DEPARTMENT OF MATHEMATICS
UNIVERSITY OF CALIFORNIA, RIVERSIDE

Academic Plan, December, 2001

Background information

Mathematics is a fundamental area of human knowledge that provides powerful means for studying other areas of human knowledge. It provides a systematic way of stripping problems down to their formal essentials, and the analysis of such resulting formal structures quite frequently turn out to have applications that were not at all anticipated in the original work. Subjects studied for their own sake have repeatedly turned out to have uses that could not have been imagined when the original work was done, and one can seriously question how well some of these applications would have developed without earlier mathematical research that was ahead of its time, or indeed whether they would have developed at all. One physicist characterized this as the "unreasonable effectiveness" of mathematics for attacking difficult problems.

Depth in mathematical expertise is fundamental to a research university for a variety of reasons tied to research and teaching. All major academic units within such an institution are likely to have mathematical requirements for their students, and the scholarly work of many departments relies heavily on mathematics for both its methods and its overall approach to problems. If one considers the benefits of strength in mathematics versus the necessary investment of resources, the ratio of the first to the second is extremely high.

Departmental outlook

The Department of Mathematics at UC Riverside has built a solid reputation for quality in mathematical research in algebra, analysis, geometry and topology. Its research profile has been quite high for a department of its size, and a sequence of excellent appointments in the past dozen years have revitalized some key areas and provided a firm base for maintenance of quality for the foreseeable future. In particular, the Department has two recipients of highly prestigious Sloan Foundation Research Fellowships; namely, Professors Z. Ran (1987-89) and X.-S. Lin (1992-94), and a highly competitive NSF Career Award to Professor F. Wilhelm (1994-98). Another indication of the high level of broad faculty visibility is the steady record of invited talks throughout the world that our faculty members have given in recent years. Yet another is faculty participation in organizing conferences. In recent years, many fairly extensive conferences have been organized at UCR by a wide range of faculty members whose research interests cover most of the areas represented on campus. In addition, several faculty members have been involved in organizing about a dozen conferences and programs at other highly respected institutions throughout the world. Faculty members in the Department have also hosted two Regents Lecturers during the past five years, and a biennial lecture series funded mainly from a donation by Professor Emeritus Victor Shapiro has brought recipients of two of the most prestigious awards in mathematics and physics – the Fields Medal and the Wolf Prize – to the campus.

Although research support in mathematics in this country has dropped precipitously over the past half dozen years, a significant number of faculty members still receive funding from extramural grants, and the record for NSF support of junior faculty is particularly strong. Faculty members have also been active in submitting proposals for funding of programs from an increasingly wide range of activity including conferences and outreach programs, and these proposals have been successful in a respectable number of cases.

It should be added that there are few problems with research inactivity within the Department, and even among the older full professors the productivity records are good. All but three of 24 current regular faculty members have published regularly in refereed journals with good reputations within the past few years. This is above average for departments in major state universities. In contrast, numerous areas of mathematics that have flourished during the past 10 to 20 years are is well represented in the Department, and it is in an excellent position to increase its reputation even further. For example, considerations from physics have had an enormous impact on mathematics during that time, and aside from the well recognized research of our researchers in mathematical physics (J. Baez and M. Lapidus) ideas arising from mathematical physics in recent years are immediately apparent in a wide range of research by faculty members such as V. Chari, Z.-D. Guan, C. Hacon, X.-S. Lin, I. Penkov, Y.-S. Poon, Z. Ran and F. Xu.

The Department of Mathematics has maintained interactions with other departments in the College where there are overlapping interests. There are three faculty members with cooperative appointments in Computer Science (Professors G. Gierz, N. Gretsky, L. Harper); one emeritus faculty member (Professor J. dePillis) also holds such an appointment, and one faculty member has a cooperative appointment in Electrical Engineering (Professor M. Lapidus) and another has a cooperative appointment in Physics (Professor J. Baez). Conversely, Professors M. Chrobak and T. Payne of the Computer Science Department are cooperating faculty members in the Department of Mathematics. Professor Lapidus also is a member of the University's Research Center of Excellence in Intelligent Systems. The jointly sponsored visits of two Wolf Prize recipients are further illustrations of the well established interaction between Mathematics and Physics. Professor B. Arnold of the Department of Statistics has played an important role in the deliberations of departmental search committees, and Professor M. Chrobak has also served on a search committee charged with filling three positions. One long term instructor in the Department (Dr. P. Clute) had held a split appointment between Mathematics and Education until she became Director of the University's ALPHA Project, and she remains active in working on issues involving Mathematics and Education. Professor Poon has worked with her and others at the Campus and System levels on numerous issues concerning mathematics education. Professor Gierz has been closely involved for many years with personnel in Plant Pathology on modeling problems related to fungus growth.

