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DEPARTMENT OF MATHEMATICS

COLORADO STATE UNIVERSITY

CCHE REVIEW

MARCH 1996

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EXECUTIVE SUMMARY

Overall Assessment of Quality. During the period under review, the Department of Mathematics continued its steady rise towards national and international prominence. Peer comparisons indicate that the Department is in the upper quartile in terms of contract and grant production and degree production. External reviewers have lauded the Department's program in applied/computational mathematics as one of the nation's best. Recent graduates of the Ph.D. program have received prestigious postdoctoral appointments. GRE scores of entering graduate students are now significantly higher than the national averages for mathematics.

The Department has continued a tradition of attention to quality service instruction. Student and external evaluations point to a high level of satisfaction with almost all courses. The undergraduate mathematics major program continues to be well received by the students and continues the quality which led to a CCHE Excellence award in 1983. The quality of entering undergraduate students has improved significantly in the last two years.

Anticipated Program Changes. Instructional and research programs will change gradually to reflect an increasing emphasis on the mathematics of information intensive science--the recognition and description of patterns in massive quantities of data. Instructional programs will continue to be restructured to take advantage of technology and to give the student increased involvement in the learning process. University enrollments are projected to increase by approximately 15% in the next five years. This will result in substantial increases in enrollment in virtually all of the Department's courses and programs.

Support and Resources. Peer comparisons indicate that the Department is far more efficient than the average mathematics department. The University will continue to rely upon the Department for this efficiency. However, mathematics research and mathematics instruction are continuing to undergo changes which require additional resources. Efficiency in M141 has been achieved at the expense of quality. An immediate investment of \$70K is needed to hire two postdoctoral teaching fellows to reduce section sizes. Research and instruction in the mathematics of information intensive science will require increased use of technology to recognize and visualize patterns in massive quantities of data. Additional high end graphics workstations, software and support staff is likely to cost an additional \$80K per year. Student-centered instruction is more labor intensive than large lectures. While innovative design can make heavy use of undergraduate assistants, approximately \$80K per year will be required to implement the necessary changes. If University enrollment increases are at the level of 15% as projected by some sources, the Department will need an increase in budget of approximately \$115K. These dollars can be used to hire a junior faculty member and two postdoctoral teaching/research fellows which will enhance the Department's nominated Program of Research and Scholarly Excellence in Applied/Computational Mathematics as well as meet the enrollment increases.

I. OVERVIEW OF THE DEPARTMENT AND ITS PROGRAMS

A. Brief History of the Department

The Department of Mathematics was among the departments when Colorado Agricultural College published its first catalog in 1878. Until 1947 the Department was solely a service department, offering courses to students in other degree granting departments. The first baccalaureate degree in mathematics was awarded in 1947. The first M.S. degree was awarded in 1958. The first Ph.D. degree was awarded in 1965.

The first statistics courses at Colorado State University were offered in the Department of Mathematics in 1924. The first computer laboratory at Colorado State University was organized

within the Department of Mathematics in 1958. In 1962 the Department was renamed the Department of Mathematics and Statistics and organized with distinct Mathematics and Statistics Sections. In 1971 the Statistics Section became the Department of Statistics, a Computer Science Section was created and the name was changed to the Department of Mathematics and Computer Science. In 1973 the Computer Science Section became the Computer Science Department and the name reverted to the Department of Mathematics.

In the 30 years since awarding its first Ph.D., the Department of Mathematics has become a mature, comprehensive research department. The current faculty, all of whom hold the Ph.D. or its equivalent, have produced more than a thousand publications and have given invited lectures in 25 countries and on 6 continents. The Department has developed concentrated research strength in algebra/discrete mathematics and applied/computational mathematics.

B. Goals from the Previous Report

In the sequel, the following departments are used for purposes of comparison:

University of Illinois
 Purdue University
 Ohio State University
 University of Texas
 Texas A&M University
 University of Arizona
 Arizona State University
 Iowa State University
 University of Oklahoma
 Kansas State University

The first eight of these, along with Colorado State University, were selected by the Department of Mathematics at Texas A&M as its peers for a comparison study done in 1992-93. We have added the University of Oklahoma and Kansas State University. The first four (Illinois, Purdue, Ohio State, and Texas) are generally regarded to be among the top 30 mathematics departments in the nation. Since there are 172 mathematics departments which offer the Ph.D. degree, these four are in the top 17% of mathematics departments.

Resource and Staffing Goals.

"The overall resource and staffing goal of the Department of Mathematics is to achieve a consistent and predictable level of funding and staffing consistent with the goals and responsibilities of the Department ."

Figure 1 traces the Department's resident instruction budgets and student credit hour production as a percentage of the same categories for the College of Natural Sciences over the past two decades. A more detailed discussion of these data appears in Appendix D. The figure shows that the Department's share of the resources lags behind its share of the instructional load. It is reasonable to expect the Department of Mathematics to provide instruction efficiently. However, in the decade from 1979-80 to 1989-90, heavy instructional loads and inadequate budgets created severe problems for the Department. In the period under review, the Department has achieved a sustainable balance between its instructional load and its resources. However, the balance has been achieved at the expense of quality of instruction in some courses.

