DEPARTMENT OF MATHEMATICS
UNIVERSITY OF CALIFORNIA, RIVERSIDE

Hiring Plan, October, 1999

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 earlier in this decade have revitalized some key areas and provided a firm base for maintenance of quality for some time. However, the precipitous enrollment increases of the past two years, and very substantial increases that are projected over the next decade, 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 strained its ability to maintain the standards for research and teaching it has held. Further strains caused by resource shortfalls will not only risk changing a high quality department into a unit that is so burdened with day to day teaching responsibilities that it can hardly do anything else; the reputation of the entire University will suffer if it allows one of its historically recognized departments to stagnate or squanders some of its valuable assets.

Departmental missions

The research profile of the Department of Mathematics has been quite high for a department of its size, and a sequence of excellent appointments earlier in this decade should insure a maintenance of quality for some time. 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, fairly extensive conferences have been organized at UCR by Professors N. Gretsky on functional analysis and stochastic processes, by V. Chari and I. Penkov on algebra, by J. Baez and M. Lapidus on analysis, by Y.-S. Poon on complex geometry, and by M.-C. Chang and Z. Ran on algebra. In addition, Professor Penkov has been an organizer of several conferences in the State on representation theory as well as a co-organizer of a three month program at the Schrödinger Institute for Mathematical Physics in Vienna, and Professor Lapidus has organized special sessions at annual meetings of the American Mathematical Society. Professor X.-S. Lin was an organizer for a week long conference held at the Mathematical Sciences Research Institute in Berkeley in early 1997, and in 1998. Also, in April of 1997 Professor Penkov was the host for a visit by the prominent mathematician Y. Manin as a Regents Lecturer, and in January of 1999 Professor Lapidus was a co-organizer of a visit by a prominent physicist (Michael Berry of the University of Bristol, the 1998 recipient of the highly prestigious Wolf Prize in Physics) that was jointly sponsored by the Departments of Mathematics and Physics. Professor Berry gave two lectures in mathematics and physics, and the lecture primarily concerning mathematics was the first in a biennial series funded mainly from a donation by Professor Emeritus Victor Shapiro.

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. These include an NSF Infrastructure Grant to Professor I. Penkov and two mathematicians at other UC campuses, three standard NSF grants to Professors M. Lapidus, X.-S. Lin and F. Wilhelm, and a NATO grant to Professor Y.-S. Poon. Professor Poon also holds a grant with the California Department of Education in connection with his work on outreach and the Department's elementary service courses.

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 21 regular faculty members have published regularly in refereed journals with good reputations within the past two years.

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). 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. Another faculty member (Professor J. Baez) has frequently taught at the graduate level in the Department of Physics. The jointly sponsored visit of Professor Michael Berry is another illustration of the interaction between Mathematics and Physics. Professor B. Arnold of the Department of Statistics played an important role in the deliberations of the 1998-1999 search committee whose work culminated in the hiring of a probabilist. 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 involving mathematics education.

Departmental needs

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. This program has faced huge challenges on several fronts, such as the search for qualified students, especially domestic ones. One promising approach, which has worked elsewhere, is to produce a more attractive Master's program with additional job opportunities outside of the academic community; there is a good market for students coming from such programs. For this purpose as well as the more basic need to provide graduate students with a strongly balanced set of options for doctoral study, the Department must continue to hire in the three basic subareas of mathematics; namely, algebra, geometry-topology and analysis.

There are also issues that involve the interaction between Mathematics and Education. For many years Dr. Pamela Clute has used her joint appointment in Mathematics and Education to create a bridge between the two departments that had not previously existed. Recently she became Director of the University's ALPHA Project. This has already reduced the time she is available to teach within the Department. Highly placed University officials have predicted that her responsibilities will eventually exceed the University's current expectations, and if this happens two units of the University that should maintain an active relationship might end up without one (plans for a mathematics subject specialist on the Education faculty are nebulous, and the two Mathematics faculty members with the most involvement in Education are not in a position to drop other service activities of theirs). There is yet another potential future strain on our resources. Most of our service teaching for Management students is done by a VERIP faculty member (Professor J. Ratliff). For the time being this seems likely to continue, but eventually the loss of his major contribution to our program will intensify the need for new regular faculty appointments.