PART ONE – CHALLENGES FACING THE DEPARTMENT

The strong reputation that Department of Mathematics has earned over the years provides a solid base for even further achievement, and the faculty is intent on increasing its academic profile accordingly as the campus continues its rapid expansion. However, the precipitous enrollment increases of the past five years, and very substantial increases that are projected over the next fifteen years, indicate that the Department of Mathematics is at a crossroads. When UC Riverside was small, it was straightforward for the Department of Mathematics to handle its teaching obligations quite effectively, and even at the enrollment levels of the early nineties the Department was able to make adjustments so that it could faithfully carry out its teaching responsibilities. However, sharply increased enrollments since 1997 have seriously challenged its ability to maintain the standards for research and teaching it has held, and the modest increases in resources during that time have done little more than to keep things functioning on a day by day basis. Further strains caused by personnel and physical resource shortfalls will not only risk changing a high quality department into a unit that is so burdened with day to day teaching and administrative responsibilities that it can hardly do anything else. The reputation of the entire University is at stake if it allows one of its historically recognized departments to stagnate or squanders some of its valuable assets.

Student enrollments and faculty positions

The extent of the challenges the Department faces can be seen very easily from some striking quantitative evidence. Here is a summary of personnel changes during the past ten years:

Table 1

AREA OF RESEARCH	RESIGNATIONS	RETIREMENTS	APPOINTMENTS
Algebra	1*	2	1
Geometry–topology	2	1	4
Analysis	2	4†	3

The asterisk (∗) signifies that one faculty member has announced an intention to accept another position in Fall 2002 but no resignation has been received to date, and the dagger (†) signifies that one faculty member is retiring effective June 30, 2002.

The table above indicates that the Department is down four regular faculty positions over the period despite increases in our course enrollments that outpace the overall increases in the University. Over the past three years one regular faculty position has been vacated and not yet filled, with the search for a replacement currently in progress. The University has provided funds for temporary personnel to fill some of the gaps, but the drawbacks of relying extensively on such appointments have become apparent in the past three years, partly because the massive enrollment

increases require us to go further down the list to fill all the openings and partly because such temporary personnel cannot be expected to make sustained contributions to the Department aside from teaching their classes and, in the case of Visiting Assistant Professors, providing temporary enhancements to the Department's research activities. Temporary positions will always be needed, but they cannot be a comprehensive long term solution.

In contrast to the decrease in regular faculty positions, here are undergraduate enrollment figures since the Fall of 1996 (Mathematics 3, a remedial course that does not carry academic credit, is not included in these numbers).

Table 2

ACAD. YR.	FALL	WINTER	SPRING
1996–1997	1958	1921	1716
1997–1998	2293	2374	1772
1998–1999	2987	2724	2560
1999–2000	3394	3027	2838
2000–2001	3725	3439	2847
2001–2002	3860		

These figures represent a doubling of enrollments in only five years' time! This is a great deal to ask from any department, and it seems particularly noteworthy that the Department of Mathematics has held up so well under such intense pressure. The aim of the University should be to provide substantially increased support to a Department that has carried out such a demanding task so successfully with marginal resources rather than to allow the pressure to increase any further. At least some of the leveling off in recent quarters can be attributed to the University's decisions not to provide new classroom facilities despite its skyrocketing enrollments. The Department is receiving rooms that are smaller than requested with increasing frequency, and negotiations with the Registrar's Office for space have become increasingly difficult and unsuccessful. The University's failure to provide adequate classroom space for the students it admits is an issue that clearly deserves prompt remediation, but it will not be pursued further in this document.