Figure 1: Student Credit Hour Production and RI Budgets

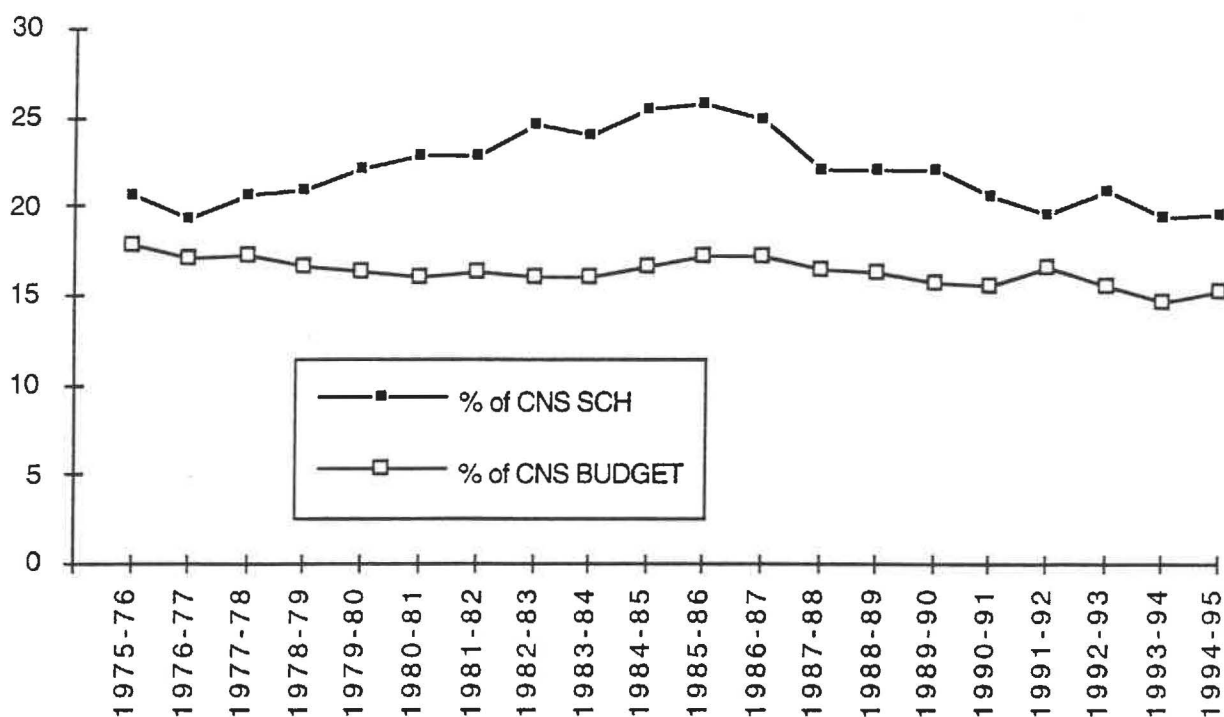


Table 2 presents comparisons from a study conducted by Texas A&M University.

Table 2: Instructional Salaries per Registered Mathematics Student: Fall 1992

<i>Department</i>	<i>Math Course Registrations Fall 1992</i>	<i>Instructional Salaries 1992-93</i>	<i>Salaries per Registration</i>
Illinois	9,528	\$5,723,898	\$601
Ohio State	13,150	7,550,000	574
Arizona	9,200	5,100,000	554
Purdue	12,000	6,300,000	525
Arizona State	7,800	3,500,000	449
Iowa State	7,660	3,357,818	438
Texas	12,000	4,500,000	375
Texas A&M	12,491	4,376,639	350
Colorado State	8,549	2,624,900	307
Average			\$464

The data for 1995-96 would likely be very similar. These data make clear that the Department performs its instructional mission with extraordinary efficiency. The efficiency is achieved through the design of the Individualized Mathematics Program, through the use of graduate teaching assistants to teach sections of calculus, and through the use of large lectures. While the Department can document that the first two of these devices is very effective, the use of large lectures without recitations provides inadequate quality of instruction.

At the time of the previous report, the Department was heavily dependent upon faculty leaves without pay, turnaway funds, and revenues from the Division of Continuing Education to support undergraduate hourly workers in the Individualized Mathematics Program, supplement GTA stipends, and cover operating expenses. In the period covered by this report, the following major changes in budget patterns have occurred:

- a. Faculty leaves without pay, once amounting to \$150K per year, have fallen to virtually nothing and are no longer a significant source of discretionary funds..
- b. Turnaway funds, amounting to \$120K per year, have become a part of the base budget and are now a more predictable element of the budgeting process.
- c. Continuing education revenues, once amounting to \$80K per year, have nearly disappeared as a result of changes in policies for the Division of Continuing Education.
- d. External research funding has increased dramatically. Indirect cost revenues returned to the Department for departmental administration now amount to \$40K per year.
- e. Expenditures associated with computing have increased from \$40K per year to \$140K per year.

These changes have resulted in a more predictable revenue pattern. However, the decrease in faculty leaves and elimination of much of the revenue from Continuing Education activities has necessitated reduction in instructional staff. It has also been necessary to reallocate resources used for instructional staff to computing hardware, software, and support. The resulting reductions in staffing are reflected in Table 3.

Table 3: Faculty, Graduate Assistant and State Classified Staffing

	89-90	90-91	91-92	92-93	93-94	94-95
Faculty	31	31	30	29.5	29	27.5
State Classified	4	4	4	4	4	4
GTA	42	43	42	38	37	35

*reductions
in faculty
and GTA's*

The typical teaching assignment for faculty members engaged in research has remained constant at 12 credit hours per year. These are hours spent in front of the classroom and exclude thesis, supervision, seminars, and individualized instruction. Teaching loads at CSU are higher than the national average for mathematics departments with comparable research missions. About 35% of such departments have teaching loads which consist of 2 courses in one semester and one course in the second semester.

