION

The Mathematics Department has an exceptionally wide-ranging and critical mission at the University of Tennessee, which reflects the fundamental role that mathematics plays in the sciences and in our technological society. We teach the largest number of students of any Arts and Sciences department, with over 14,000 student enrollments annually. We provide basic education at the GenEd level, background for science and engineering students at the calculus level, a comprehensive mathematics major, a highly successful department Honors Program, and a thriving graduate program. We have an outstanding research faculty. We play a key role in NIMBioS, and connect to other departments and the Oak Ridge National Laboratories through collaboration and joint appointments. We serve the university, community and profession in numerous ways. We have had considerable success across the wide spectrum of our mission, although there is room for further improvement.

In 2010 the National Research Council (NRC) published the results of its 2005-2006 survey of graduate programs. The NRC report allows one to look at a department's standing relative to other departments in the same field across the country. We use the NRC data as a starting point in our analysis below of our performance in the areas of research, graduate education, and diversity. In the 1995 rankings, the UT Math Department was ranked 73rd among 135 doctoral-granting departments in the survey. The 2010 rankings have several measures. Out of 127 ranked programs, we ranked 50th (30th among public institutions) in the *S* ranking, 52nd (30th among publics) in the *R* ranking, and 56th (37th among publics) in research. These rankings, when normalized for the number of programs in each field, are on the average the highest in the UT College of Arts and Sciences.

Despite ranking at the top of the College in research indicators and service load, the Mathematics Department is near the bottom of the College in resources allocated. Our Full Professor salaries rank 16th among the 21 College departments, when compared to norms in each field. We have the second lowest number of tenure-track faculty positions in the College relative to the total number of student credit hours generated. Math is one of a few departments in the College whose faculty teaching load is set above national norms in our discipline.

The 2010 NRC rankings place the UTK Mathematics Department within striking distance of the University's goal of being in the Top 25 among public institutions. Although competition is intense at this level, we believe that it will not require prohibitively large resources for our department to rise to be among the top 25 public university mathematics departments. Our primary requests are to re-invest the salaries of our faculty who will soon retire into new faculty lines, and to add a number of departmentally funded postdoctoral positions.

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What distinguishes UT most clearly from other public higher education institutions in Tennessee is our responsibility for conducting research at the highest level. The practical benefits of mathematics research are often too long-range to be profitably supported by private enterprise, so our society has primarily delegated the discovery of fundamental mathematical truths to the university setting. The UTK Mathematics Department has been highly successful in its research mission. Our recent NRC rankings are the highest or second highest in the College of Arts and Sciences in each of the three measures most closely connected to research. Our faculty members have received substantial recognition at the University, national, and international levels. We carry out research in a broad range of areas, from core pure mathematics (algebra, analysis, geometry, topology), to areas which can be theoretical or applied (differential equations, probability), to areas focused on applications (numerical analysis, scientific computation). We have recognized international strength in each of these areas.

A.) Resources

Our research faculty currently consists of:

36 tenure-track and tenured faculty who are 100% in Math (23 Full Professors, 6 Associate Professors, 7 Assistant Professors)

1 faculty member (Bob Daverman) who is in the first year of a 2 year phased retirement at 50% time

1 Joint Faculty (JFO Yulong Xing) who is 50% at UTK, 50% at ORNL

2 faculty members joint with EEB (Lou Gross, 25% in Math, and Sergey Gavrilets, 20% in Math)

1 faculty member shared with EECS (Judy Day, 75% in Math)

1 faculty member shared with Microbiology (Vitaly Ganusov, 25% in Math)

1 recurring postdoctoral position, and 1 limited time postdoctoral appointment (Jerry Day)

A list of current tenure-track and tenured faculty, by research area, is given in Appendix I, p. 1.

B.) Achievements and Strengths

1.) The 2010 NRC Rankings

Assessing the overall research strength of any university department, and making comparisons across departments, is exceedingly difficult. Each research discipline has distinct practices and metrics. The only serious effort to comparatively evaluate departments within a discipline across the country has been carried out by the National Research Council (NRC). Up through 1995, the NRC rankings were based entirely on reputation, with data gathered from surveys of faculty members. In the 1995 ranking, the UTK Mathematics Department ranked 73rd out of the 135 public and private mathematics departments included in the rankings. After 1995, for their next survey, the NRC carried out a data-based methodology for rankings rather than a reputation-based approach. Data on 20 topics, such as publications, grants, citations, awards, student support, and diversity, was gathered in 2005-2006 and reported in 2010. The NRC procedures are described in more detail in Appendix II, where the results for UTK departments in the College of Arts and Sciences are also given.

The NRC generated data in the areas of Research Activity, Student Support and Outcomes, Diversity, and two overall measures, called S and R. We will discuss the Student Support and Outcomes ranking and data when we address Graduate Education, and the Diversity ranking in the section on diversity. We include the S and R rankings with the Research Activity ranking in this section because they are overall measures of research quality. For reasons explained in the appendix, we prefer the S-measure to the R-measure.

Some key examples of specific data published in the NRC study are as follows:

	UTK Math Department	median of all 127 ranked departments
average annual # journal pubs, 2000-06, per faculty	.88	.89
average annual # of citations per publ, 2000-06	1.36	.90
percentage of faculty with grants	47.5	53.9
average number major honors/awards per faculty	.21	.64

From this data we see that our faculty publication frequency is right at the national median, and our grant production is a little below the median, but our citation rate is well above the norm. Citation rate is a measure of the quality and influence of journal articles. Our number of honors and awards was lower than average. It has risen substantially since the NRC data was collected, as will be noted.

For each school the NRC provided a range of possible rankings, roughly corresponding to a 90% confidence interval for each rank. For simplicity, we took the midpoint of that range. For example, the S-rank range for the UT Mathematics department was 36-62, among the 127 schools with Ph.D. granting Mathematics Departments in the survey. Hence in the first column below we list the average of 36 and 62, which is 49. Ranking all 127 mathematics departments by this average gives our relative standing, which is slightly different: 50th. In the final column we note our rank among the 89 public institution mathematics departments.

	midpoint out of 127	rank by midpoint all 127 departments	rank by midpoint of all 89 public universities
S-rank	49	50	30
R-rank	52	52	30
Research	56	60	37

The S, R, and Research rankings are relatively consistent, showing an overall ranking between 50 and 60 and a ranking between 30 and 37 among public universities. **Note that we are not far from being among the Top 25 public institution mathematics departments.** It is not clear how much of the increase from the ranking of 73 in 1995 is due to departmental improvement and how much is due to the data-driven methodology used for the new rankings, but the results are encouraging in any case. The UTK Math department ranked ahead of the mathematics departments in all three rankings (S, R, and Research) at, for example, UNC-Chapel Hill, Dartmouth, and Washington University at St. Louis, and in two categories of the three at Rice University, North Carolina State, Johns Hopkins, Ohio State, and USC.

Comparing, for example, S-rankings to the 27 schools listed in the “Top 25 Benchmark Schools” in UT’s Top 25 Initiative, the UT Mathematics Department ranked above the math departments in 8 of these schools: all three of our “Current Peer Group” (Auburn-123, Iowa State-86, and North Carolina State-59), two schools in the “Top 25 Target Group” (Georgia-87 and Clemson-95), and three schools in the “Aspiration Group” (UNC-Chapel Hill-61, Florida-62, and Ohio State-63).

There were 16 programs in UTK’s College of Arts and Sciences that were ranked in National Research Council (NRC) report released in 2010: Anthropology, BCMB, Chemistry, EEB, English, EPS, Geography, History, Mathematics, Microbiology, Philosophy, Physics, Political Science, Psychology, Sociology, and Spanish. The NRC data is complex, so it takes some work to summarize it. To get a comparison, we took the midpoint of the 90% interval provided by the NRC, and divided by the number of ranked programs, which varied considerably by field, to get a normalized rank. (For example, in Mathematics there were 127 programs ranked, whereas there were 49 in Geography and 236 in Psychology. Math’s midpoint S-rank was 49, as described above. We divided 49 by 127 to get 35.9, our relative or normalized S-rank. We did the same thing for the R, Research, Student, and Diversity ranks.)

The results of this analysis were startling. In the three categories reflecting research strength, Math ranked second (behind Spanish) in the S-rank, second (behind Earth and Planetary Sciences) in the R-rank, and first in Research Activity. Looking at these results and the tables in Appendix II, we see that no other department ranked consistently as high as Mathematics in these categories. According to the NRC data, Mathematics is the strongest research department in the College of Arts and Sciences.

2.) Other indicators of strength

In addition to the NRC data, the research strength of the UTK Mathematics department is demonstrated by a number of international, national, University, and College recognitions, awards, and distinctions. Some of the most prominent are listed in Appendix I, page 2.

Research in mathematics roughly breaks down into 6 areas: Algebra, Analysis, Applied and Computational Mathematics, Differential Equations, Geometry and Topology, and Probability. Appendix I shows the UTK faculty in these groups, listed in order of their

appointment at UTK. We have recognized international strength in each of these areas. In Appendix I, page 3, we give a brief indication of some of the accomplishments of some of our senior leadership in each area, not intending to be comprehensive.

Among younger faculty, James Conant (Topology) and Steve Wise (Applied and Computational Mathematics) are emerging as stars, having won UTK awards for research and having received considerable NSF support. Two of our 2010 hires, Joan Lind (analysis) and Judy Day (Applied and Computational Mathematics) obtained NSF grants in their first year at UTK. Many other of our young faculty show excellent research promise.

Our faculty have done a good job of trying multiple avenues to obtain grant support. Suzanne Lenhart plays a major role in NIMBioS, whose funding is \$16 million for the first 5 years. We have had a number of individual NSF grants (Feng, Lind, Schulze, Sundberg, Richter, Wise, Xiong have PI grants, and Judy Day holds a co-PI grant), even though competition for NSF support is intense and the success rate is low. Our applied and numerical group has been very successful, obtaining not only personal NSF grants, but Dr. Schulze has held a DOE grant and currently holds an NSF FRG grant, and Dr. Alexiades is a co-PI on an NIH grant. Two members of our probability group (Rosinski and Xiong) have held grants from the NSA recently. Professors Denzler, Stephenson, and Thistlethwaite were successful in obtaining Simons Collaboration grants in the first year of this Simons program.