We shall next discuss quantitative evidence of the Department's needs. Here is a summary of personnel changes during the past eight years:

Table 1

AREA OF RESEARCH	RESIGNATIONS	RETIREMENTS	APPOINTMENTS
Algebra	1	2	0
Geometry–topology	2	1	3
Analysis	1	4	1

This indicates that the Department is down seven 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 the lack of upward adjustments to some salaries also compromised our competitive position. The latter can be seen particularly if one looks at the advertisements of other UC Departments of Mathematics for similar positions. 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		

Note that the Fall Quarter enrollments increased by about 17 per cent between Fall 1996 and Fall 1997 (the first year of the current expansion phase) and by an unanticipated 30 per cent between Fall 1997 and Fall 1998, for a total expansion of 53 per cent over two years. The corresponding increase between Winter 1997 and Winter 1999 is less but still quite substantial at 43 per cent. This quarter the enrollment is up 14 per cent, which is about twice the increase that was projected a year ago and brings the total increase over Fall 1998 to 62 per cent. According to the most recent numbers from the UCOP this past summer, 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 closer to three times that amount at least for the first half of the period. Figures from the past three 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 over the past three years. This yields the following projections for the numbers of enrollments in undergraduate mathematics courses (excluding Mathematics 3).

Table 3

Quarter	Projected enrollment
Fall 1999	3400
Fall 2000	3750
Fall 2001	4100
Fall 2002	4550
Fall 2003	5000
Fall 2004	5500
Fall 2005	6050

This translates into a potential 209 per cent increase between Fall 1996 and Fall 2005. Since there were 22 regular faculty members in the Fall 1996, simple arithmetic shows that the regular faculty would need to triple in order to keep pace with the projections of Table 3.

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 2005 enrollment would be approximately 5100, which is over two and one half times the figure for Fall 1996 and would correspond to a corresponding regular faculty count of 57. 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.

Since research is an important part of the mission of the University of California, it seems appropriate to discuss the needs of the Department in this respect. It is clear that the Department's activity in research also needs to expand to keep pace with the growth in its teaching load. Teaching assistants are needed to staff the large numbers of discussion sections, and this requires a strong graduate program which in turn requires a faculty with high quality research. It also requires a large enough faculty so that an adequate number of graduate courses can be offered; 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 should not continue indefinitely. Even if the NSF support for research in pure mathematics has diminished over the past few years, the costs of doing research in mathematics are still quite small compared to those of sciences with substantial laboratory needs, and as such they still provide a means for a University to maintain a high quality program in an important subject at a relatively modest cost.

Planning for expansion of the Department of Mathematics

The Department's overall plans for hiring additional personnel have three objectives. First, the quality 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. Third, the development of clusters of excellence to enhance the Department's strength and visibility must be considered in future growth and revitalization. Therefore it is anticipated that future growth will be over a broad range of specialties but that appointments within a branch of mathematics will provide critical masses for the specialties that are represented. In the 1999 extramural review of the Department, the reviewers indicated that one should have at least three persons in a given area to ensure a critical mass but that at least two are absolutely necessary.