As reported by OBIA, the average faculty teaching load of 666 student credit hours in 1994-95 was 19.3% higher than the average for the College of Natural Sciences. This teaching load is calculated by dividing the total academic year student credit hour production by the number of FTE faculty--including GTAs figured at 0.5 FTE per GTE. The teaching load increased by 4% over the review period.

Professor Painter has entered a transitional appointment beginning with the 1995-96 academic year. Professor Deal ended his transitional appointment at the end of 1994-95 academic year. Professor Prenter plans to end her transitional appointment at the end of the 1995-96 academic year. We have recently hired three replacement faculty members. Gerhard Dangelmayr arrived in Fall 1995, Wai Chin will arrive in Fall 1996, and Gary McGuire will arrive in Fall 1997. A new position is advertised for Fall 1996.

Neglecting new initiatives and needed enhancements, which will be discussed later in this report, we estimate that an additional \$70K per year would be required to provide smaller classes to bring the instructional quality of M141 up to minimal standards. Two post-doctoral fellows would reduce the student faculty ratio from 300 to 1 to 100 to 1.

how?

Conclusion. The goal of bringing predictability and stability to the budget has been achieved. but at a level of overall funding inadequate to fully support the Department's instructional programs.

Graduate Program and Research Goals.

"The Department aspires to have its overall research and graduate programs ranked among the top 40 in the nation in terms of quality."

What are the benefits to the University which are provided by a Department of quality? Certainly among those are the ability of the department to attract external funding, the ability of the department to attract students, and the ability of the department to place students in attractive positions when they graduate.

annual expenditures ?

Table 4 presents data comparing external contract and grant activity of departments in the peer group of selected state universities described above. The data are for academic year 1994-95. The Department's contract and grant support for 1994-95 fell into the following categories:

Federal mathematical research support (NSF, DOD, NSA)	5 projects	6 faculty
Mathematics education support (DOE, CCHE)	4 projects	2 faculty
Industrial research support (Glaxo, IBM, Loral, Martin-Marietta)	4 projects	4 faculty

Table 4: Contract and Grant Activity (1994-95)

<i>Department</i>	<i>C & G Dollars per Faculty</i>
Arizona	34,212
Purdue	33,385
Colorado State	25,370
Arizona State	20,796
Ohio State	20,520
Texas A&M	20,378
Texas	17,593
Illinois	14,743
Oklahoma	10,588
Kansas State	9,509
Iowa State	8,432
Average	\$19,593

Table 5 presents comparisons of degrees awarded for the same peer group as above.

Table 5: Mathematics Degrees Awarded (1994-95)

<i>Institution</i>	<i>Faculty</i>	<i>B.S. Degrees Per Faculty</i>	<i>M. S. Degrees Per Faculty</i>	<i>Ph.D. Degrees Per Faculty</i>	<i>Degrees/ Per Faculty</i>
Texas	66	1.94	.52	.17	2.62
Illinois	80	1.64	.46	.21	2.31
Colorado State	28	1.57	.43	.14	2.14
Ohio State	68	1.29	.37	.18	1.84
Purdue	62	1.08	.23	.26	1.56
Arizona	61	1.23	.15	.10	1.48
Iowa State	47	0.85	.15	.15	1.15
Texas A&M	72	0.65	.26	.10	1.01
Arizona State	55	0.53	.24	.09	0.85
Oklahoma	28	0.36	.36	.07	0.79
Kansas State	32	0.50	.13	.16	0.78
Average					1.50

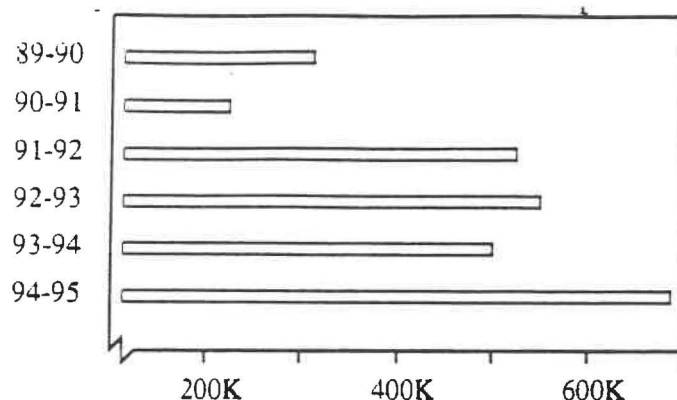
All 16 of the Department's Ph.D. graduates in the review period are employed. In the past year, the Department placed two of its four Ph.D. graduates in prestigious post-doctoral appointments at Michigan and MIT. The other two graduates took teaching positions at four-year colleges. Of the other 12 Ph.D. graduates in the review period, 3 are employed in industry and the other nine are employed in academic positions. Three of the academic positions are at foreign institutions. The domestic academic positions are at institutions including Washington State, Colorado School of Mines, and the University of Southern Colorado.

There are other measures of quality which have less to do with the benefits provided directly to CSU and more to do with the Department's contribution to the discipline. In 1994-95, the CSU Mathematics Faculty gave 68 invited lectures in 18 countries. While we have no comparative data, this gives another clear indication of the energy and reputation of the faculty.

Conclusion. By objective productivity measures of contacts and grants and degree production, the Colorado State mathematics faculty is similar to departments widely regarded to rank in the top 30.