Figure's from the UC President's Office indicate that the projected University growth through the end of the next decade will average 7 per cent on a compounded basis. However, the growth of the College of Engineering, which has many students in Mathematics courses at both upper and lower levels, will be more than twice that amount at least over the period. Figures from the past five years show a pattern of enrollment increases well above the overall growth of UCR, and a projection of at least 10 per cent annually is consistent with the Department's experiences during that time. This yields the following projections for the numbers of enrollments in undergraduate mathematics courses (excluding Mathematics 3).

Table 3

Quarter	Projected enrollment
Fall 2002	4300
Fall 2003	4800
Fall 2004	5300
Fall 2005	5800
Fall 2006	6300
Fall 2007	6900

This translates into a potential 250 per cent increase between Fall 1996 and Fall 2007. Since there were 22 regular faculty members in the Fall 1996, simple arithmetic shows that the regular faculty would have to triple in order to keep pace with the projections of Table 3, even if one assumes that temporary instructors will teach a significant part of the load.

Even if one simply does a compounded growth calculation using the University's overall 7 per cent authorized annual growth figure through the end of the next decade, the projected Fall 2007

enrollment would be approximately 5900, which is over three times the figure for Fall 1996 and would correspond to a corresponding regular faculty count of 66. In either case there are several reasons why some temporary faculty appointments might be preferable to planning exclusively for regular appointments to fill teaching needs, the most obvious of which is the need to be highly selective in filling new positions in order to maximize the quality of the faculty.

Effects on programs

Both the undergraduate and graduate programs face challenges, but of a highly different nature. On the undergraduate side the problems involve the enormous enrollment increases and the lack of resources to give long range instructional issues the attention they really should receive. The regular faculty's overall service load is currently too extensive for capable faculty members to concentrate on such matters, largely because their talents are more urgently needed to maintain the graduate program. The graduate program has faced huge challenges on several fronts, such as the search for qualified students, especially domestic ones.

In recent years most of the work on maintaining elementary service courses like precalculus and mathematics for management students has been done by two individuals who are not regular faculty members; namely, Dr. Clute and Professor Emeritus J. Ratliff. It is not clear how long either will remain willing and able to do such work, and whenever either is no longer available the problem of dealing with instructional issues will become even more challenging than it is right now.

The most recent extramural review of the Department recommended that the dormant graduate programs in applied and applicable mathematics be overhauled and revitalized. This would provide students with a broader range of options for both study and subsequent employment. Again, the Department needs additional regular faculty in order to implement and sustain such a program successfully. Increased undergraduate enrollments provide excellent opportunities for corresponding increases in the graduate program, particularly because the students are largely supported by teaching assistantships and one can make firm financial commitments for such support without running massive deficits that may have disastrous consequences for everyone. However, to realize this opportunity it is necessary to have a faculty that is large and strong enough to manage the increase in graduate students. This is needed both for basic graduate instruction as well as supervision of doctoral students. Needless to say, the large growth in undergraduate enrollments have hampered the Department's ability to offer all the courses that would be useful to its graduate students, and this situation cannot continue indefinitely, particularly if the Department is to revamp its applied mathematics program and offer the courses needed for such degrees. In order to accommodate increased numbers of students it will be necessary to build the Department's research profile in selected areas of strength that cut across all of mathematics. A major university may not be able to excel in everything, but unless it has a recognized presence in more than a handful of areas one can question whether an institution is indeed a major university.

A third programmatic area with challenges involves the Department's interaction with other units within the University. Although it was noted that mathematics often comes up with the tools other subjects need when it studies problems for their own sake, it is also clear that a strong Department of Mathematics should not be isolated from other units in the University. With the expansion of the campus it is clear that new opportunities for interaction have developed and will continue to develop. The Department needs to be in a position to exploit these opportunities and welcomes the challenge of doing so, but this can only happen if it receives additional faculty positions that can be used to promote increased activity with other departments.

Many choices need to be made regarding the areas for interaction, and various efforts are planned to identify the most promising opportunities. An interdisciplinary discussion group on mathematical modeling is being organized by the College, and the Department will take new initiatives to become more familiar with the uses of mathematics in other departments, particularly as they have been affected by new appointments in recent years of scientists with strong mathematical backgrounds.