Implications for Faculty Hiring

During the past three years the Department has been able to make some adjustments in order to fulfill its teaching load more efficiently, and a large number of temporary appointments have played an even greater role in allowing the Department to provide enough classes for students. Even if further efficiency measures can be introduced - which is not certain - and still more temporary appointments are made - which is likely - the University will need a substantially larger mathematics faculty in order to maintain and hopefully improve the quality of its Mathematics Department. Clearly there are limits on the number of new appointments that can be made in a given academic year; if the number is too large, there is a risk that quality will be compromised. Presently the Department is authorized to expand to 24 faculty members in the Fall 2000 Quarter, and the current Dean's recommendations are for two new appointments effective in Fall 2001 and Fall 2002. The Department feels that it will be able to fill three tenure track positions with high quality candidates per year, and such appointments are needed to facilitate the Department's teaching, research and service programs. Therefore, The Department strongly recommends that the number of additional new appointments beginning in Fall 2002 be increased to three and that three new appointments be authorized beginning in each of the Fall 2003, 2004 and 2005 Quarters. This would bring the authorized strength of the Department to 39 at the end of the current five year plan. The allowable ranks for most of these appointments are yet to be determined, but the current University guideline of one tenure level search per three or four searches seems appropriate and is a departmental objective; it is also anticipated that senior level appointments will be considered in most if not all of the categories in which hiring will take place. Further expansion plans for the University indicate that a faculty size of about 52 will be the minimum needed when enrollments reach 20,000 at the end of the next decade.

Profile of an Expanded Faculty

The University Administration has repeatedly made two points about faculty expansion. Namely, there should be some idea of what a department will look like in 5 or 10 years, and the expansion should provide departments that are better and not merely larger. Currently there are some strong research areas at UCR that appear to have high potential for future progress, but there is also a need to replenish some areas with similar promise that have been hit by retirements or resignations (for example, differential equations), and there is also a need to add new research specialties in applied or applicable mathematics. Added opportunities for interaction with other departments are also highly desirable. One projection of a department with 52 faculty members is given below:

A MATHEMATICS DEPARTMENT WITH 52 REGULAR FACULTY

Subject	Number of Faculty
Algebraic geometry	5
Algebra, Lie and commutative	7
Applied areas (including combinatorics and numerical analysis)	7
Basic (real, complex, harmonic, functional) analysis	4
Differential equations	4
Geometry	7
Order theory	2
Mathematical physics	5
Probability	5
Topology	6

The motivations for this projection will be described for each subject individually.

ALGEBRAIC GEOMETRY. This area has seen explosive growth throughout the twentieth century, and during the past 20 years this has been reflected particularly by the Fields Medal awarded to S. Mori in 1990. To a substantial extent the best works of Fields Medalists S.-T. Yau (1983), S. Donaldson (1986), V. Drinfel'd (1990) and M. Kontsevich (1998) also involve algebraic geometry (the Fields Medals are generally viewed as awards for mathematicians comparable to Nobel Prizes, normally with two to four awarded every four years). Professors Z. Ran and M.-C. Chang are active algebraic geometers in the middle of their careers, and there have been a number of successful Ph. D. students who have written dissertations in the subject during the past few years. This is an area where there is already a basis for developing a productive and prestigious group. At the end of the nineteenth century L. Kronecker speculated on the existence of a more unified perspective for questions in algebraic geometry and number theory. During the past half century there has been enormous progress in this direction, and the work of A. Wiles (who received the 1995/6 Wolf Prize in Mathematics and a special award at the 1998 International Congress of Mathematicians) that yielded a proof of Fermat's Last Theorem in the early nineties is one of several major triumphs; the same can be said for the work of G. Faltings, who was awarded a Fields Medal in 1986. Therefore the possibility of an appointment in an area of number theory sufficiently close to algebraic geometry will also be considered.