"The research and graduate programs in applied/computational mathematics should be ranked in the top 10."

The applied/computational research program was nominated by the Department for designation as a Program of Research and Scholarly Excellence. To support that nomination, the Department solicited reviews of the program by 9 distinguished researchers in the area. Although the reviewer's responses (see Appendix C) are not easily quantifiable, they clearly convey that the program is very well regarded by experts in the field. Much of the contract and grant funding in the Department is due to the applied/computational group. Figure 5 gives the contract and grant expenditures for the years under review.

Figure 6: Contract and Grant Expenditures

The expenditures for the last three years were 66% higher than the expenditures for the first three years. It should be noted that during this time period, funding for mathematical sciences research has become increasingly difficult to secure. Funding for the applied/computational group now averages more than \$50K per faculty member.

Unfortunately, it is very difficult to obtain comparative data for applied mathematics programs. There is no consensus about the way applied mathematics should be defined.

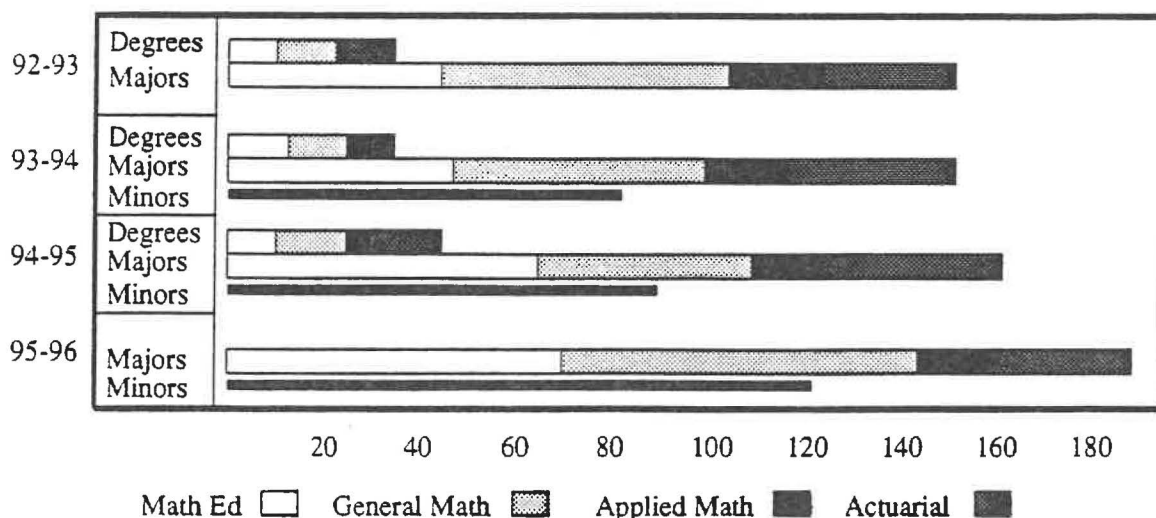
Conclusion. The applied/computational mathematics program is very well regarded and contract and grant output is quite good and increasing, but there are no studies which can be used as a basis for a ranking.

Undergraduate Major and Minor Program Goals.

"The Department aspires to have the best undergraduate major program within a 1000 mile radius."

Figure 7 indicates the number of majors and degrees in each of the Department's four undergraduate concentrations.

The data indicate the beginning of an upward trend in the number of undergraduate mathematics majors and minors. As indicated in Table 5 above, the Department has a high level of degree production compared to peers.

Figure 7: Majors, B.S. Degrees, and Minors

We have only incomplete data on the placement of graduates. We do know that approximately 90% of our graduates from the Mathematics Education Concentration take positions in secondary schools. Anecdotal information indicates that these graduates often move rather quickly into leadership positions. About half of the graduates from the actuarial concentration obtain employment as actuaries. The other half take positions with financial services companies as loan officers, benefits officers, etc. Graduates from the applied mathematics concentration often take positions as software development companies. Approximately 15% of our graduates enter graduate programs.

Data presented later in this report will address the quality of the undergraduate program as perceived by the current majors. These data will demonstrate a high level of satisfaction.

"The department should play a leadership role in the improvement of training of secondary school mathematics teachers."

Key elements of the Department's leadership role over the period under review have been the following projects and activities:

Western Mathematics Scholars. Funded by NSF. This was an intensive sequence of month long summer workshops over a period of three summers. There was emphasis on both content (e.g., discrete mathematics) and pedagogy (e.g., small group discovery).

Colorado Mathematics Pacesetters/Northeast Colorado Mathematics Project. Funded by CCHE. This is a sequence of summer workshops with academic year follow-up. The emphasis is on student-centered learning, manipulatives, assessment, and technology.

Discrete Mathematics Instruction and Cooperative Learning. Funded by NSF. This is a pre-service experience for prospective secondary teachers. Mathematics education students learn discrete mathematics in M335 and served as facilitators for students in M130.

Rocky Mountain Teacher Enhancement Consortium. Funded by NSF (to CSMATE). A project for pre-service training of secondary teachers. CSU courses (e.g., M369 and M470) are under revision to better model appropriate teaching/learning environments.

Colorado Integrated Mathematics Initiative. Funded by the Gates Foundation and CCHE. This is a project designed to help schools and school districts update and improve their mathematics curriculum. During the first three years teachers from 14 school clusters (consisting of a high school and one or more feeder middle schools) have been trained to implement new curricular materials.