C.) Challenges

A critical challenge facing the UTK Mathematics Department over the next several years will be the retention of existing faculty and recruitment of new faculty. Retention has been a problem in the past. In 2004, Bo Guan left to take a position at Ohio State. Last year we lost Petr Plechac, who was joint faculty (JFU) with ORNL, but left to take a position at Delaware. Also, Pavlos Tzermias is on a leave of absence but has taken a position in Greece from which he may not return. Bill Wade retired in December 2011, and we expect a number of additional retirements over the next few years. The UTK Mathematics Department has 12 faculty who are age 60 or greater, with 7 being over 65. Along with Dr. Wade and Dr. Daverman (now in the middle of a 2-year retirement agreement), these faculty (Alexiades, Anderson, Dobbs, Dydak, Hinton, Karakashian, Rajput, Rosinski, Stephenson, Sundberg, Thistlethwaite, and Wagner) form a very distinguished group who played a major role in establishing the quality and reputation of our department. It will not be easy to replace these faculty with young colleagues of similar, or even higher, caliber. Hiring in mathematics has become intensely competitive, and other mathematics departments have recruiting incentives that we can not always match.

1.) Faculty Lines

At one time, faculty lines resided in departments, so that a department could count on replacing a retiring or departing faculty member. With the budget cuts of 2008-9, this policy was changed and all lines are automatically consolidated to the College level. Departments then compete for available lines through the RFP process. Since the nationalization of lines, the Mathematics Department lost 5 lines (those formerly held by Sam Jordan, Cheng Wang, Raj Soni, Phil Schaefer, and Bob Daverman).

Since then we have hired a total of 4 faculty. Two of the filled lines (Maroulas and Phan) came from the RFP procedures. When the NIMBioS proposal was written, the higher administration agreed that if it was funded, they would fund 5 new positions in

mathematical biology. It was specifically stated that these lines would be new lines, not replacing existing lines. Through the NIMBioS search, Judy Day (75% in Math) and Vitaly Ganusov (25% in Math) were hired in 2010, for an FTE of 1 line. Joan Lind was hired through the College's Target of Opportunity Search, which was specifically described as not affecting a department's chances of hiring through the RFP process.

Since the consolidation of lines, Math has lost 5 lines and has had 2 lines approved through the RFP process, which seems well below average for the College. Even with the outstanding achievement of the NIMBioS grant and the extraordinary success of our Target of Opportunity recruitment, we have suffered a net loss of one position.

2.) Teaching Load

Teaching loads were addressed directly in the Math Department 2008 Mid-Cycle Review Report, in which the review team made the following recommendation:

“Offer competitive teaching loads. Teaching loads in mathematics nationally have been changing since the 1980s. Most major departments now allow a 2-1 or lower load, and we strongly recommend that the Administration work with the Mathematics Department to support a similar change here. Achieving this goal with limited resources may require restructuring course offerings and establishing differential teaching loads based on research productivity and other contributions, but there are several reasons that this would be a good move:

- Recruiting and retaining high quality faculty is an essential step in making any significant improvements in the Department. With most major departments allowing a 2-1 or lower load, the current higher load becomes a significant issue in recruitment and retention efforts.
- Maintaining a nationally and internationally competitive research program simply requires more time than it did 30 years ago when 2-2 loads were the norm.
- Creating and maintaining a good graduate program is very time-intensive. The Administration wants the Department to enlarge and strengthen its program, and that is likely to happen only if time is made in faculty schedules.
- Addressing the complex array of programs and problems that the Mathematics Department must engage requires good leadership, and good leadership takes time.”

At the time of this mid-cycle review, the UTK Math Department teaching load was 2 courses per semester. There has been some progress since then, in an agreement by which our tenure-track faculty teach about 10 calculus classes per year in a large lecture format and the department is allowed to offer an equal number of course reductions. This arrangement has allowed us to offer about 1/4 of our top research faculty a 1.5 course/semester teaching load, so that our top group are competing on a level playing field with faculty from peer departments. This advantage is partially offset by the extra administrative work involved in teaching large lectures, and the result is still far from the desired level of an average of 1.5 courses per term for the entire department. Nevertheless it is important movement in the right direction and brings the issue forward for further consideration.

Appendix III contains data gathered on Mathematics Department teaching loads. We began with a data set provided to us by Ruth Charney, chair at Brandeis, who used the data to get her department's teaching load reduced from 2 courses per semester to 1.5. We added some data we collected in fall 2008 on departments not on Dr. Charney's list. Some of this data is not up-to-date, as more departments move toward a 2-1 load (for example,

LSU has recently made this change). We have listed teaching loads in order of 2010 NRC S-rank midpoint, as discussed above. We find many departments ranked below UTK with teaching loads less than ours, and nearly all who are ranked above us have lower loads.

If we are going to maintain the high level of research accomplishment that we currently enjoy, and have any hope of breaking into the top 25 public universities, we must find some way to reduce our teaching load to reach levels competitive with our peer or aspirational peer departments.

3.) Faculty Compensation

Faculty compensation is a key factor in hiring and retaining quality faculty. In 2010-2011, the UT Faculty Senate gathered data on faculty salaries compared to other universities, by department and faculty rank. This data is recorded in Appendix IV. One of the comparison groups was the top 25 group the university is aiming to break into. The average Full Professor salary in the UTK Mathematics Department was 75% of the average for Full Professors in Mathematics Departments in universities in the top 25 category. For the College of Arts and Sciences as a whole, that percentage is 83%, so Math is well below the A&S mean. Of the 21 departments in the College of Arts and Sciences, the Mathematics Department's rank in this statistic was 16th, as shown in the following table:

Department	Percentage of Top 25	Department	Percentage of Top 25
Microbiology	114%	Sociology	83%
EPS	111%	Religious St	81%
Theatre	99%	Anthropology	77%
Physics	99%	School of Art	76%
EEB	96%	Mathematics	75%
BCMB	95%	English	74%
School of Music	89%	MFLL	72%
Geography	89%	Psychology	69%
Classics	88%	Philosophy	65%
Chemistry	87%	Political Science	61%
History	85%		

This data requires some interpretation. Averages in some departments are influenced strongly by special cases such as Governor's Chairs, and, for example, the high percentage for Microbiology comes from the fact that currently they have only 2 Full Professors. Still, Math's salary rank is low, especially in relation to its research rank. Compared to the other departments in the natural sciences division of the College, it is particularly low. Appendix IV includes graphs representing each NRC-ranked College department as a data point, where the first coordinate is the department's normalized S-rank (as discussed above) and the second coordinate is its percentage of Top 25 salary rank. A line which was suggested by the Faculty Senate as "ideal" is also graphed. Departments with points beneath that line can be considered undercompensated relative to their quality. Note that Math is perhaps the most undercompensated on this basis. Appendix IV also includes similar graphs for Associate Professors and for Assistant Professors. For Assistant Professors, the points for most departments are much closer to the ideal line, reflecting the necessity of hiring at or near market rates. The results for Associate Professors are in-between those for Assistant and Full. In every case, Math is below the ideal line, and in the Associate and Full Professor categories, Math is one of the most undercompensated.

Typically UT has allocated departmental raise pools as a percentage of the existing wage level, where that percentage is the same for all departments. This procedure perpetuates inequalities. It makes it very difficult for a department to move up in compensation, regardless of its quality, and gives little incentive for relatively well-compensated departments to improve. The Faculty Senate presented a proposal to differentially allocate department raise pools based on quality. The Mathematics Department was disappointed that this recommendation was not adopted with the 2011-2012 raises.

4.) Postdoctoral Positions

In the field of mathematics, nearly every faculty member completes a 2-3 year postdoctoral appointment prior to obtaining a tenure-track appointment. Unlike postdoctoral positions in the sciences or engineering which are generally supported by grants, mathematics postdocs are independent research and teaching positions supported by departmental funding. Postdocs play the same role as assistant professors, except that postdocs do not normally engage in department service activities, and postdoctoral appointments are time-limited. For the department, postdocs are a great benefit. They enhance the research environment with new directions and ideas that they bring from their doctoral institution. Postdocs normally teach the same amount as an Assistant Professor, at a significantly lower salary (roughly \$20,000 less than for a tenure-track Assistant Professor).

At one time, salary from our vacant lines was used to hire visitors, which enhanced our research environment by providing valuable collaborators for our faculty. With the end of the “second look at the budget,” we have very limited funds for visitors. Having more postdocs would partially make up for this loss.

Departmental postdoctoral positions contribute to the research strength of a department. The top departments have prestigious named postdoctoral positions, such as the Van Vleck postdoc at Wisconsin, the Dickson at Chicago, and the Hedrick at UCLA. Here is data we have gathered showing the number of departmentally supported postdoctoral positions at the top 26 public university Mathematics departments, as measured by their 2010 NRC S-ranking.

Department	Dept Postdocs	Department	Dept Postdocs
1. UC Berkeley	5-9	14. Illinois	8-9
2. Penn State	3-8	15. Texas A & M	18-20
3. Wisconsin	6-12	16. Arizona	2
4. Michigan	~ 30	17. Maryland	0
5. UC Davis	8	18. Arizona State	1-2
6. Indiana	6.5	19. Michigan State	3
7. UCLA	12-14	20. Virginia	3
8. Texas - Austin	8	21. UC Santa Barbara	6
9. UC Irvine	10	22. Purdue	7
10. UC San Diego	4	23. Kentucky	0
11. Delaware	6	24. Georgia Tech	0
12. Rutgers	6-8	25. SUNY	6
13. U Mass - Amherst	5	26. Minnesota	14-21

The UTK Math Department has 1 postdoctoral position, negotiated with the hire of an external Head in 2006. Since the term of a postdoctoral position is 3 years, each of the 6 research areas can expect to hire a postdoc in their area once every 18 years. This is not a

viable program. A high priority for our department would be to add several postdoctoral positions. For example, if we could add three postdoctoral positions at \$50,000/year each, with a 4 course/year teaching load for each, and if we could use that additional teaching power to offer 12 more of our tenure-track faculty 2-1 teaching load per year, we would have a dramatic enhancement of our research competitiveness and significantly improved recruiting and retention prospects, at the moderate cost of \$150,000 per year.

Mathematics grants usually aren't large enough to fund postdocs. However, sometimes they could provide half the funding needed for a postdoctoral position, if the department could fund the other half. If we had a more robust postdoctoral program, such cost-sharing could be feasible, allowing us to leverage our resources to further increase our postdoctoral cadre.

D.) Opportunities

The substantial number of retirements expected in the Mathematics Department is an opportunity as well as a challenge. Our recent hiring has been very successful. Our young faculty show every sign of being excellent disciplinary researchers, committed and capable instructors at the undergraduate and graduate levels, and good department and university citizens. If we can continue that success in hiring, we can maintain and even enhance our strong research standing.