ALGEBRA, LIE AND COMMUTATIVE. Commutative algebra was at first jointly motivated by considerations from number theory and algebraic geometry (for example, it was crucial to putting algebraic geometry on a logically sound basis during the first part of the twentieth century), but it also has had enormous impacts on other areas of mathematics including topology and combinatorics. Professor D. Rush has worked productively in this area and has directed several Ph. D. dissertations in recent years. Lie algebra can be viewed as a version of anti-commutative algebra that first arose in connection with questions about differential equations and quickly became closely related with questions in group theory, which is the mathematical theory of symmetry. An important milestone in the history of twentieth century mathematics was the formulation of a classification for certain finite-dimensional Lie algebras, and this has led to many breakthroughs in a broad range of mathematical subjects; in particular, successive refinements of the classification scheme eventually led to a description of all finite simple groups about 20 years ago. The most widely known work of V. Drinfel'd (mentioned above as a 1990 Fields Medalist) is on the development of quantum groups, which are essentially Lie-theoretic objects that have had many important applications to algebra, mathematical physics and topology in the past two decades. The work of Fields Medalist E. Zelmanov on group theory (1994) also makes extensive use of Lie-theoretic methods and results, and the work of Medalist R. Borcherds (1998) provides powerful new information on some questions in Lie algebras that are closely related to the study of a particularly significant finite simple group (the so-called Monster Group). Within the UCR Department of Mathematics, Professor V. Chari has studied questions about quantum groups extensively, and in addition she has coauthored a long reference work on them and had one student complete a Ph. D. dissertation. Professor I. Penkov works in other aspects of Lie theory that include items like superalgebras, which have received a great deal of attention from prominent mathematicians and physicists over the past two decades, and he has also produced one extremely strong Ph. D. student and has a second who is at the candidacy level. There have been two retirements of active faculty in this area during the past decade; namely Professors R. Block and J. Ratliff. The total research output at UCR in this area has been extremely good over the past few years, and there have also been quite a few students; consequently, this is also an area where there is already a basis for developing a potentially strong and multifaceted group.

APPLIED AREAS (INCLUDING COMBINATORICS AND NUMERICAL ANALYSIS). The May, 1999, extramural review confirmed the Department's view that a significantly enhanced presence in applied areas is necessary, both in terms of the graduate curriculum for Master's students and the offering of a sufficiently broad array of choices for Ph. D. students. To quote the report, *There are areas of applied mathematics that might fit well into the program ... We are attracted to the many possibilities in computational mathematics; for example, numerical methods and optimization, computational number theory, and computational geometry and topology, to name a few. Combinatorics is another broad area. Of course there are the classical areas of applied mathematics related to partial differential equations, wave mechanics and dynamical systems.* The work of W. T. Gowers in combinatorics and combinatorial number theory was noted specifically when he was awarded a Fields Medal in 1998. Professor L. Harper has worked in combinatorics with particular interest in optimization; in recent years he has successfully directed two Ph. D. dissertations. Two specific area in combinatorics that have been mentioned are complexity theory, a relatively new applied topic that is fundamental to computer security, and algebraic combinatorics, which exploits deep relationships between enumeration theory and Lie and commutative algebra. It is expected that at least one of the new appointees will work in some branch of combinatorics. Due to retirements this decade there are no longer any faculty members whose primary interests lies in numerical analysis, and it is strongly felt that a presence in this particular specialty needs to be restored. The subject has natural ties to applications of mathematics, advances in computer technology have enabled researchers to handle problems that would have been forbiddingly difficult a few years ago, and students with a good background in numerical mathematics have a wide assortment of attractive career options. As noted before, a critical mass of at least two or three faculty members will be needed in the long run. It seems premature to be overly specific about other applied areas that might receive priority for hiring, but there is a general agreement that an initiative in at least one more applied area should be launched. Two possibilities that have generated interest are mathematical biology and financial mathematics; the long term plan would include hiring a second or third person in such an area (depending on where the Department actually hires). It is also possible that an applied appointee could work in differential equations, mathematical physics or probability, but a serious involvement with applications would be expected. The demand for graduates with a background in applied mathematics is greater than for pure mathematics, and this is an important reason for substantially increasing the Department's profiles in these areas.

BASIC (REAL, COMPLEX, HARMONIC AND FUNCTIONAL) ANALYSIS. Historically the basic areas of analysis were sources of a major share of the Department's research activity and graduate student production. However, there have been numerous retirements during the past decade and the remaining faculty members are all close to retirement age, and consequently significant hiring in this area is needed to provide balance in the overall program as well as the options for graduate students. Over the past third of a century, the focal points of activity in analysis have shifted, but the continuing vitality of analysis is reflected by the Fields Medals awarded to A. Connes (1983), J. Bourgain and J.-C. Yoccoz (both 1994) and W. T. Gowers (1998). Professors B. Chalmers and M. M. Rao have long records of continuing activity in functional analysis, and Professor B. Wong's work is largely centered in multivariable complex analysis. One critically important goal in appointing new faculty in basic analysis is to find excellent researchers whose interests and accomplishments indicate a strong capability to supervise a generation of marketable Ph. D. students. Rebuilding the Department's presence in analysis will be extremely important for the sakes of both the Master's and Doctor's programs.