Adventures in Supercomputing. Funded by DOE. A project to link K-12 electronically with higher education and the internet.

Colorado Council of Teachers of Mathematics. Duane Clow is President of this organization of several thousand K-16 mathematics teachers.

International Society for Exploration of Teaching Alternatives. Kenneth Klopfenstein was recently named a distinguished fellow.

"The Department should explore the use of instructional formats which provide more student involvement in the learning process."

Several courses have employed student active teaching formats. Among the collaborative learning methods employed are the 'group notebook technique used in M130: Mathematics for the Social Sciences, the group projects used in M335: Projects in Applied Mathematics, peer evaluation in M369: Linear Algebra, and the group MAPLE labs assigned in M160-M161-M261:

lots of
initiation
in section
support

Calculus for the Physical Sciences I, II, and III. We use a wide range of instructional technology in our classes, including graphing calculators in M155: Calculus for the Biological Sciences and M229: Linear Equations and Matrices, MAPLE in M160-M161-M261, and Geometer's Sketchpad in M470: Euclidean and Non-Euclidean Geometry. Detailed descriptions of these courses is beyond the scope of this report.

"The Department should improve its efforts to recruit high ability students."

The successful CSU Math Day program has been augmented by a Mathematics Scholarship Program. Funds contributed by the Luckasen family and funds contributed as a memorial to Arne Magnus are used for this purpose.

Conclusion. While the Department has made substantial progress towards each of the subgoals, there is insufficient data to confirm the achievement of the overall goal.

Undergraduate Service Instruction Goals.

"The Department aspires to serve the mathematics instruction needs of all CSU students with courses of high quality but offered at the lowest cost consistent with sound educational principles."

"The Department should participate in the national movement to revise the content and emphases of calculus."

The Department has implemented use of the Maple V software package in M160, M161, and M261. Students in these courses work on projects in small groups using the software. Projects are capped by written reports.

Calculus for Biologists (M155) now has a higher enrollment than M160, reflecting the popularity of biological science majors. M155 is now taught using a "reform" text wherein calculus topics are motivated by biological contexts. Topics are explored in small groups using graphing calculators.

The Department should implement a new generation of procedures and materials for the Individualized Mathematics Program.

The Individualized Mathematics Program has undergone continual and substantial revision--facilitated by the computer management system implemented at the beginning of the review period. The IMP program has been reviewed by two external experts on instruction, Neil Davidson of the University of Maryland and Jim Cooper of the California State University--Dominguez Hills, and has received very positive reviews from both. They view the IMP system as an innovation of major national significance.

Conclusion. With the exception of M141, much progress has been made. However, there is still much to be done. Some of that work is outlined in subsequent sections of this report.

C. Departmental Statistics

	<u>1989-90</u>	<u>1990-91</u>	<u>1991-92</u>	<u>1992-93</u>	<u>1993-94</u>	<u>1994-95</u>
FTE Faculty	29.92	28.11	25.22	30.65	30.25	26.41
FTE Support Staff	8.32	5.36	2.95	3.88	4.18	2.83
Credit Hours Produced						
Lower Division	24,594.0	21,797.0	20,258.0	22,781.0	21,047.0	21,533.0
Upper Division	4,177.0	3,691.0	3,432.0	3,290.0	3,476.0	3,175.0
Graduate I	1,120.0	1,108.0	1,171.5	1,176.5	1,203.0	1,031.0
Graduate II	236.0	183.0	161.0	218.0	223.0	275.0
TOTAL	30,127.0	26,779.0	25,022.5	27,465.5	25,949.0	26,014.0
Average Faculty Salary	\$47,934	\$51,317	\$53,847	\$55,127	\$57,506	\$60,012
Student/Faculty Ratio	21.40	21.88	21.88	23.41	20.75	22.19
Average Class Size						
Lecture	94	77	33	37	30	33
Laboratory	26	22	19	12	18	30
Avg. Faculty Teaching Load	642.09	656.35	656.41	702.26	622.58	665.66
Number of Courses Offered						
Lower Division	29	28	29	29	28	29
Upper Division	30	31	28	26	28	26
Graduate I	31	32	34	35	35	34
Graduate II	7	9	6	5	7	6
TOTAL	97	100	97	95	98	95
Number of Degrees Granted						
B. Science	39	52	42	41	28	39
M. Science	14	21	12	9	13	13
M. Arts for Teachers	0	0	0	0	0	0
Doctor of Philosophy	1	1	5	2	6	2
TOTAL	54	74	59	52	47	54
Number of Majors-Fall Hdct						
Undergraduate	229	201	166	154	137	162
Graduate	56	52	54	56	58	57
TOTAL	285	253	220	210	195	219

Note: For 1989-90, FTE figures were budgeted. Since 1990-91, figures are actual.

D. List of Academic Programs

Minor in Mathematics

Bachelor of Science in Mathematics

General Mathematics Concentration

Actuarial Science Concentration

Applied Mathematics Concentration

Mathematics Education Concentration

Master of Science in Mathematics

Master of Science

Master of Science with Outside Specialization

Master of Science with Specialization in Applied Mathematics

Doctor of Philosophy in Mathematics

II. ASSESSMENT OF THE DEPARTMENT PROGRAM(S) WITHIN THE CONTEXT OF THE DEPARTMENT, COLLEGE AND UNIVERSITY MISSION

GOAL 1: TEACHING AND ADVISING

LOWER DIVISION INSTRUCTION.