The possibility of hiring a Governor's Chair in computational mathematics is an outstanding opportunity to improve our department. The resources available for Governor's Chair hiring are so much greater than for ordinary hiring that there is a chance to hire a true "game-changer" - someone who would elevate our departmental stature for the long run. One such candidate was identified and pursued for nearly two years, but ultimately we were unsuccessful in luring him away from Berkeley. We are working with our colleagues at ORNL to identify our next Governor's Chair candidate.

Another hiring opportunity related to ORNL comes about through JICS (Joint Institute for Computational Science). Yulong Xing was hired through JICS as a JFO (Joint Faculty - Oak Ridge based), 50% at UTK and 50% at ORNL. Dr. Xing has been a very valuable contributor in our department, for example, collaborating with Professors Feng and Karakashian. A second JICS position was held by Petr Plechac before his departure. We hope to be able to hire into the position vacated by Dr. Plechac.

NIMBioS has provided valuable opportunities for research collaboration which have enhanced our research environment. Several of our faculty have conducted NIMBioS tutorials (receiving a buy-out from NIMBioS that allowed a course reduction) and several have participated in NIMBioS working groups on collaborative research projects.

E.) Goals and Strategies

The Mathematics Department's primary goal is to at least maintain, preferably to improve, our research quality, productivity, and reputation. Research metrics include the quantity of publications, quality of publication venues, citations of publications, grants, faculty awards and recognitions, and future NRC rankings.

Research quality in mathematics results from recruiting and retaining excellent faculty, providing a stimulating research environment, and giving research faculty the support they need to do their work.

Our recruiting has been strong in recent years. The College's recent policy of offering competitive starting salaries has been very helpful. In addition to our usual recruiting

procedures, which seem sound, we hope to enhance our hiring in computational mathematics by working with ORNL to hire a Governor's Chair in computational mathematics, and another Joint Faculty associated with JICS.

Retention of faculty can be difficult. There is always the possibility of an outstanding faculty member being poached by higher-ranked departments. However, that possibility is increased if annual raises do not keep pace with other institutions, or if the teaching load is not competitive with peer and aspirational peer departments. Both of these issues are problematic at UT. To a large extent, they are not under the department's control, so our strategy is to continue to inform those in control of the importance of these factors. We hope to make further progress on teaching loads, to move closer to the 2-1 load which is nearly standard now in quality departments.

There are several components to maintaining a stimulating environment and supporting faculty research. For some faculty, especially in applied and computational mathematics, computer equipment and support is critical. Our equipment needs seem to be met, and we are continuing to improve our computer support. For other faculty, research collaboration via travel is of the utmost importance. By travel we mean both our faculty travel to conferences or other universities, and the travel of other faculty to UTK. We will continue to support faculty research travel, through the commitment of recovered F&A and other funds. Our annual Barrett Lectures bring noted experts to UT, enhancing our visibility as well as providing further stimulation. We have agreed to host a regional meeting of the American Mathematical Society, which would have similar benefits. We plan to maintain an active colloquium, as well as occasional distinguished speakers.

Postdoctoral faculty members enhance the department's research environment. Given that we have only one such postdoctoral position, this means that this enhancement benefits only one research group at a time. We will continue to lobby for additional postdoctoral positions.

The UTK Mathematics Department is well-balanced among its 6 broadly defined research areas (see Appendix I, p.1), both in size and strength of the faculty. Such balance is typical of strong departments of moderate or large size. The reputation of a major state university's mathematics department would be significantly decreased if one of the 6 areas was not represented with some prominent strength. A gap in one or more areas would negatively impact graduate student recruiting, because many incoming mathematics graduate students do not yet know which area they want to pursue, and would like to have all options open. It is beneficial to have easily available expertise in all areas, because mathematics research today often requires ideas from more than one mathematical subject area. In spring 2010, the Mathematics Department voted unanimously to maintain balance in hiring among the six disciplinary areas. Not doing so would effectively give up on being a first class department. Committing to maintaining a balanced department also helps preserve a collegial atmosphere by preventing negative competition between groups. The positive departmental atmosphere in turn aids in recruitment and retention of faculty.

F.) Requests

At the minimum, the Mathematics Department's outstanding research record and its huge, critical educational mission merit full replacement of all tenure-track faculty retirements and departures. If the department was made aware of such a policy, it could plan effectively in advance. Anything less will not allow us to keep all of our six areas at critical

mass, and the department will phase from being a major, full-service department to a specialty department. If resources for growth in faculty lines become available, as suggested by our higher administration, Mathematics deserves a high priority, based on its excellence and the large number of students we serve. Additional tenure-track lines are always preferred, but additional postdoctoral lines are less expensive.

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Our educational mission has several somewhat distinct components. We provide instruction in fundamental mathematical skills for thousands of students annually in our General Education courses (Math 113, 115, 123, 125, 141, and 142) as well as prerequisite courses (Math 119 and 130). Courses numbered below 141 are taught primarily by our Lecturers and Graduate Teaching Assistants. Each semester hundreds of science and engineering students take Math 141, 142, 241, 231, 251, and a selection of specialized courses at the 300 and 400 level. These courses are also taken by our mathematics majors, who also take a range of courses at the 300 and 400 level. The number of mathematics majors has risen substantially in recent years, but is still low compared to national needs. We have a highly successful departmental honors program that has been NSF-supported. We increased our

graduate student population by 10 a few years ago. Recently we have had some excellent placements and notable successes among our doctoral graduates.

A.) Graduate Education

The Mathematics Department offers three graduate degrees: the Ph.D., a Master's Degree, and the MM degree. The MM Degree is intended for future and current teachers.

1.) Resources and Analysis of the NRC Data

The Mathematics Department's resources for Graduate Education include our Tenure-Track Faculty (see Appendix I, p. 1), our Graduate Director, and our Graduate Assistant. The Graduate Committee is one of the department's standing committees, with at least 7 faculty members. The Mathematics Department has been allotted 66 tuition waivers, which allows us to fund 66 GTAs at any time. We have had a few graduate students supported on research grants or on special fellowships, but the vast majority are supported by teaching assistantships. We have some Science Alliance funding which we use to reduce GTA teaching workloads as students make progress toward their degrees.

The purpose of the NRC rankings is to rank graduate programs. Research quality is considered because it is a key component of the quality of a graduate program. However, some of the NRC survey questions deal specifically with the quality of graduate students, their support, and the outcomes of the graduate program. Here are the questions of this sort in the NRC survey. We have omitted the yes/no questions such as: "Do you track your graduates?"

	UTK Math Department	median of all 127 ranked departments
percent of Ph.D. students with support	100	91
percent Ph.D. students who obtain Ph.D. in ≤ 6 yrs	34.2	41
median time to Ph.D.	6.7	5.4
percent new Ph.D.s with immediate academic position	84.6	70.6
annual Ph.D.s granted	3.8	5.4
student's average GRE quantitative score	777	779
percent new students with grants	0	6.1
student activities	16	16

This data shows that we do not do well on time to degree and 6 year graduation rate. Most of our incoming students are not prepared to start with graduate level classes. Instead most take a year of 400 level courses as preparation and begin graduate classes in their second year. Although this phenomenon exists nationwide, it seems more pronounced at UTK and partially accounts for our slow time-to-degree. On the other hand, we seem to do well by our students who do graduate, as our immediate academic placement rate is well above average. We don't regard the GRE quantitative exam data as significant because that exam is not highly challenging for mathematics majors. A much better indicator would be the GRE advanced subject exam in mathematics, but we have no data for that. The NRC data shows that our annual number of Ph.D.s is low, but this number has increased substantially in the last few years.

Based on this data, the NRC generated a ranking called “Student Support and Outcomes,” abbreviated simply as “Student” rankings. Here is Math’s Student ranking compared to other doctoral granting mathematics departments in the NRC survey.

	midpoint out of 127	rank by midpoint among all 127 departments	rank by midpoint among all 89 public universities
Student	53	48	23

Our Student rank is above that for the Mathematics Departments at Michigan, Wisconsin, Cal Tech, Penn State, Columbia, UNC Chapel Hill, Rice, Texas, Johns Hopkins, UCLA, Michigan State, Ohio State, Maryland, and Purdue.

If we determine normalized ranks for the Student ranking for all doctoral granting departments in the UT College of Arts and Science, Math ranks 10th out of 16 (see Appendix II, p. 10). This low ranking contrasts sharply with our much higher *R*, *S*, research, and diversity rankings. Below we consider the possible reasons for this result.

2.) Achievements and Strengths

At one time we had a large proportion of terminal Master’s students instead of doctoral students. We supplied a regional need because Master’s students could find teaching positions in four year colleges, often in Tennessee. Over the last several years we have completed a transition to focusing primarily on our Ph.D. program. This was appropriate for two reasons. First, even four year colleges are now expecting to hire faculty with doctorates. Second, emphasis on a doctoral program is appropriate for a research department at our level, and for the flagship public university in Tennessee. Our department has awarded 10 doctorates in each of the last two academic years, 2009-2010 and 2010-2011. This is an unusually large number, which we don’t expect to maintain. A more typical number would be 6 or 7 per year.

Starting in 2008-09, our number of GTAs increased from 56 to 66. This increase resulted from an agreement to transform 5 Lecturer positions into 10 GTA positions. We had been asking for this type of exchange for years, but were held up by the issue of tuition waivers. We expect this increase in the number of GTA lines to pay off in a further increase in the number of doctorates granted, one of the key VolVision and Top 25 objectives.

Our graduate program has shown a number of very good placements in the last few years. Michael Nielan, who obtained his Ph.D. in 2009, obtained an NSF Postdoctoral Fellowship, the first ever from UT. About 25 of these are given nationally each year. Michael currently holds a tenure-track Assistant Professor position at the University of Pittsburgh. Rachel Nielan, also a 2009 Ph.D. from UT, held a postdoctoral appointment at LSU. Her work at UT with Suzanne Lenhart and others on cholera modeling was showcased in an article in Science News.

Our placements from the last two years include: Rachel Leander (2010, postdoc, Ohio State), Ben Lynch (2010, postdoc, NC State), Nick Geweke (2011, postdoc, Delaware), Leonard Wilkins (2011, postdoc, Connecticut), Andreas Aristotelous (2011, postdoc, SAMSI and Duke), Chuan Li (2011, postdoc, Clemson), Masato Kobayashi (2010, Saitama University, Japan), Gerardo Chacon (2010, Pontificia Universidad Javeriana, Columbia), Jacob Ogle (2011, Assistant Professor, Kansas Wesleyan), Chris Sass (2011, Assistant Professor, Young Harris College), Harold Smith (2010, Thomas More College), and Erin Bodine (2010, Rhodes College). Some graduating students took government or industry positions: Brian Irick (2010, NSA), Gerald Orick (2010, Naval Air Warfare Systems Command).