DIFFERENTIAL EQUATIONS. The study of ordinary and partial differential equations is closely connected to basic analysis, and it also was a source of high quality research and successful graduate students within this Department. At the beginning of the decade the senior person in the area (Professor V. Shapiro) played a leading role in the Department's research and graduate programs, and he has not been replaced; two other faculty members in the subject who were also active in working with graduate students have also retired during the past ten years and not been replaced. Many potential applicants to the graduate program have a strong interest in studying partial differential equations, and hiring in this area is extremely important for the enhancement of the options available for graduate students. The Department's two mathematical physicists (Professors J. Baez and M. Lapidus) have substantial research experience dealing with partial differential equations, but their research interests have largely moved in other directions and there is an urgent need to restore the Department's previous strength in this area, which has close contact with many of the applications of mathematics. Replenishments of the Department's strength in both ordinary and partial differential equations are desirable. Much of the work in analysis cited above is closely related to questions about differential equations, and the award of a Fields Medal to Professor P.-L. Lions in 1994 was in recognition of his contributions to partial differential equations and illustrates the continuing vitality of this subject. Once again it is important to find candidates with extremely strong future potential and to build a critical mass of at least two or three individuals.

GEOMETRY. More precisely, the centers of interest here are the subjects classically known as differential and complex analytic geometry. During the past three decades the focus of differential geometry has undergone a radical transformation due to the introduction of powerful new methods from complex analysis and the theories of ordinary and partial differential equations on one hand and strikingly original ideas from classical synthetic geometry and topology in other directions. Their respective impacts are reflected in the awarding of Fields Medals to S.-T. Yau and W. Thurston in 1983, to S. Donaldson in 1986, and to C. McMullen in 1998; in addition, M. Gromov was awarded the Wolf Prize in Mathematics (1993) for his work in geometry. Much of the work of Professor Wong fits into this subject, and the papers of Professors Y.-S. Poon and F. Wilhelm are firmly within this area; there are clear connections between portions of their work and that of Donaldson and Gromov respectively. Research productivity within the subject has been quite good during the past few years and one Ph. D. student has been produced. There are enormous potentials for hiring in this area that would provide opportunities for interaction with other parts of mathematics such as analysis or topology. In particular, during the past few years there have been many excellent job applicants whose research deals with geometric analysis, and there are strong sentiments for building a significant research group in this direction.

ORDER THEORY. Currently the Department has two researchers in this subject who continue to have active publication records, and the projection assumes the number of faculty in this subject will not change.

MATHEMATICAL PHYSICS. Over the first part of the past half century, there was an increasing separation between mathematics and physics, but during the past two decades ideas of physics have had tremendous impacts upon virtually all areas of mathematics, and the effects have been felt even in some of its most theoretical parts. This can be seen from the Fields Medals awarded to A. Connes and S.-T. Yau (both 1983), S. Donaldson (1986), V. Drinfel'd, V. Jones, and E. Witten (all 1990) and M. Kontsevich (1998). The Department has two researchers in the area, Professors J. Baez and M. Lapidus, both of whom are extremely prolific researchers in the middle of their careers and have directed several Ph. D. dissertations in recent years. The current work of Professor Baez deals with quantum gravity theory and the applications of higher order categorical algebra to quantum theory; the work of Witten and Jones has been very influential in the creation and development of quantum gravity, and the work of Witten on quantum field theories and related objects is one stimulus for Baez' work on higher categorical algebra and quantum field theories. Professor Lapidus' work has also been in two directions. One involves the operational calculus developed by Nobel Physics Laureate R. Feynmann. Both mathematicians and physicists have found this to be a very powerful and useful technique, and many of Witten's mathematical achievements involved his use of Feynmann calculus to predict answers to certain questions, but unfortunately the foundations of the techniques cannot be made mathematically rigorous at this time; Lapidus has made substantial progress in rigorously justifying conclusions that are obtainable from Feynmann's machinery. Another interest of Lapidus involves the fractal objects arising from the well publicized work of B. Mandelbrot (a recipient of the 1993 Wolf Prize in Physics) and related questions about complex dynamical systems (a central theme in the work of Yoccoz). The Department has a very strong base here upon which an area of excellence can be formed, and finding the right combination of new appointees to complement our current strengths is an important priority. The possibility of an appointment in dynamical systems exists if the candidates ties to differential equations or mathematical physics are sufficiently strong.