Mathematics courses taught at the 100 and 200 levels serve the needs of both majors and non-majors.

Objective. The Department aspires to serve the mathematics instruction needs of all CSU students with courses of high quality but offered at the lowest cost consistent with sound educational principles.

The challenge of numbers. There are 8,000-9,000 registrations for mathematics courses each semester. Approximately half of the majors in the University require calculus instruction at some level. An understanding of the Department's instructional program must begin with an appreciation for the sheer volume of instruction. Since there are 28 mathematics faculty members, there are approximately 300 registrations per faculty member each semester. Serving students in these numbers would be a challenge even if we had no majors and no research responsibilities. As noted elsewhere in this report, we have more majors and more research activity than the average for mathematics departments.

That these courses are delivered in an overall efficient manner is evident from Table 2, Page 3. The Department is meeting the demand for mathematics instruction with essentially no turnaways. The efficiency of the Department of Mathematics course offerings is achieved through the unique design of the Individualized Mathematics Program, through the extensive use of graduate teaching assistants to teach calculus and through the use of large lectures in selected calculus courses.

Instructional innovation and reform. The 20 year old Individualized Mathematics Program is the longest running, large scale, non-traditional instructional system in the nation. During the review period the system underwent extensive revisions. These have led to improved performance of students, reduced frequency of cheating, and greater campus acceptance of the system. The system has been reviewed by two external experts, Neil Davidson, Professor of Instruction and Curriculum at the University of Maryland, and James Cooper, Professor of

Educational Psychology at California State University--Dominguez Hills. Both expressed enthusiasm for the philosophical underpinnings and the quality of the system. With support from the Commission on the Undergraduate Experience, the Department developed M180, a version of M120 and M121 called "Algebra in Context" which uses applications based problem solving, collaborative groups, and new methods of assessment. Features of the M180 course are being prepared for implementation into the IMP program. The Department is also proceeding with plans to integrate MATH 117 (an informal remedial course) into the IMP framework as a laboratory supplement to M120.

Consistent with the recommendations of national committees, the Department has initiated reform of M155, M160, M161, M261, M335, M340 (Introduction to Ordinary Differential Equations), M369, and M470. Several of these reforms were enhanced by interaction between the mathematics faculty and CSMATE. The changes include use of writing exercises, use of technology, and the use of student-centered activities in the classroom.

Quality of undergraduate instruction Virtually all CSU mathematics courses are evaluated using the ASCSU evaluation form. In almost all courses, mathematics majors comprise a minority of the students. Question 16 on the form asks: "Would you recommend the instructor to another student?" Table 7 presents the fractions of the student responses which fell into each category for the most recent semester.

Table 8: Student Evaluations (Spring 1995)

	SA	A	N	D	SD
Taught by Faculty					
300-400 Level	.60	.21	.10	.04	.04
100-200 Level	.52	.27	.09	.03	.08
Taught by GTAs					
100-200 Level	.56	.28	.10	.03	.03

These evaluations suggest that the students are generally quite satisfied with the quality of instruction offered by the mathematics faculty. Note that the graduate teaching assistants are as well-received as the faculty. The success of the graduate teaching assistants is due to careful selection as well as supervision and training.

The Department faculty is dissatisfied with the quality of instruction in M141. Large lectures with no recitations make implementation of instructional reforms very difficult. Some faculty are not yet satisfied with the use of Maple in M160, M161, and M261. Some of the difficulty with Maple lies in the software itself. The current version of Maple has presented both students and faculty with many frustrating idiosyncrasies. Special users manuals written by Jay Bourland and a new version of Maple, due in the very near future, should alleviate some of the difficulties. Some advocate replacing the use of Maple with the use of graphing calculators. Graduate teaching assistants in both M155 and M160 need more training, guidance, and support in implementing the new technologies.

UNDERGRADUATE MAJOR PROGRAM.

Objective. The undergraduate major program should be recognized as the best in the region.

Satisfaction of undergraduate majors. Almost two thirds of current undergraduate majors responded to a survey. The student evaluations are very consistent with the results of the survey of current undergraduate majors. The responses to the key questions were as follows:

"Have you been generally satisfied with your experience in your courses?"

yes!				no!
.41	.45	.07	.07	.01

"Do you feel your instructors have a high level of subject matter expertise in the courses they were teaching?"

yes!				no!
.72	.28	.00	.00	.00

"Were the methods of instruction used in your courses effective?"

yes!				no!
.27	.49	.11	.08	.04

"Were your instructors generally accessible and helpful?"