3.) Challenges

Our highest priority for improving our graduate program is in the area of student recruitment. A better-prepared and more talented incoming class would not need to spend as much time taking background courses, hence would graduate more quickly, and should have even better placements than our current students.

Improving recruitment is a difficult challenge. A large portion of the top national undergraduate talent will go to the highest ranked schools in any case. For the best of the remaining students, many factors can play a role. GTA salaries are certainly important, and stipends at UT are notoriously low (in Math: GT Assistants \$14,613, GT Associates \$16,268). At Vanderbilt, the range is \$21,200 - \$31,200; at Emory it is \$19,000 to \$24,000. Another factor is the GTA workload. Most of our GTAs have full responsibility for teaching 3 semester courses per year, which is at the upper end of teaching loads for GTAs nationally.

A part of the budget cuts initiated in 2008 was a loss of \$60,000 in our GTA budget, which would cut 4 positions. These losses were offset by stimulus funds for 2 years, and since then these positions have been folded into our CIP budget. The CIP budget stayed the same, but these GTA positions were funded from the existing CIP budget instead of independently, as before. Hence there was an effective CIP cut of \$60,000, but so far we have been able to absorb it via Lecturer cuts instead of decreasing our number of GTAs.

A significant limitation of our graduate program is the limited number of advanced graduate courses we can offer. We run a few 600 level graduate sequences and topics courses, but compared to more prominent programs, the number of graduate courses we offer is minimal. Advanced instruction is done via reading and independent study courses, which do not count towards the advisor's teaching load. The amount of time that graduate instruction takes away from faculty time for research serves as an unfortunate disincentive for faculty to take graduate advisees. If we can increase the number of GTAs, we can get more graduate level courses to run, thereby enriching the graduate curriculum while taking some of the burden off advisors.

Of the five NRC rankings, Student Support and Outcomes is the only area in which the UTK Mathematics Department is not among the top four in the College. A large part of the NRC data in this area deals with time to degree, which is largely influenced by the level of preparation of our incoming students. Our students' preparation level is largely dependent on our recruiting, which is determined to a significant extent by factors largely out of our control, such as stipends and teaching load. Our relatively low ranking in the College in the NRC Student category indicate that our graduate program is under-resourced relative to the research quality of the faculty.

4.) Opportunities

Our higher NRC rankings should improve our recruitment, since ambitious prospective graduate students will pay attention to national rankings of programs. Because we have only recently transitioned to a higher emphasis on doctoral production, it may take time for this emphasis to be known at undergraduate institutions, with the consequence that UT becomes a graduate program of choice for more students. Our current students' success, as it becomes known, should also help, as advisors may recommend their students to apply to UT. The UTK/ORNL Joint Graduate Fellowship Program and the CIRE Program, which have annual stipends of about \$30,000, should help us recruit some highly qualified graduate students who we could not normally get.

We hope that some of the current funds available for academic investment will be used to increase graduate stipends, which would help us recruit more competitively. The recent change in the model for summer school instruction, which allows departments to share in some of the income they generate, should provide resources which we can use for our graduate program. Possible uses for that money include modest stipend supplements for some of our GTAs, or providing summer support and thus release from summer teaching, as our students focus on their thesis work.

5.) Goals and Strategies

Our goals for our graduate program are to increase the number of doctorates we grant, and to improve the quality of our graduates as measured by their time-to-degree and placements, especially into research-oriented academic positions. Increasing the quantity of doctorates can be achieved either by decreasing their average time to degree, or by increasing the number of GTA positions in the department. We hope to do both. Decreasing the time to degree is most likely to be achieved by bringing in better prepared graduate students, through improved recruiting, and by finding ways to release some teaching responsibilities to allow greater concentration on thesis work. To improve recruiting, we hope that some funds to increase GTA stipends will become available, and we hope to have good participation in special programs such as CIRE and the UTK/ORNL distinguished fellowship. Our MM program for math teachers could be enhanced by offering online courses, since many teachers throughout Tennessee can't participate in this program unless it is offered remotely. To increase the number of GTA lines, we hope that central resources become available, and we hope we will be allowed to convert Lecturer lines to GTA lines on a 1-2 ratio, as we have done before, when Lecturer lines become open through attrition.

6.) Requests

If additional resources become available, we ask for an increase in the number of funded GTA lines and in increase in stipends. We also ask to be allowed to carry out further conversion of Lecturer lines to GTA lines, at our discretion.

Another request is that the University establish a permanent fund for overbooking of GTA offers. When we make offers to prospective GTAs, we have to restrict the number of offers we make on the first round, to make sure we don't offer more positions than we can afford, because the percentage of acceptances is not fully predictable. Once we have the acceptances and declinations on the first round, we normally have additional positions, which we offer on the second round. The pool available for the second round is significantly weaker than on the first round, as stronger candidates have already accepted a first round offer elsewhere. If we had a fund available to cover if we get one or two more acceptances than available slots, we could significantly increase the number of first round offers, and bring in a substantially stronger class. We have sometimes been able to obtain an extra waiver for a year, but the process should be more routine and flexible. Those extra slots would decrease the number of openings the next year, so the additional cost is only for one year. Thus the funds spent one year would be returned to the overbooking fund in subsequent years. The overbooking fund would require a recurring commitment, but that commitment would not increase after the first year, except marginally with stipend increases. Thus a modest investment could substantially improve graduate recruiting throughout the university.

B.) Undergraduate Education

Every student needs some degree of education in mathematics. As a consequence, the Mathematics Department handles a huge number of student enrollments. Our undergraduate mission breaks down into three components. We handle about 9,000 student enrollments in courses below Math 141, Calculus I, every year. Students in the sciences and engineering require a background in Calculus as well as selected courses in differential equations and linear algebra, so the Mathematics Department instructs about 4,500 student enrollments per year in 100 and 200 level courses from Math 141 up. We instruct our own majors, including those in our departmental Honors Program, and some students from other departments, in our 300 and 400 level courses, for more than 900 enrollments. See Appendix V for a breakdown of student enrollments by course and semester over the last several years.

In absolute terms, the Mathematics Department's student service load is the highest in the College of Arts and Sciences, and presumably in the entire university. One might expect that our tenure-track faculty size is proportionally large, but that is not the case. We have gathered data on the number of student credit hours per tenure-track faculty member by department in the College. This data, based on data provided by the College for the Fall 2009 semester, is presented in the following table.

Department	# 2009 TT Fac, FTE	Fall 2009 Total Stu Cred Hrs	SCH/# TT
Theatre	12	1,778	148
Art	23	4,289	186
Music	36	8,186	227
BCMB	27	5,092 + 1,893 = 6,985	259
EEB	26	4,829 + 1,893 = 6,722	259
Physics	28	7,587	271
EPS	14	5,322	380
Chemistry	25	10,235	409
Microbiology	10	2,315 + 1,893 = 4,208	421
Geography	11	5,069	460
Sociology	14	6,891	492
Psychology	30	16,127	538
MFLL	29	16,068	554
English	38	21,751	572
Anthropology	11	6,359	578
Classics	6	3,690	615
History	17	10,569	621
Political Science	16	10,053	628
Religious Studies	5	3,480	696
Mathematics	35	26,040	744
Philosophy	7	6,585	941
Total	420	187,995 + 2,169 = 190,164	453

To obtain this data, we used a page (Appendix V, p. 4) in the 2010 College of Arts and Sciences Budget request to the Provost that allows us to deduce the numbers. Dividing the Fall 2009 TLF-SCH (total number of student credit hours generated by the tenure-line faculty in Fall 2009, the third column of numbers) by the TLF-SCH per effective FTE

(the fourth column of numbers) gives the number of tenure-line faculty. Adding the Fall 2009 TLF-SCH to the Lecturer SCH (the number of student credit hours generated by the Lecturers and GTAs, apparently, although this number for GTAs was not distinguished, the fifth column of numbers) and dividing by the number of faculty gives the total number of student credit hours for the department per tenure-track faculty member. The hours attributed to the Core Biology Lecturers were divided equally among BCMB, EEB, and Microbiology. We were not able to determine how to divide the hours generated by the Africana Studies or Medieval Studies Lecturers. These 2,169 hours were not attributed to specific departments, although they were included in computing the overall College average.

The College counts included modifications to take into account faculty on leave in fall 2009, and other adjustments, so this data is only approximate. These numbers will change slightly from term to term. In addition, we recognize that there are necessary differences in how courses are delivered in different departments, especially for the fine arts (Music, Art, and Theatre). Still, the differences are striking. For Math to deliver 26,040 credit hours, as in fall 2009, at the College average of 453 hours per tenure-track faculty member, we would need 57.48 tenure track lines, an increase of 22.48 faculty lines (or 64%) over fall 2009.

The Mathematics Department does a large amount of instruction at the Gen Ed level, primarily using Lecturers and GTAs. There are two other departments that are largely dependent on Lecturers to deliver massive numbers of Gen Ed credit hours, English and MFLL. Math's student credit hours per tenure-track faculty member are 30% higher than for English, and this number is slightly higher for English than for MFLL. Math experienced a substantial undergraduate enrollment increase following the establishment of the current GenEd requirements around 2005-6, as demonstrated by the enrollment data in Appendix 5, pages 1-4, but no additional tenure-track faculty positions were provided during that time. Even though Lecturers and GTAs cover a large number of these student credit hours, the overseeing of these personnel and their classes is a major administrative workload carried by the department.

If we look at this data in financial terms, the tuition that would be generated by 26,040 student credit hours at the current in-state tuition rate of \$302/credit hour is \$7,864,080. By comparison, the department's base budget plus CIP allotment for 2011-2012 is \$6,006,304. Hence the tuition generated by the Mathematics department **in the fall semester alone** is 30.9% more than our total annual budget.

We do not expect that tenure-track faculty lines sufficient to teach all Math courses with tenure-track faculty be provided. It is not an efficient use of resources to have research mathematicians teaching large numbers of courses below Math 141. What would be reasonable would be if there were enough tenure-track lines to allow a teaching load consistent with peer institutions (see section II.B.2 above) and to teach all classes from Math 141 (Calculus I) up with tenure-track or postdoctoral faculty. To do so would require several more tenure-track or postdoctoral lines than we currently have.