PROBABILITY. This is a subject where interaction with many other areas, both in the sciences and elsewhere, are taking place at a rapid rate. Professor Rao has a long and well recognized record of research for over four decades in this area, and during this decade he successfully supervised several strong Ph. D. dissertations. Professor U. Keich, who joined the faculty this year from Cal Tech, also works in this area, and Professor Poon has also become increasingly active in some aspects of probability. This subject has a much larger representation at most UC campuses; for example, at UCSD there are at least six probabilists at the full professor level. As in Basic Analysis, this an area where building is needed to maintain a historic strength of the Department, to be competitive with other UC campuses and similar institutions, and to provide attractive options for its graduate students.

TOPOLOGY. During the nineteen sixties there were several important breakthroughs that enabled mathematicians to obtain a great deal of information about the topology of high dimensional objects. However, the center of activity in geometric topology during the eighties and nineties has been the topology of three and four dimensional spaces. The dramatic progress during this time is evident from the works of Fields Medalists W. Thurston (1982), S. Donaldson and M. Freedman (both 1986), V. Jones and E. Witten (both 1990) and C. McMullen and M. Kontsevich (both 1998). Furthermore, there are strong reasons to believe that much more can and will be done in the area. Several major problems in low dimensional topology are still open, the progress over the last two decades had considerable motivation mostly from other fields and such interactions should continue to bring fresh motivations and new techniques, and the visual appeal of low dimensional topology will continue to be attractive to mathematicians. The institution of the F. Burton Jones Chair in Topology made the Department quite visible in the area, and finding a new candidate for this position is a current priority. The appointments of Professors X.-S. Lin and R. Schultz added even more visibility for the Department in geometric and algebraic topology. Portions of the work of Schultz are closely tied to the work of Thurston, Donaldson and Freedman, and there are strong connections between the work of Lin and the results obtained by Freedman, Jones, Witten and Kontsevich. Activity in topology here has benefited greatly from interaction with faculty in mathematical physics, differential geometry, and representation theory, and these resources are potentially attractive to others. Emphasis on filling positions in topology will be on areas related to the interests of the Jones Chair appointee as well as low dimensional topology. There is considerable faculty sentiment about realizing the great potential here for building a focus of excellence if action is taken promptly.

DEPARTMENTAL FIVE YEAR PLAN

The first phase of the proposed expansion would be to a faculty with 39 members. Here is a more detailed summary of the proposed sequence of searches.

CURRENT YEAR

22. The Jones Chair in topology
23. Junior position in geometry
24. Open position in algebra or analysis

SEARCH FOR 2000-2001

25. Position in area not filled by 24
26. Junior position in geometry/topology
27. Combinatorics or another applied/applicable area

SEARCH FOR 2001-2002

28. Analysis
29. Algebra
30. Applied and related areas

SEARCH FOR 2002-2003

31. Geometry/topology
32. Algebra
33. Applied and related areas

SEARCH FOR 2003-2004

34. Geometry/topology
35. Analysis
36. Algebra

SEARCH FOR 2004-2005

37. Geometry/topology
38. Analysis
39. Applied and related areas

Some explanatory comments

Questions about the levels of such appointments were discussed earlier. Past experience strongly indicates that some flexibility in area will promote the hiring of the best possible candidates, and this is one reason why the areas for the positions are stated broadly. To elaborate, algebra essentially encompasses algebraic geometry, commutative algebra and Lie theory, while analysis covers basic analysis, differential equations, numerical analysis, mathematical physics or probability. Finally, there will generally be some limited priorities within each broad area, roughly based upon the time elapsed since the most recent appointment in a given subarea.