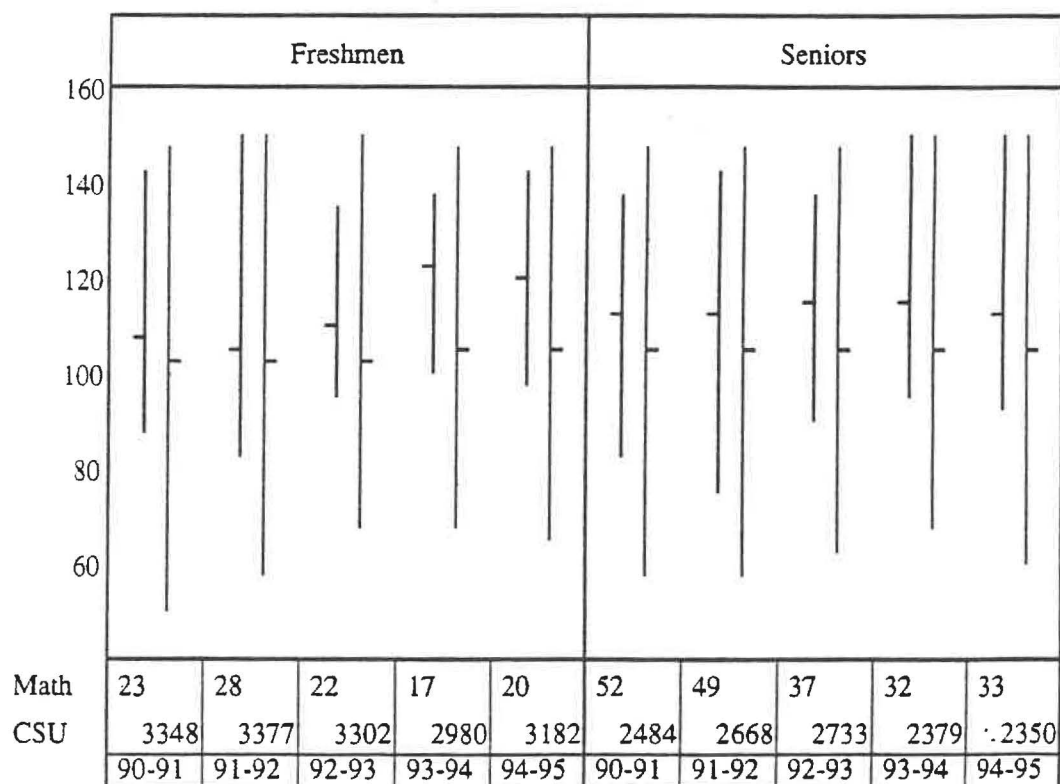
yes!				no!
.61	.25	.08	.03	.02

"Have you been satisfied with the advising provided by the department and your academic advisor?"

yes!				no!
.45	.31	.17	.06	.00

Quality of undergraduate majors. Figure 9 presents admissions index data for freshmen and seniors. Note that admissions index data is not available for many students who enter as transfer students.

Figure 9: CCHE Admissions Indices



The table indicates a significant improvement in the quality of freshmen entering the major program in the last two years. This coincides with the implementation of the Luckasen and Magnus scholarship programs. We note that the number of seniors is consistently higher than the number of entering freshmen. Many of mathematics majors come to the Department via internal transfer.

GRADUATE MAJOR PROGRAM.

Objective. The overall graduate program should rank in the top 10% nationally among departments of comparable size. The graduate program in applied/computational mathematics should rank in the top 10.

Quality of graduate instruction. Graduate student responses to Question 16 on the ASCSU evaluation from are tabulated below.

Table 10: Student Evaluations for Graduate Courses (Spring 1995)

	SA	A	N	D	SD
500-700 level	.57	.26	.07	.06	.04

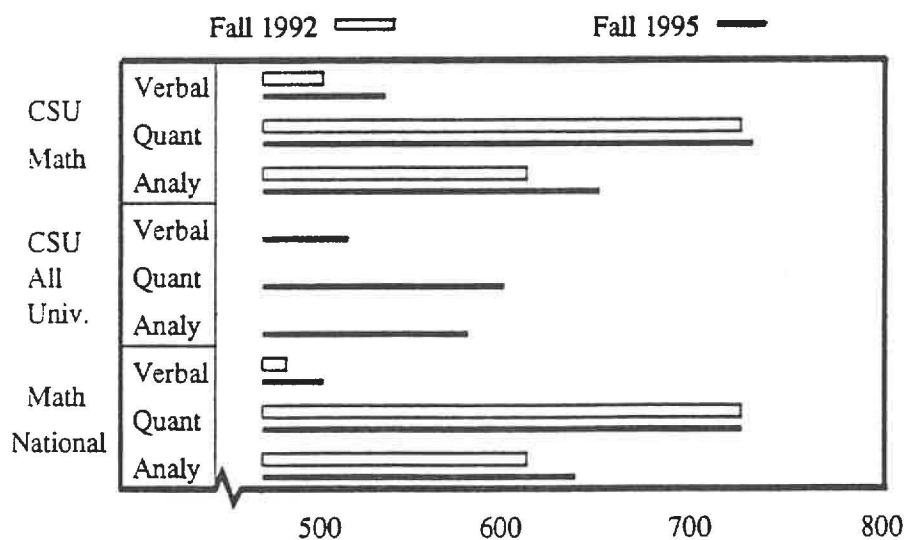
These are very similar to the undergraduate evaluations. The vast majority of students are satisfied with the quality of instruction.

Satisfaction of graduate majors. Current graduate students were asked to respond to a series of open-ended questions. There were many useful comments, but no responses which can be tabulated. Students expressed general satisfaction with their courses, their graduate teaching assistantship teaching and research assignments, and the quality, accessibility and friendliness of the faculty.

There were suggestions that more applied mathematics courses are needed. There were also suggestions that the implementation of Maple should have been handled more smoothly.

Quality of graduate majors. Figure 11 presents data on GRE scores.

Figure 11 : GRE Scores



dept GRE compare well with national averages, better than CSU

The GRE scores for CSU mathematics graduate students in Fall 1995 are higher than for Fall 1992. They are also higher than the national averages for mathematics and applied mathematics. They are much higher than the university averages for Fall 1995.