1.) Service Component below Math 141

Students are placed into entry level math courses based on their Math ACT scores. Students unsatisfied with their placement can take our online placement exam, or follow one of several suggested remediation paths. Math 113 (Mathematical Reasoning), 115 (Elementary Statistics), 123 (Finite Math), and 125 (Basic Calculus) satisfy the Gen Ed requirement for graduation. Math 119 (College Algebra) and 130 (Precalculus) do not satisfy the Gen Ed requirement, and hence are only taken by students who need this material

in order to take a more advanced math course. Enrollments are huge in these courses. They are taught in several formats: small sections (30-35 students), double-size sections (60-70 students), or large lecture with recitation sections (140 or 250 students). These courses provide the mathematical background needed by students in the arts, humanities, social sciences, business school, etc. Math provides the foundation in quantitative reasoning required for every UT student.

a.) Resources Courses below 141 are taught almost entirely by our Lecturers and GTAs. We currently have 22.5 FTE Regular (full-time) Lecturers and 66 GTAs. We sometimes use a few Term Lecturers. One of our Lecturers serves as Service Course Coordinator, to oversee all of these courses. Each course below Math 141 has a Lecturer assigned as Course Coordinator, to provide a common syllabus, oversee the instruction in that course, and in the cases of Math 119 and 130, provide a common final exam.

b.) Achievements and Strengths Over many years, the Math Department has developed an appropriate sequence of courses to provide fundamental mathematics instruction at the appropriate level, to meet the needs of a very wide variety of students. Moreover, we have developed effective methods to administer these courses to maintain quality control and oversight. The result is the high-quality, inexpensive delivery of a huge number of credit hours. We have also developed efficient means of enrollment management to maximize the use of our teaching resources.

Given the number of students served and the unease that many students have with introductory mathematics courses, we have a very low number of student complaints. Two of our Lecturers have won the Chancellor's Excellence in Teaching Award: Bob Guest (2007) and Malissa Peery (2008).

Many students in courses below Math 141 are taught in classes entirely run by our GTAs. Each such course has a course coordinator who oversees the GTAs, for example checking their exams for clarity and appropriateness. In 2006 we started a mandatory teaching seminar that runs one day a week in the fall of a GTA's first year. That seminar is continued on a voluntary basis in the spring semester, with a good enrollment.

We have experimented with implementing various emerging technologies in the classroom. We use WebAssign for computer-generated homework and as an electronic supplement in several courses. Due to budget cuts, we were asked to plan a fully online delivery of Math 119. In fall 2010 we piloted 3 online versions that use the electronic instructional packages WebAssign, ALEKS, and MyMathLab, and compared these sections' performance to sections taught in standard in-class formats. We are still evaluating these approaches. In fall 2011 we delivered the major part of Math 119 in an online format using ALEKS.

c.) Challenges We are fortunate to have a stable core of committed, experienced Lecturers who we depend on year after year. With low entry level salaries (\$28,000 for Lecturers with a Master's Degree, and \$32,000 with a Ph.D.) which have not increased in more than 10 years, it is difficult to recruit qualified new Lecturers. The budget for Lecturers was targeted for a 20% cut in 2008, which would have required us to reduce most of our Lecturers to less than full time. These cuts seem to have been averted, but there was substantial damage to morale. As a cost-cutting measure, we have eliminated the appointment and compensation of a Lecturer as scheduling officer. We are working to shift these duties to the Undergraduate Director and the Undergraduate Assistant.

We are concerned that the online delivery of Math 119 will be less effective, and the student success rate, which was never high in that course, will drop. Currently we are offering tutor support to students in the online sections, but this support reduces the cost savings that are the rationale for online delivery. If budgetary constraints force us to cut tutorial support, the success rate for Math 119 may decrease further.

d.) Opportunities The existence of extensive electronic instructional supplement packages allows us to provide additional opportunities to students at low cost, although we believe that availability of personal, individualized instruction is still essential, and distinguishes UT from online, for-profit universities. Instructional packages seem to be reaching a higher level of maturity and utility, making them easier to use and more successful.

The University has attempted to increase summer instruction, especially to include incoming freshmen. If successful, many students' time to degree should decrease, as they get past their math hurdle earlier. Increased summer instruction would also provide additional compensation opportunities for our underpaid GTAs and Lecturers.

We applaud the University's initiative in developing the promotion ranks of Senior Lecturer and Distinguished Lecturer. This new policy shows a very welcome recognition of the critical instructional role that Lecturers play, and a long overdue recognition of their professionalism. Such indications of appreciation should improve morale among Lecturers.

e.) Goals and Strategies Our goal is to maintain educational quality despite the budget cuts we have sustained. We are trying to achieve this goal by carefully considering and testing a variety of online instructional supplements, to see which are most effective in aiding student learning. So far we have had good success with WebAssign in a number of courses, as an online homework system. Clickers are useful in classes taught in a large lecture environment. We are still evaluating our online delivery of Math 119.

The existence of promotions in rank for Lecturers should give additional incentive for Lecturers to achieve the goals we set for them in annual evaluations, since attaining a high level of instructional success is a prerequisite for promotion.

f.) Requests Entry salaries for Lecturers have not changed for more than 10 years. It is not easy to find people with a doctorate in mathematics who are willing to teach 4 classes per semester for \$32,000/yr. Although the institution of Lecturer ranks makes the position more attractive than formerly, the initial salaries need to be raised. The Mathematics Department is fortunate to have a core group of long-term Lecturers who have chosen to make education their career. However, as some of them retire or leave, it is difficult to replace them with instructors of the same caliber.

One way we considered responding to the budget cuts of a few years ago was to increase class size, using the double-size section more frequently. Lecturers expressed concern that the level of personal interaction with students would drop if we implemented that change. For the skills-based classes that the Math department teaches, having the option to get individual help is invaluable to some students. We hope that the budget has stabilized to the point that increasing class size will not be necessary. In a related request, additional funding for the tutorial center would be very helpful to a number of students. The Tutorial Center seems to be very successful, but its funding has not increased in several years. Ultimately the tutorial center is only as good as the students who staff it, and many of them leave the tutorial center because of higher pay for other tutoring jobs on campus.

2) Service Component: Calculus and Higher

All engineering and science majors take some calculus, with many taking the full Calculus sequence Math 141-142-241 and Math 231 (Differential Equations). Many also take Math 251 (Linear Algebra). Many in computer science take Math 300 (Introduction to Abstract Mathematics) and possibly Math 371 (Numerical Algorithms). Biology and Health Science majors generally take the 151-152 sequence (Mathematics for Life Sciences). Math 323 provides a foundation in probability for many who take statistics in the business school, and higher level courses such as Math 431 and 435 (Differential Equations) are taken by some advanced students in engineering. The Mathematics Department provides a whole layer of critical background which is fundamental to students in the sciences and engineering. There are roughly 4,500 non-math major enrollments in mathematics courses numbered 141 or higher each year, with the largest part being in Calculus I, II, III, and Math 231.

a.) Resources Our Calculus courses and Math 231 are taught either by tenure-track faculty, our postdoc, or by doctorate-holding Lecturers, of which there are only a few. The 300 and 400 level courses noted above are almost always taught by tenure-track faculty. Supervision of these courses is provided by our Undergraduate Director, and there is an Administrative Assistant dedicated to the undergraduate office.

b.) Achievements and Strengths The Mathematics Department has a strong commitment to excellent instruction. One indicator is the large number of teaching awards that Mathematics Department faculty have won in recent years:

College Awards:

College Convocation Excellence in Teaching Award, Senior Level: Chuck Collins (2009)
James R. and Nell W. Cunningham Outstanding Teaching Award: Carl Wagner (2009)

University Awards:

UTK National Alumni Association Outstanding Teaching Award: Bill Wade (2006)
UTK Chancellor's Excellence in Teaching Award: Pavlos Tzermias (2006)
UTK Chancellor's Excellence in Teaching Award: Suzanne Lenhart (2008)
UTK National Alumni Association Outstanding Teaching Award: Don Hinton (2009)

Over the last several years, enrollments in Math 141-142-231-241 have increased considerably (see Appendix V, pp. 1-4). This seems to be part of a national trend toward more students majoring in science and engineering fields. In the last 2 years, we have starting offering Math 141, 142, and 241 in the lecture-recitation format. The lectures have enrollments up to 140, and meet 3 times a week. Students also meet GTAs in recitation sections one day a week. This delivery method was instituted at the request of the College as a way of increasing the number of students being instructed by research faculty. Implementing this change has taken a degree of organizational effort. The financial savings due to efficiency are small, because the GTAs needed for the recitation sections no longer teach their own sections of lower level classes.

c.) Challenges Maintaining the effectiveness of our calculus instruction under the lecture/recitation model is a concern. In some lectures, the failure rate has been high. Students seem to prefer the small sections, evidenced by the fact that enrollment in the small

sections fills up first, and there is some evidence that teaching evaluations are typically lower for an instructor in a lecture than in a small class.

We are still working to document a comparison of teaching effectiveness in the lecture/recitation versus small class formats. A first impression is that an excellent instructor will do well in either format, so putting that instructor in front of a large lecture maximizes the value delivered. However, some instructors who may be successful in a small class environment are not so successful in a lecture, which is a serious problem because of the number of students affected.

Having lectures taught by tenure-line faculty has increased the involvement of the research faculty in calculus instruction. However, it requires committing a significant number of tenure-line teaching assignments to calculus instruction, which has not always been the case in past semesters. The result is difficulty in covering all of the classes we normally offer at the 300, 400, and graduate levels. If enrollments increase further, or if additional tenure-track lines are lost, this problem will become critical and will require reducing the number of courses offered.

d.) Opportunities So far our use of online systems such as WebAssign has been primarily confined to courses numbered below Math 141, except for experimental use in Math 241. Once we are sufficiently familiar with these systems, we may want to implement them in Math 141-142-241. Currently most texts have electronic supplements, but they are not as widely used as they could be.

e.) Goals and Strategies Our primary goal is to make the lecture/recitation format in 141-142-241 effective. As we develop more experience with that format, we hope to formulate best practices for how to run the large lecture most successfully. We hope to investigate online supplements such as online homework via WebAssign that will increase student time-on-task. We will continue to investigate innovative approaches to teaching this material, such as Nick Brodskiy's delivery of Math 241 using WebAssign and Wolfram-alpha.

f.) Requests If we do not adapt a computerized homework system on a wide scale in Calculus, we will continue to depend on weekly homework or quizzes to force students to keep up with the material and practice it to an appropriate degree. Most other research universities provide funds to hire undergraduates to grade homework. Availability of homework graders at UTK is limited to GTAs who owe an odd hour or two of service. Many faculty members spend a significant amount of time grading calculus homework. Although this effort is good for the students, it is not an efficient use of faculty time. If funds are available, we would like to fund undergraduate graders for Math 141, 142, 231, 241, and 251.