A broad range of faculty members within the Department of Mathematics strongly believes that increased support of the Department is extremely worthy of attention and that a major effort to address its needs should not be postponed any further. Any setting aside of large pools of resources for projects that might eventually be worthy of attention is unfair if it obstructs the University's ability to deal with the challenges it actually faces right now and require urgent attention. The faculty strongly believes that the issues involving the Department of Mathematics will benefit the entire University far more immediately and demonstrably than speculative plans that might never materialize.

PART TWO – RECOMMENDATIONS FOR GROWTH

Clearly the Department of Mathematics can continue increase in strength under its extremely heavy workload only if its resources are increased substantially, and in fact this is probably even a prerequisite for the Department to continue functioning at its current high level. It is not in anyone's best interests to neglect a major academic unit within a university.

The Department's overall plans for hiring additional faculty have both qualitative and quantitative objectives. There are four basic objectives on the qualitative side. First, the mathematical strength of the individual candidates is by far the most important consideration. Second, the various faculty specialties should provide graduate students with a reasonably balanced set of options in algebra, geometry/topology and analysis, with specific areas chosen by evaluation of their current status and future potential. Third, the development of clusters of excellence to enhance the Department's strength and visibility must be considered in future growth and revitalization. Fourth, the promotion of further interaction with other units in the University is an important priority that deserves substantially increased attention. Finally, substantial increases in the options available to both graduate and undergraduate students as well as program management adjustments to reflect the dramatically increased demands upon the Department are absolutely necessary.

The quantitative goals for expanding the Department are as follows: First, areas of current research strength should be increased to provide particularly attractive opportunities for graduate students and postdoctoral appointees. Second, all positions that have become or will become vacant must be returned to the Department, with priority for maintaining strength in the corresponding areas. Third, areas that were successful in research and graduate student production before the retirements of the previous decade should be rebuilt in proportion to their present status and future potential. Fourth, substantially more representation in the applications of mathematics to other disciplines must be pursued because of its strong potential benefits for everyone.

Taken together these objectives combine a continuation of the excellence the Department has historically maintained with a broadening of its mission and the capacity to handle a drastically increased workload. In all these cases, building the strength of the research group in analysis at all faculty levels will play an important role, and there is a broad faculty consensus for significant and sustained investment in this direction as well as for growth in other applicable branches of mathematics such as combinatorics.

DEPARTMENTAL FIVE YEAR PLAN

Filling three new faculty positions during each of the next five years would be a major step towards bringing the faculty up to an appropriate size with respect to the rest of the campus, and there is a broad faculty consensus to grow at that rate. Currently there are 24 positions, with searches authorized for two more and one or two positions becoming vacant at the end of the current year. This would increase the size of the Department to 41 regular positions. Even with such an increase the Department will still be understaffed, but this seems like a minimum necessary for the Department to function at the standard it believes is appropriate. In addition to these requests, there is an extremely forceful and broadly shared faculty opinion that all vacancies that exist now and will develop in the future must be returned to promote the fundamental objectives of the Department. Normally these would be filled in the same general area as that of the retiring or departing faculty member.

Over the current year and the next five years the following plan reflects the views of the Department that have been summarized. At least two of the positions in analysis should be at an open level with the intention of identifying senior candidates, the option of searching for a third candidate at an intermediate level also deserves serious consideration, and one each in the remaining three areas would be appropriate.

2001-2002: Currently the Department is searching to fill two positions; namely, the Jones Chair in Topology and a junior position in analysis. The Department requests that it also be allowed to search for a replacements of the faculty member in analysis who is retiring in June of 2002 in that the position be added to its current analysis search. As noted above, the rebuilding of analysis is an important priority and the faculty would like to do as much as possible as soon as it can.

2002-2003: (0) [*If current expectations materialize*] Replacement of the faculty member in algebraic geometry who has indicated that he will also be leaving at that time, provided that he does indeed resign as currently seems almost certain. A replacement appointment in algebra would

reflect current strengths in the Department. (1) A junior position in geometry or topology, the precise specialty to be determined upon filling the Jones Chair in Topology. When hiring a very senior faculty member holding a named position there is an expectation that the appointee will have an opportunity to provide immediate input into future growth. (2) A position in analysis and its applications, with priority for currently productive or promising areas in which retirements or separations have depleted the Department's presence. (3) A position in extrinsically motivated mathematics. This rubric is meant to cut across the lines of all algebra, geometry/topology and analysis, the objective being to identify and hire mathematicians with expertise bridging different areas in pure and/or applicable mathematics as well as potential for interaction with other departments in the sciences, engineering or economics depending on the outcome of College and Department discussions that are anticipated (for example, a modeling group, interdepartmental committees or interdisciplinary colloquia).