Need to fill vacancies as they arise

Despite the large number of retirements this decade, the age profile of the Department also suggests the possibility of two or three retirements between now and 2005, and normal turnover suggests that another one or two faculty members may leave for other reasons. In view of the critical shortages of faculty that already exist, the Department will ask for the return of all such positions in the strongest possible terms.

Departmental needs for temporary faculty

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. The help of higher administrators in this connection is gratefully acknowledged along with the hope that such assistance will continue so that the Department can fulfill its teaching obligations satisfactorily. 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, several features of the Visiting Assistant Professors program within the Department need urgent attention. A survey of the other UC Mathematics Departments in 1998 indicated that the salaries and workloads for our Visiting Assistant Professors are substantially less favorable than at other UC campuses, and the same could be said for other institutions with which we should be competitive. Appointments of new Ph. D. mathematicians to positions with heavier than normal teaching loads, low salaries and expectations of research productivity have been criticized strongly within the American Mathematical Society, which is the major professional society for research mathematicians within the U. S., and a continuation of the status quo carries the risk for the Department and University. The May, 1999, extramural review also mentioned several points that had been previously raised within the Departmental and in discussions with the Dean's office, and the Department would like to act upon these points at the earliest possible opportunity.

Here are some relevant quotations from the review:

A well thought out program of postdoctoral appointments (see below) also enhances the faculty scholarship. ... Temporary appointments in a research department should, if at all possible, enhance the research and scholarship of the department and improve the scholarship and learning of the appointee. Therefore, we strongly encourage a thoughtful (teaching) postdoctoral program. Young mathematicians, less than three years beyond the doctorate, selected with specialty in areas of strength in the Department, are one of the most cost effective ways to improve the scholarship of a Department and assist with teaching (without permanent financial commitment). It is reasonable to have at least 3–5 new appointments each year or a group of 6–10 at any one time. The majority of these should be funded within the regular budget and should be hired not later than the period January-March in the year they are to start. If there are two faculty members in an area, then each year 1–2 postdocs can make a tremendous difference to the activities of that group. This can be done with the regular entry of new people and at a relatively safe commitment to the Department and the University. These are sometimes referred to as teaching postdocs; however, their teaching duties should be no more than those of the research faculty, and, if possible, less will make the positions more competitive [current teaching loads for our Visiting Assistant Professors are one third **more** than for regular faculty]. *Most important is not to hire late, after the best have accepted positions elsewhere.*

The criteria for selecting Visiting Assistant Professors include strength of research accomplishments and potential for future growth; none of these figure in the appointments of lecturers, yet the salaries of Visiting Assistant Professors are only slightly more than lecturers with a Ph. D. degree. It seems appropriate that the salary level for such visiting appointees should be at least equal to that of an Assistant Professor I.

The review also suggested that the Department follow the lead of certain other mathematics departments and plan emphasis years in which there would be preference for temporary appointments in a particular area. This seems like an excellent idea, but in order to realize this it will be necessary to receive authorization to make temporary appointments at the same time as regular appointments. By the time the Department is able to search for Visiting Assistant Professors, many of the top choices for such positions already have found positions elsewhere.