3.) Math Major and Honors Program

The third component of our undergraduate educational mission is the mathematics major. Students major in mathematics with a variety of career objectives, including academic or non-academic research careers, employment in industry or a national laboratory, teaching in the K-12 system, or teaching at a junior college or four year college. Our course offerings at the 300 and 400 level, mostly designed for our majors, are necessarily broad to accommodate this range. Enrollments in 300 and 400 level courses have risen in recent years (see enrollment data in Appendix V). The number of mathematics majors at UT is

small compared to some other departments in the College of Arts and Sciences, echoing an unfortunate national trend, but that number has risen significantly in recent years.

We initiated a departmental Honors Program in 2005 with a \$1 million grant from the National Science Foundation. Most of that money went directly to the Honors students in the form of scholarships. The Mathematics Department Honors Program has about 25 students at any time. It has been extremely successful, with many students going on to excellent graduate schools in mathematics.

a.) Resources Our math major courses at the 300 and 400 level are taught entirely by our tenure-track faculty and our postdoc. We have an Undergraduate Director, and an Undergraduate Assistant. Associated with the Honors Program is an Honors Director. The Undergraduate Committee consists of at least seven faculty members.

b.) Achievements and Strengths In recent years we have seen a significant increase in the number of Undergraduate Mathematics majors. The data available on majors is imperfect, but the trend is clear from the following partial data.

Semester	Math Majors	Math Interest	Math-2nd Major	Math Minor
Fall 2005	62	55	NA	NA
Fall 2006	59	62	4	NA
Spring 2007	80	41	10	1
Spring 2008	90	54	18	9
Spring 2010	107	53	28	17
Spring 2011	123	51	NA	NA
Spring 2012	147	47	7	5

The category “Math Interest” (2nd column) covers students who indicated that they wanted to be math majors when they applied to UT and have not declared another major since then. They are typically 1st and 2nd year students. The administration only started accurately counting 2nd Majors and Minors in 2007/2008, and that data was not be available in 2011 due to the switch to Banner.

The VolsTeach effort is designed to increase the number of students who will become K-12 teachers in the STEM areas. Math is pleased to be a part of VolsTeach. We have constructed a course for VolsTeach students, Math 205, to be taught using our instructional staff. We hope that VolsTeach will attract prospective mathematics teachers who will major in math and hence increase our number of majors.

Our Departmental Honors Program has been extremely successful. Its innovative design was developed in 2004 by Conrad Plaut, who is the PI on the NSF-funded Honors grant which has been funded from 2005 to 2012. Students who do well in Math 300, our first course in theoretical, proof-oriented mathematics, are recruited into the Math Honors Program. Since the material in Math 300 is essentially independent of calculus, interested students are encouraged to take Math 300 as early as their freshman year, and enter the Honors Program right after Math 300. In fact, talented high school students have the option of studying the Math 300 text in the summer and taking an oral exam which can result in placement into the Honors Program as incoming freshmen.

Students in our Honors Program are carefully advised by the Honors Director. They are required to write an Honors Thesis, under the direction of a faculty mentor. The department offered undergraduate honors summer research programs in 2006 and 2008 mentored by

Grozdena Todorova and in 2010 mentored by Plaut. Research from participation in these and other summer programs has resulted in five publications by math honors students in professional mathematics journals, with additional publications currently in preparation. For undergraduates to publish in regular mathematics journals is extremely rare and is a high mark of distinction for our Honors Program.

Also associated with our Honors Program is an undergraduate honors seminar, a Junior Colloquium that features undergraduate-friendly mathematics seminars, and an active Putnam team. The Putnam Team prepares for the Putnam Exam, a famous North American mathematics competition. The Putnam Team prepares by taking a 1-credit course, Math 309, in the fall of each year. Faculty teach Math 309 as a service; no credit is counted toward their teaching load. A few years ago, the UT Putnam Team placed 17th among over 1200 colleges in North America.

The Honors Program is designed to give students the classical pure mathematics background that is expected of students in a first year graduate sequence in a quality doctoral program. Many math majors across the country do not receive this background as undergraduates, and their graduate progress is delayed as they spend their first year in graduate school taking senior-level courses to reach the required background. Our Math Honors students not only learn this material as undergraduates, many of them take one or more graduate sequences as undergraduates. As a result, our Honors Program graduates have been very well prepared for graduate studies in mathematics, as demonstrated by the outstanding record of graduate placement and success our graduates have attained. UT Math Honors graduates are currently pursuing graduate degrees in mathematics at the following institutions:

U. Arizona, U. Connecticut, U. Colorado, U. Georgia, Indiana U., U. Maryland, Michigan State, NC-State, UCLA, UC-Riverside, UC-Santa Barbara, UNC-Chapel Hill, UTK, U. Texas-Austin, Vanderbilt, and Virginia Tech.

All of these students are supported by graduate assistantships or fellowships, including prestigious NSF Graduate and VIGRE fellowships. In fact, 100% of Math Honors graduates who have applied for a math graduate assistantship have received at least one offer from a department in one of the top two tiers of PhD-granting institutions as ranked by the National Research Council and American Mathematical Society. (Math Honors students do not even apply to math programs in the third tier of PhD-granting institutions or those that only offer a masters degree.) Of the eight Math Honors graduates who have so far earned a PhD in mathematics, four now have postdoctoral positions (U. British Columbia, Mathematical Biology Institute-Ohio State, Duke University, and Courant Institute). A fifth went from a postdoc at LSU to a tenure-track position at U. Pittsburgh. Yet another earned his PhD from Cornell with fellowships from both the NSF and NSA, and now works in industry.

This record of undergraduates succeeding in top graduate programs is very unusual for all but the highest tier of mathematics departments.

We are currently in our sixth year of running the annual UT Undergraduate Mathematics Conference. This conference, held on a Saturday in April, features undergraduate students from Tennessee and neighboring states presenting lectures on their mathematical research. Many of our Honors Program students have given talks at this conference.

c.) Challenges Recruiting more mathematics majors is a critical but very difficult challenge. Mathematics is not a popular major across the country, despite the strong national need for more mathematicians, scientists, and engineers. There is concern generally that grade inflation in non-STEM fields is driving students away from mathematics and the sciences. At UT this problem may be more acute than elsewhere because of the GPA requirements for the Hope Scholarship. Mathematics does not have the option of participating in grade inflation because of the sequential nature of mathematics courses: for example, passing a student in Calculus I who hasn't achieved the needed skills only means that he or she will have no chance to pass Calculus II.

So far we have been able to handle the increase in the number of mathematics majors with existing instructional resources because we previously had unused capacity in many of our 300 and 400 level courses. Most of these courses are now running at high enrollments, so a further increase in the number of mathematics majors could not be accommodated without some increase in instructional capacity. If we experience a further loss of faculty lines, we will have to reduce our range of undergraduate course options.

We hope to obtain a continuation grant for our Honors Program. Two follow-up proposals have been unsuccessful, but they were positively reviewed. Dr. Plaut incorporated suggestions from these reviews in his most recent proposal, and has proposed adding an applied mathematics honors track to the program. We hope that these improvements, together with the emerging record of success of our Honors Program so far, will result in renewed funding.

However, even if funding is obtained, it will be for at most 5 more years. At some point we must face the issue of sustaining the Honors Program after funding ends. We have made funding for the Honors Program a priority of our development efforts. Most of the Honors Grant funding went into student scholarships. There is no question that this funding attracted students we would not have had otherwise, but we hope that if we ran the Honors Program without the student scholarships, its history of success would attract a sufficient critical mass to be successful. We note, however, that the direction of Honors Theses and other faculty involvement in the Honors Program is highly time-consuming, and we have not found ways to free up additional faculty time to invest in our Honors Program.

d.) Opportunities There is a great demand for mathematics majors in the current market, much more than for many other majors. We hope that disseminating this fact will allow us to recruit mathematics majors in greater numbers. VolsTeach has the potential to substantially increase the number of our math majors as well. Possibly connections to ORNL can be used to encourage students to major in mathematics. Also, the recent change to allow students to utilize the Hope Scholarship in the summer may allow us to teach more 300-400 level courses in the summer, thus easing student demand.

e.) Goals and Strategies Our two main goals in this area are to increase the number of math majors, and to make our Honors Program self-sustaining. To increase the number of math majors, we are enthusiastically participating in VolsTeach and we are attempting to create a community of math majors through the department's math club, which is a recently initiated, ongoing initiative headed by Chuck Collins and Suzanne Lenhart. To maintain the Honors Program, we are actively pursuing an NSF grant renewal, and working with the Development Office to solicit financial support that will make the Honors Program self-sustaining.

f.) **Requests** If funds were available, a contribution of some institutional support for the Honors Program would be very helpful.

IV. SERVICE AND CONNECTIONS TO THE COLLEGE, UNIVERSITY, COMMUNITY, AND PROFESSION

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Mathematics maintains its vibrancy and relevance through its relation to science and the larger community. These relations are reflected in the various connections maintained by the UTK Mathematics Department. Within the University of Tennessee, Math has long had close connections to the department of Ecology and Evolutionary Biology. This group, including joint faculty Lou Gross and Sergey Gavrillets, along with Suzanne Lenhart, who is 100% in the Mathematics Department, played major roles in the winning of the NIMBioS grant and have been key figures in the administration of NIMBioS. The great success of NIMBioS resulted from interdisciplinary activities in mathematical biology that were supported by the Mathematics and Biology Departments at the University of Tennessee over 3 decades. The Mathematics Department also has connections with the Mathematics Education group in the College of Education, Health and Human Services. Outside of the University, we are related to the Oak Ridge National Laboratories, especially through the Joint Institute of Computational Sciences. We play a significant role in community outreach through the UTK/Pro2Serve High School Math Contest. We have brought a number of public lecturers to campus to inform the community about mathematics. Our faculty play a significant disciplinary service role as editors of many journals, as referees of papers and grant proposals, and in advisory capacities for a number of national organizations. We run the Barrett Lectures, a high-profile mathematics research lecture series, annually.

A.) Resources Many of our tenure-track faculty have research programs which connect to other units on campus. In particular we have a number of joint faculty with other departments: Lou Gross (75% EEB, 25% Math), Sergey Gavrillets (80% EEB, 20% Math), Judy Day (75% Math, 25% EECS), and Vitaly Ganusov (75% Microbiology, 25% Math). We also have one joint faculty with ORNL, namely Yulong Xing, who is a JFO appointment, 50% ORNL, 50% UTK. We had a second joint faculty member with ORNL, Petr Plechac, a JFU tenured faculty member, but he left to take a position at Delaware in 2010. Some of our Lecturers have been involved in teaching special courses for the professional development of K-12 teachers. Virtually the entire department (staff, tenure-track faculty, Lecturers, and GTAs) are involved in running the UTK/Pro2Serve High School Math Contest.