2003-2004: (1) A position in analysis and its applications, with priority for currently productive or promising areas that are represented by faculty research. (2) A position in combinatorial or algebraic structures to build upon current or anticipated areas of faculty strength. (3) A position in geometrical mathematics to build upon current or anticipated areas of faculty strength and to provide opportunities for interaction either with other branches of mathematics or with other subjects.

2004-2005: (1) A position in analysis and its applications, with priorities as in the previous year. (2) Another position in combinatorial or algebraic structures to build upon current or anticipated areas of faculty strength, with priority for the choice not filled during the preceding year. (3) A position in extrinsically motivated mathematics consistent with the previous hiring record and anticipated needs.

2005-2006: (1) A position in analysis and its applications, consistent with the previous hiring record and anticipated needs. (2) Another position in combinatorial or algebraic structures consistent with the previous hiring record and anticipated needs. (3) A position in geometrical mathematics consistent with the previous hiring record and anticipated needs.

2006-2007: (1) A position in analysis and its applications, consistent with the previous hiring record and anticipated needs. (2) Another position in combinatorial or algebraic structures consistent with the previous hiring record and anticipated needs. (3) A position in geometrical mathematics consistent with the previous hiring record and anticipated needs.

In all cases the precise areas will be determined by the strengths of the appropriate pools of applicants.

A ten year perspective

The preceding would provide an adequate but not lavish foundation for expansion in the subsequent five years to keep up with the growth of the campus and to realize further the potential that will exist at the time. If expansion of the entire campus continues at the currently anticipated rate, expansion of the faculty of the Department of Mathematics should also continue at the rate described above. The record and job market indicate that such an expansion will do far more than simply create a department that is merely much larger than it is right now; recent hiring indicates that the Department is well positioned to become even more competitive with those of larger institutions in the University of California system.

Departmental needs to support new faculty

The initial complements for faculty members in mathematics are far below those needed in laboratory sciences, and this point deserves very serious consideration when setting priorities with limited resources. Traditionally the amounts have been well under $25,000 per recruitment regardless of the level, and this can be expected to continue. More urgent is the matter of physical space. Within two years the Department's space in the new Surge Facility will be inadequate regardless of whether the Department hires regular faculty or temporary personnel. Additional space is absolutely essential unless the University does not expect enrollments in mathematics courses to increase beyond their current levels in the foreseeable future. One option that has been discussed is

an aggressive campaign to acquire the space currently occupied by the Computer Science Department when they move out. This is acceptable as a temporary emergency solution, but one must question whether this provides what is actually needed.

PART THREE – OTHER PERSONNEL NEEDS AND IMPLICATIONS

The preceding discussion of faculty positions can only be viewed as part of the need for expanding the Department of Mathematics. More personnel are needed in other capacities to keep up with the growth of the campus and the projected growth of the Department's graduate and undergraduate programs.

Departmental needs for temporary faculty and instructors

The Department of Mathematics would not be able to function without the temporary lecturers and Visiting Assistant Professors it has been able to appoint over the past several years. Even with a substantial increase in regular faculty substantially larger than that requested above, the faculty to student ratio of the Department would be well above the average for the College and campus. Currently there are seven visiting faculty appointments and there are expectations for an increase to 10 or 11 in Fall 2002.

A program of this sort is an excellent means for hiring urgently needed extra personnel without extensive future commitments and simultaneously enhancing the research visibility of the Department and University.