Departmental needs to support new faculty

The need for more physical space

An increase in the faculty will also require corresponding increases in infrastructure and support. Even before the precipitous increases in enrollments, the Department had significant problems due to inadequate space and aging buildings. In the summer of 1997 the Department took steps to use its allocated space more efficiently and to relieve some of the extremely poor office space available to our teaching assistants, but the problems are returning and threaten to become a critical issue for the entire University. Increases in faculty and other personnel are bringing us to a level of unbearable discomfort. It will be possible for the Department to find office space to house all the additional regular faculty members projected in the hiring plans for the next three years, and there will also be room for additional faculty expansion, but by 2005 the Department will almost certainly run out of room to house graduate TAs and supplementary lecturers with similar work responsibilities. There may be some room for having people share desks, but many of the cubicles for our graduate students are too small for that. Reducing the space for retired faculty has repeatedly been suggested, and the Department has taken steps in this direction, but the allegedly official view that retired faculty should not be allocated any space is strongly opposed by the faculty and in any case is beneath the standards of professional courtesy one expects in a first rate university system. Common space for the Department is also a problem. Much of our main office space is now employed for multiple purposes that are not necessarily compatible. For example, the reading room containing new periodicals doubles both as a conference and examination room as well as the location for the auxiliary xerox machine. The Chairman's discussion room doubles as the location of the office typewriter. The faculty lounge also contains kitchen facilities and faculty mailboxes, and the increase in the number of regular and temporary personnel make the room particularly uninviting for the sort of interaction one normally sees in the lounge of a Mathematics Department. The space to be occupied by a newly hired personnel assistant also contains the fax machine for general use, the supply room is very cramped because many file archives are stored there, the graduate student mailboxes share the same tight quarters as the main xerox machine and its associated work area, and the mailboxes for undergraduate paper graders are sitting unprotected in the hallways (the latter may be illegal but there is no place else to put them). One cannot expect separate rooms for each of these purposes but it should be clear that the tightness of space is now interfering with faculty and staff's abilities to complete their jobs.

The extramural review committee also commented on the space problems of the Department in its report:

Currently ... this is the only space provided to the graduate students and is intended to be used for their office hours with the undergraduates as well as their private space for studies. These needs are in conflict and currently these rooms are not providing either function effectively. When one graduate student is holding an office hour attended by more than one undergraduate, the effect is often a distraction to all in the room. Because of this, most graduate students use this space only for their required office hours. This crowding has a negative effect on the sense of community among the graduate students as well as on the availability of help by TAs to the undergraduates.

The Department is engaged in a substantial recruitment program for graduate students as TAs to staff a dramatic increase over the past two years in the mathematics lower division courses. Attracting quality graduate students to their program is important both to staff these additional lower division sections as well to accompany the projected growth in a masters program and faculty FTE. Also recruitment is difficult in the current very competitive market. Frequently good domestic students travel to several universities at university expense to view the campus and department offerings. The current graduate student office arrangements are not comparable to those provided by the competition. Improvements in office space would have an immediate positive effect on many aspects of department life, cutting across undergraduate instruction, TA duties, graduate student duties and maybe most important recruitment of graduate students.

In addition to the grad student needs, the growth plan for Mathematics will require substantial additional faculty office space and space for larger computing facilities. Even with the current FTE the space allocation is very tight and in many cases not ideal. The existence of vacant office space on the fourth floor of Sproul Hall was seen by the review committee as a harsh irritant to many members of the department. Allocating these offices to Mathematics would be a good beginning to resolving some of the needs in Mathematics.

Needs for additional office personnel

With respect to office staff, one particular area of need is additional support for document preparation like technical typing; up to now this has been done by the office staff member who handles tasks associated to the graduate program, but the amount associated to the latter has grown enormously in recent years and in the future it will not be possible for the person in that position to handle technical typing work. The Department office has functioned well up to now, but the increased demand for personnel processing and schedule adjustments, and increasing difficulty in dealing with dissatisfied students, are straining the staff to its limits. Another person will soon be needed to handle the increasingly complex advising and registration processes. Other future needs will include computer support with respect to computer operations, instructional computing and document preparation. In considering these numbers and the ratio support staff to instructional staff, it is important to remember that the Department is likely to have a substantial number of instructional personnel beyond regular and visiting faculty and graduate students for the foreseeable future.