B.) Achievements and Strengths For many years, the UT Mathematics Department included a group of faculty engaged in mathematical biology. A year or two after the EEB Department was formed in 1995, Lou Gross, Sergey Gavrillets, Mark Kot and Tom Hallam moved their base appointments from Mathematics to EEB with Lou and Sergey

retaining 25% appointments in Math, Mark maintaining 50% in Math and Tom moving 100% to EEB. Suzanne Lenhart, a longtime collaborator with Lou Gross, maintained a 100% appointment in the mathematics department. Lou is the PI on the NIMBioS proposal, and Sergey and Suzanne are Associate Directors of NIMBioS. Winning the highly competitive, \$16,000,000 NIMBioS center over such schools as Michigan and Emory was an impressive accomplishment. Having an NSF institute at UT is one of the highest academic honors, possibly the highest, in UT's history.

The Math Department continues to have considerable interaction with NIMBioS. Lou Gross serves as Director and Suzanne Lenhart is Associate Director for Education, Outreach, and Diversity. The Mathematics Department participated vigorously in the two year multi-disciplinary search, resulting from the success of the NIMBioS proposal, that brought 6 new faculty in mathematical biology and related areas, including Judy Day (75% in the Math Department) and Vitaly Ganusov (25% in the Math Department). Several of our faculty, in addition to Lou, Sergey, and Suzanne, have mathematical biology interests and have participated in NIMBioS initiatives. Steve Wise has been a mentor in NIMBioS REUs for two summers and organized an Investigative Workshop at NIMBioS in January 2011. Jie Xiong taught a short course at NIMBioS in spring 2010. Vasileios Maroulas was an organizer for a NIMBioS REU in summer 2011 and an Investigative Workshop in October 2011. Chuck Collins is a member of a NIMBioS working group.

The Mathematics Department maintains a close cooperative relationship with EEB. Several graduate courses are cross-listed between these departments. Over many years, Lou, Sergey, and Suzanne have used their grants to support numerous Mathematics Department graduate students, many of whom have completed mathematics doctorates under their supervision.

In addition to EEB and NIMBioS, The Mathematics Department has connections to other departments on campus. Judy Day, who holds a joint appointment with EECS, is currently collaborating with Seddik Djouadi from EECS on an NSF grant. She has also submitted a proposal with Vitaly Ganusov. Vasileios Maroulas has recently submitted a proposal with Andreas Nebenführ from BCMB.

Chuck Collins has been our primary liaison with the Math Education group in the College of Education, Health, and Human Services. From 2006- 2011, Chuck was a member of the ACCLAIM management team. ACCLAIM was a multi-million dollar, multi-university, interdisciplinary mathematics education grant. He also served as mentor for a cohort of ACCLAIM students at UTK. Currently Chuck is partnering with the Education group on VolsTeach, a major initiative to increase the number of math and science teachers educated at UT. This program is modeled on the UTeach program, providing a 4-year program that prepares students for K-12 teaching.

The Mathematics Department has natural mutual interests with ORNL, especially considering their impressive computational facilities. Suzanne Lenhart has written a number of joint papers with ORNL scientist Vladimir Protopopescu, and Vasili Alexiades had a standing ORNL appointment. A few years ago, Petr Plechac organized the first Numerical Day, in which UTK and ORNL computational scientists met and exchanged information on their research projects. Another Numerical Day is being planned for spring 2012. Yulong Xing, a Joint Faculty member based at ORNL, plays an important role connecting UTK and ORNL. Vasileios Maroulas initiated a collaboration with ORNL's Alvin Weinberg Fellow, Dr. Malikopoulos.

The Mathematics Department's largest outreach project is the UTK/Pro2Serve High School Math Contest, which in 2011 is in its 13th year. It is partially supported by the Pro2Serve Corporation. The contest brings 600-700 high school students to UT for a one day contest. There are two levels of individual exams (Fermat I and II) and a team Math Bowl competition, all written and graded by the Mathematics Department. The top 10 scorers on Fermat II are offered 4 year, \$4,000 per year scholarships to attend UTK. We believe that the Math contest helps recruit far more students than the Fermat II winners, and provides a well-appreciated service to the Tennessee high school community. The entire Mathematics Department, tenure-line faculty, staff, Lecturers, and GTAs, are involved in planning and running the contest. A Lecturer organizes the contest, receiving pay equivalent to teaching a 4 credit course for this service.

Suzanne Lenhart has been involved in a large number of outreach efforts, including coaching a Mathcounts team, co-organizing Mu Alpha Theta (a high school math fraternity) state and national conventions, organizing math club activities at Beardon High School, and participating in mathematics workshops for middle school girls. Suzanne won the College of Arts and Sciences Faculty Excellence in Academic Outreach Award in 2007.

Math Department faculty carry out a number of service roles in the College and University, including serving on the College Promotion and Tenure Committee (Carl Wagner, 2009-2011, and Jan Rosinski, 2011-present), the Faculty Senate (Conrad Plaut 2010-2011, Jerzy Dydak 2008-present, Ken Stephenson 2005-2008, Jim Conant 2008-2010 and 2011-present, Fernando Schwartz 2011-present), the Faculty Research Council (Ken Stephenson 2005-2008, chair 2009-2011), the Graduate Council (Rosinski 2006-2009, Anderson 2005-2008 and 2010-present), and the Undergraduate Council (Tzermias 2006-2009). Chuck Collins has taken on a number of administrative tasks for the College, for example serving on the College Curriculum Committee Task Force, the Humanities Curriculum Committee, and the VolsTeach Advisory Council, and for the University, including, among other things, Chairing the GenEd Committee and serving on the Search Committee for the Director of Admissions, the Tennessee Teaching and Learning Committee Advisory Board, and the Provost's Task Force on Retention.

The Mathematics Department has hosted a series of high-profile public lectures in recent years. These included Jeff Weeks (MacArthur Fellow, Fall 2007, "The Shape of Space"), Ivars Peterson (noted science writer), Robert Lang ("Mathematics and Origami," joint lecture with Art and Physics, Oct. 25, 2007), Keith Devlin (the NPR "Math Guy," February 10, 2009), and Art Benjamin (author of books on "mathmagic").

In service to the profession, UT math faculty referee a huge number of journal submissions and grant proposals. Many serve in editorial roles for major journals. UT Math Faculty have organized numerous special sessions and symposia at AMS or SIAM meetings, including the International Congress of Industrial and Applied Mathematics in 2011. Since 1999, Bob Daverman has served as Secretary of the American Mathematical Society. Suzanne Lenhart served on the SIAM Board of Trustees from 2004 to 2009.

The highest profile service to the mathematical profession that is regularly provided by the UT mathematics department is the annual Barrett Lectures. Named for John H. Barrett, a former UT Math Department Head, these lectures are a national, often international, symposium of 2-3 days or more, hosted at UT in the late spring or early summer. The topic varies from year to year, as a department group will propose an area and organize the lectures on a volunteer basis each year. These lectures have brought very favorable attention

and publicity to the UT Mathematics Department. They have often been supported by NSF and other grants.

C.) Challenges We hope to expand our relationship with ORNL. We have not had much connection with Tennessee Community Colleges, which would be welcome.

D.) Opportunities NIMBioS has provided great opportunities for our faculty to extend their connections to areas of biology. We have taken good advantage of these opportunities so far and hope to continue to do so. NIMBioS should help us attract good faculty hires, especially in mathematical areas linked to biology.

The possibility of a Governor's Chair in computational mathematics is a huge opportunity for the UT Mathematics Department. We worked very hard to land an ideal candidate in 2010-11, but a very generous offer from the administration was declined. We are working with ORNL now to identify and pursue new candidates.

The existence of the two joint faculty positions associated with JICS, one which was held by Petr Plechac and one currently held by Yulong Xing, is a great opportunity for us to enhance our relationship with ORNL. We are eager to hire into the position vacated by Dr. Plechac.

E.) Goals and Strategies Our goal is to maintain our vital connections on campus and in the larger community. We hope to increase our relationship with ORNL. First, we hope to hire into the open JICS joint faculty position with ORNL. Most importantly, we hope to recruit a Governor's Chair in computational mathematics. We plan to maintain university connections through College and University committees and other service responsibilities. We plan to continue our outreach efforts in running the UT/Pro2Serve High School Math Contest and our service to the profession through the Barrett Lectures.

F.) Requests It is very important for our ORNL connections that we regain the JICS joint faculty position. In the long run, more joint faculty lines with ORNL would be desirable. We hope that the excellent support from the administration for our efforts to recruit a Governor's Chair in computational mathematics will continue. We hope that there will be additional joint faculty appointments with other units on campus, such as EEB, Microbiology, EECS, and potentially Math Education. Several years ago Math had a position for an Outreach Mathematician. We would be interested in reconsidering that possibility. If student demand is sufficient, we would be interested in hiring a faculty member with the expertise to develop an actuarial mathematics minor.

V. DIVERSITY

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The UT Mathematics Department has long had a great deal of international diversity. We currently have faculty members from Greece, Romania, China, Canada, Poland, Lebanon, India, Germany, England, Bulgaria, the former Soviet Union, Brazil, and Chile. However, we have no African-American faculty and only a few Latino faculty. Most glaringly, until recently the department had only two women tenure-track faculty, Suzanne Lenhart and Grozdena Todorova.

A.) Resources and Analysis of the NRC Data

The 2010 NRC report included data on the percentage of minority and women faculty and graduate students, and the percentage of international students, based on 2005-6 data, summarized in the following table.

	UTK Math Department	median of all 127 ranked departments
percent minority faculty	7.7	4.5
percent women faculty	7.1	12.5
percent minority grad students	6.1	8.7
percent women grad students	31.3	28.2
percent international students	31.3	41.9

Our department ranked below the median of all ranked departments in percentage of women faculty. We ranked above the median in percentage of minority faculty, perhaps because of faculty classified as Latino. Our percentage of minority graduate students was slightly below the median, but our percentage of women graduate students is a little above. Our percentage of international students is below the median.