However, it is important to remember that such positions do not carry the service expectations of regular faculty positions. One fundamental concern is that the salary levels be maintained at competitive levels. Recently salaries were raised significantly above the levels of most ot the previous decade, but it is important to increase these salaries in a manner consistent with regular faculty raises. Specifically, the same percentage raises granted to regular faculty should be applied to visiting positions. There is broad agreement within the faculty that visiting positions should not be used as a substitute for increasing the size of the regular faculty at the recommended rate. Normally the number of visiting positions should not become too large. One option would be to limit the "base ratio" of regular to visiting faculty at 3 to 1, with additional visiting positions as needed to fill regular positions that are vacant at a given time. Many previous concerns about these positions have been resolved in a favorable manner with the help of the College Administration; in particular, recommendations from the most recent extramural review have been implemented to a considerable extent.

Given the uncertainties attached to skyrocketing enrollments, particularly in elementary service courses, it is clear that some lecturers will need to be appointed as primary instructors to cover part of the teaching load. On the other hand, there is overwhelming faculty sentiment for a goal of limiting lecturer appointments to elementary courses below the levels of courses that are traditionally the entry points for science and engineering students at major universities; specifically, these include precalculus and the calculus course for management students. Most faculty members have very little contact with such courses, but the maintenance of these is an important and increasingly time consuming task and the option of hiring lecturers at somewhat higher levels whose responsibilities include the coordination of such courses deserves serious consideration. One factor in Professor Hacon's decision to accept the position at the University of Utah (a highly regarded research institution) was the opportunity for his wife to obtain such a position in their Mathematics Department (which is also quite highly regarded).

Needs for additional office personnel

The Department office has functioned well up to now, but the increased demand for paperwork, personnel processing, grant preparation, schedule adjustments, and increasing difficulty in dealing with dissatisfied students, are straining the staff to its limits. One particularly crucial need is for additional and relatively sophisticated clerical help to handle tasks like the processing of grants and proposals. Furthermore, better computer support is absolutely essential for many reasons; in particular, staff turnover has left the Department without technical typing capabilities in the office staff, and there is a need to hire someone whose duties will include support of document and other materials processing. Currently there are over 100 people working for the Department in one capacity or another, and this number should be viewed with more significance than just the number of regular faculty. An annual increase in office staffing of one third of a full time position per year seems like an absolute minimum.

Impact on the graduate program

A ratio of 1.5 graduate students per regular faculty member has been a goal of the Department, and with expansion and renewal of the faculty this ratio can almost surely be increased to 1.8 to 1 or higher, particularly after a new Master's Degree in Applied Mathematics is implemented. Traditionally most of the support of graduate students has come through teaching assistantships, and with the expansion of the campus there are plenty of classes in mathematics that require such positions. This base provides extraordinarily good opportunities to maintain large enrollments, allowing fiscally sound commitments of support that will not create massive deficits that will come back to haunt everyone in times of budgetary crisis. An increase in the faculty will substantially broaden the options available to graduate students that include the program in applied mathematics which virtually everyone wants to implement. Increased faculty numbers are also certain to improve the quality and quantity of interaction between faculty and graduate students.

Impact on the undergraduate program

An substantial increase in the size of the faculty should have a very strong and positive impact on the undergraduate program of a department with one of the heaviest teaching loads on the campus. This will make the difference between a program that is currently struggling to avoid being overwhelmed by the sheer size of its workload and a program that grows in size and stature along with the rest of the campus.

It is expected that the number of undergraduate majors should at least keep pace with the expansion of the University, and the recent enhancements to the teacher education program supervised by Professor A. Stralka should provide some particularly favorable opportunities for growth in view of the serious shortage of qualified mathematics teachers in the State.

More faculty members will enable the faculty to be more attentive to the needs of students at all levels, and more graduate students will have a corresponding effect on undergraduate students as well. Wider ranges of course options for students are to be expected. A larger faculty will be able to take over more of the teaching, coordination and supervision of the entry level undergraduate courses than it does now as well as providing the resources needed to evaluate the effectiveness of instruction and make sound recommendations for changes. Increases will also enable the faculty to devote more time to various activities that are crucial to the quality of any undergraduate program: Regular review of course content, thoughtful study of the need for new courses, changes to existing courses as well as elimination of outdated ones, more focused attention on the role of computer technology in the program, more contact with other departments involving service courses and interdisciplinary programs, and maintaining the freshness and vitality of departmental programs by regular rotation of faculty through leadership positions. In order to handle all of these successfully on the larger scale to which the University aspires, a sufficiently large faculty is absolutely essential.