If we look at the midpoint of the 90% interval for diversity and rank the UT Math Department compared to all ranked mathematics departments or to all public university ranked departments, we obtain the following data.

	midpoint out of 127	rank by midpoint all 127 departments	rank by midpoint of all 89 public universities
Diversity	84.5	85	59

Our Diversity Rank is above that of U. Penn, Cornell, Dartmouth, Rice, U. Chicago, UCLA, Duke, Berkeley, UCSD, Texas, and USC. However, this ranking is lower in absolute terms than our *S*-rank, *R*-rank, research rank, or Student Support and Outcomes rank. This shows us that we have considerable room for improvement. An interesting phenomenon became apparent when we normalized the rank by the number of programs, and did the same analysis for the other departments in the College of Arts and Sciences (see Appendix II, p. 11). Math ranked 4th in Diversity (behind Microbiology, Spanish, and EPS), much higher than many departments in the social sciences and humanities which are normally thought of as diverse. This data suggests a couple of conclusions. First, it appears that diversity at UT is weak in most departments. Possibly the perception of East Tennessee culture as non-diverse makes recruitment of diverse candidates difficult, or perhaps UT historically lagged behind other institutions in recognizing diversity as a value. Second, the data suggests that whatever lack of diversity may exist in the UT Mathematics Department compared to other Arts and Science departments is largely due to factors common to the mathematics discipline.

It is easier to recruit diverse faculty if there are existing role models in the current faculty. We are fortunate to have Drs. Lenhart and Todorova among our senior faculty. Dr. Lenhart has a long history of support for women mathematicians. Her standing in the department and University as Chancellor's Professor demonstrates that women faculty are recognized for their accomplishments at UT.

We have had excellent support from the administration in our hiring efforts that involved diversity. For example, when we hired Judy Day, the administration provided resources for a spousal postdoctoral position. We hope we can continue to depend on such support, considering that the competition for top women and minority mathematicians is intense, with better-funded universities often making very attractive offers to young mathematicians from under-represented groups.

The UT Mathematics Department is very interested in increasing its diversity. Such an increase is a national trend, and maintaining our standing requires us to be competitive in this, as in all other, areas.

B.) Achievements and Strengths We made significant progress in 2010 in improving gender diversity with the hires of Joan Lind and Judy Day. Among current supported graduate students, we have 3 who are African-American (Sarah Abdalmajeed, Jimmy Miller, and Shalanda Satchell) and 3 who are African (Ernest Jum and Eric Numfor from Cameroon, and Boloye Gomero from Nigeria).

As noted above, Suzanne Lenhart has a long record of support for women and under-represented groups in mathematics. She was President of the Association for Women in Mathematics from 2001 to 2003. Suzanne was recognized for her leadership on diversity issues with the College of Arts and Sciences Diversity Leadership Award in 2009.

C.) Challenges Recruitment of top mathematicians who are women or members of underrepresented groups is intensely competitive. Better resourced universities often make very attractive offers to candidates from these groups. In some cases UT simply doesn't have the resources to compete. This became evident in 2010 when the mathematics department tried to recruit Carlos Castillo-Chavez in the College's Target of Opportunity search. Carlos runs a presidentially recognized program in mathematics education which has a high concentration of underrepresented groups. Carlos was attracted to UT because of our strengths in his research area of mathematical biology, and faculty with a strong

record on diversity, like Suzanne Lenhart. However, when it came down to making an offer, the resources Carlos required were far beyond what UT was willing or able to consider. In recruiting Assistant Professors, our high teaching load (see § II.2) makes it very difficult to compete for outstanding women or minority candidates.

D.) Opportunities The College's Target of Opportunity Hiring Program made it possible to recruit Joan Lind. Her recruitment was successful due to a combination of unusual and fortunate circumstances. The University's spousal support program is helpful in recruiting women mathematicians. Special programs and scholarships for undergraduates or graduate students, for example PEER, are also helpful in recruitment.

E.) Goals and Strategies One goal is to continue to increase the percentage of tenure-line faculty and GTAs who are women and/or member of underrepresented groups. About 30% of doctorates in the US are currently granted to women, whereas the percentage granted to other underrepresented groups is much smaller. Hence we have the best chance to improve our gender diversity. Our strategy at the faculty level is to make the department attractive to strong candidates, by advertising our high quality and success as indicated, and by urging the administration to help us address the salary and teaching load issues that separate us from our peers. At the graduate level, we hope to recruit under-represented groups effectively, partially by advertising our NRC standings, and to advocate for higher stipends for our GTAs.

F.) Requests If an opportunity to hire a woman or minority candidate arises in our usual hiring process, we hope that the administration will be willing to meet or exceed competing offers, which may go well beyond the targeting salary range determined at the outset of the search. Additional scholarships for Undergraduates or Graduate Students would always be helpful and welcome.

VI. CONCLUSIONS AND ACTION POINTS

The 2010 NRC data showed that in each of the S , R , and research ranks, the UT Mathematics Department ranking between 50th and 60th among all ranked mathematics departments, and between 30th and 37th among all public mathematics departments. Hence we are close to the University's goal of ranking in the top 25 public institutions. When normalized by number of programs, the UT Mathematics Department was unique in ranking first or second in the College of Arts and Sciences in all three of the aforementioned categories.

With regard to educational service, the UT Mathematics Department also ranks first, providing about 20% more student credit hours than the department with the second highest total in the College, despite having 3 fewer tenure-track faculty than that department. In fact, our ratio of total student hour production to tenure-track faculty is the second-highest in the College.

The Mathematics Department's top research rank and high service production stand in stark contrast to the resources that we have received. Nearly all of the departments in the College have faculty teaching loads that are consistent with those of their peer institutions (1-1 in most of the sciences, 2-2 in the humanities and social sciences), whereas the teaching load in the Math Department is significantly above nearly all peer institutions. Our Full Professor salary level is 16th among the 21 departments in Arts and Sciences, when normalized by disciplinary averages. Our highest paid Full Professor, a Chancellor's Professor, has a salary below the average for Full Professors in Mathematics in top 25 institutions.

The UT Math Department cannot be expected to continue indefinitely to overachieve relative to its resource base to the extent that it has. At the very least, to sustain or enhance our status and ranking, it is essential that we preserve or increase our number of tenure-track faculty lines. In particular, if the salaries of this year's and next year's expected 3 retirees could be retained in the department, those salaries would fund 4 Assistant Professor positions, and hence allow us to recover one of the positions lost in the recent cuts.

The top 15 or 20 US mathematics departments stand out; after that the quality level is relatively flat among the next 50 or so departments. Consequently it would not take tremendous resources to move the UT Mathematics Department into the top 25 public university math departments. The most cost-efficient way to significantly improve our department would be to add regular postdoctoral positions, which in mathematics are departmentally funded and include a full teaching load and an independent research program. We have one such position currently; typically top 25 departments have 5-10 department postdocs. We would like to have at least 6, one each for the major research areas in the department. The teaching provided by these positions would allow us to offer teaching loads which are on a par with our peer institutions. Having such a teaching load will allow our faculty to compete on a level playing field for grants, and allow us to recruit outstanding young faculty, especially women faculty or faculty from under-represented groups. Maintaining our ranking will help us recruit strong graduate students as well.

The Mathematics Department has accomplished a great deal with minimal resources. We could make significant improvements with moderate additional support. Recruitment in mathematics does not require laboratory space or large start-up costs. Given these economies and the current ranking of the Mathematics Department, we contend that Math

could reach the top 25 with less additional expenditures than any other Arts and Sciences doctorate-granting department.

The most potentially transformational initiative for the department would be to hire a Governor's Chair in computational mathematics. We will continue to make every effort to succeed with a Governor's Chair recruitment.

VII. ARTICULATION WITH VOLVISION AND THE TOP 25 INITIATIVE

The University of Tennessee has embraced the challenge of becoming one of the top 25 public research universities in the United States. Combining this goal with ideas from the VolVision planning process, in January 2010 the Provost's Office released a document titled "*VOL Vision: the Pursuit of the Top 25.*" As noted earlier, the UT Math Department's *S*-rank, *R*-rank, and research rank place us between 30 and 37 among public university Mathematics Departments. By these measures, we are within striking distance of the top 25. With modest resources, we have a good chance to break into the top 25 public research mathematics departments.

VOL Vision: the Pursuit of the Top 25 includes a list of the University's 5 top strategic priorities. We copy these priorities below in boldface and then describe how the mathematics department's strategic plan aligns with these priorities.

- **Recruit, develop, and graduate a diverse body of undergraduate students**

One of the core missions of the Mathematics Department is to provide outstanding instruction in the fundamental mathematical skills that all UT undergraduate students require. Adding sufficiently many tenure-track and postdoctoral faculty positions would allow us to teach more, possibly all, of our classes from Math 141 up with research faculty. Our participation in VolsTeach should help to recruit more students into the mathematics major, helping to meet a national need in K-12 mathematics instruction. Strengthening our department should make UT more attractive to high-performing students in all areas, with particular emphasis on those in the high-demand areas of science and technology.

- **Educate and graduate increasing numbers of diverse graduate and professional students**

We plan to continue our graduate program's recent focus on doctoral students rather than terminal Master's students. We have had a number of excellent graduate student placements recently. These, along with our increase in NRC ranking, should help us recruit even more successfully. If granted, our request for funds to increase graduate stipends will help us recruit effectively, especially in competition for students from under-represented groups. We ask to continue the exchange of one Lecturer position, when it opens due to attrition, for 2 GTA positions. Adding more GTA lines will allow us to graduate more doctoral students, a key VolVision objective. We need to reduce the teaching load for our most productive research faculty to make time for the resulting increase in graduate student doctoral supervision; adding postdoctoral positions as requested will make that teaching load reduction possible.

- **Strengthen our capacity and productivity in research, scholarship, and creative activity**

Our excellent research standing, as validated by the NRC results, cannot be sustained indefinitely while our faculty have a higher teaching load than at peer departments. Our request to add postdoctoral positions will directly support our research environment by providing an input of new ideas and collaborators, but it will also provide the teaching

power needed to allow a reduction in the teaching load from 2-2 to 2-1. This will allow our research faculty to compete on a level playing field. We have shown outstanding research strength with much less resource support than competing mathematics departments or even other UT Arts and Sciences departments. A moderate influx of resources will allow us to continue to maintain, and even to improve, our current high level.

- **Attract and retain stellar, diverse faculty and staff**

The key factors that junior faculty consider when choosing which offer to accept are research environment, salary, and teaching load. The UT Mathematics Department is blessed with an excellent, collegial research environment. Although our Full Professor salaries are far below competing departments, the salaries offered to Assistant Professors are reasonably competitive. The biggest issue which makes other departments more attractive than ours is the high teaching load at UT. Our request to add postdoctoral positions will enhance our research environment, and allow us to offer competitive teaching loads. This change will be critical in attracting and retaining excellent faculty.

- **Continually improve the resource base**

The department has limited control over our resource base. We hope that our high standing and reputation in an area of critical national need will attract support from donors. In particular, we hope that our highly successful department Honors Program will impress potential donors to contribute so that the program can eventually become self-supporting.