The Department's diversity objective has been to increase the percentage of graduate students who are female. Our own female undergraduate majors with the necessary talent and drive have been encouraged to pursue graduate studies. Female applicants to our program have been informed of the success of our female students. Our progress towards equality is summarized in the following table:

Table 12: Numbers of Graduate Students by Gender

	Fall 1991	Fall 1995
Total Graduate Students	54	57
Males	39	35
Females	15	22
Percentage of Females	28%	39%

For the first time, the entering class of M.S. candidates in Fall 1995 was evenly divided between male and female students.

STRATEGIES.

1. Continue the refinement of the IMP by integrating the content and format of M180 into the mini-courses. Seek external funding for the incorporation of cooperative learning opportunities into the IMP. Incorporate MATH 117 into the mini-course framework by using a supplemental laboratory for M120.
2. Continue reform of M160-M161-M261, making use of appropriate technology.
3. Continue reform of M155, making use of appropriate technology.
4. Redesign M141, making use of appropriate technology.
5. Redesign M340, placing greater emphasis on mathematical modeling..
6. Revise the curriculum to include a greater emphasis on the mathematics of information intensive science. Enhance the computing environment to accommodate this revision.
7. Participate in College and University efforts to develop core curricula.

GOAL 2: RESEARCH AND SCHOLARSHIP

Objective. The overall research program should rank in the top 10% among departments of comparable size. The research program in applied/computational mathematics should rank in the top 10.

Areas of emphasis. The Department has focused its attention on the development of two research groups of high quality. These are the group in applied/computational mathematics and a smaller group in the geometric and combinatorial aspects of algebra. For most of the next review period the Department should continue to seek enhancements for these two areas.

Table 13 indicates the age distribution of the current faculty.

Table 13: Age Distribution of Faculty

30-34	35-39	40-44	45-49	50-54	55-59	60+
3	2	3	1	5	10	5

More than half of the current faculty falls into the last two age categories. At approximately the end of the next review period, the Department will experience a surge in retirements. During the next review period, the Department should develop a longer-term hiring plan. This plan should include provision for the continuing evolution of the existing areas of strength. For examples, in recent years pattern analysis has emerged as a new emphasis within applied/computational mathematics and coding theory has gained emphasis within the area of geometric and combinatorial aspects of algebra. These modern research specialties can provide tools for interdisciplinary research involving problems where large quantities of data are generated and analyzed. Such problems are increasingly present in the biological, physical, and social sciences.

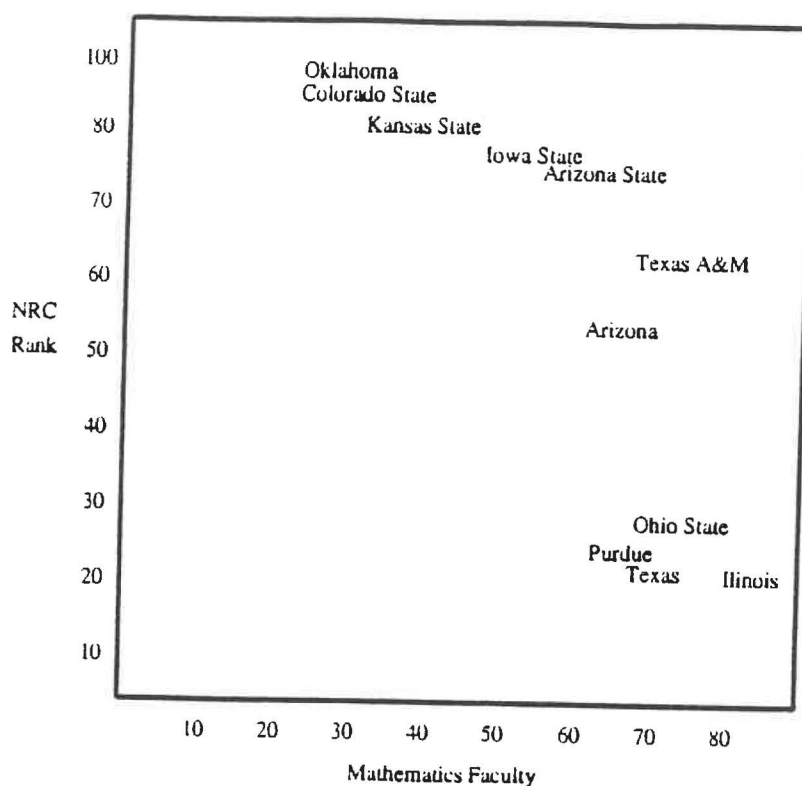
retirement incentives

On the other hand, the occurrence of several retirements will provide the Department with the opportunity to evaluate investments in other research areas which may complement existing strengths and enhance the Department's reputation. It will be a very exciting period in the Department's history where a dramatic reformation will occur.

Given the tightness of the employment market for new Ph.D. graduates, the Department will consider reallocate some graduate teaching assistantship positions to postdoctoral appointments. Such appointments can provide short-term professional development opportunities for young mathematicians both in research and teaching.

Reputations and productivity. Tables 4 and 5 on Page 5 indicate that, in terms of both contract and grant production and degree production, CSU Department of Mathematics ranks third among a sample of eleven state universities in the midwest and west. In terms of these two measures CSU faculty members appear to be much like faculty members at such universities as Purdue, Ohio State, and Illinois. The same data suggest that CSU faculty members are much more productive than faculty members at such universities as Kansas State, Oklahoma, and Iowa State.

In the recent National Research Council rankings of Departments by reputation, the average rank for the former three departments was 25th. The average rank for the latter three departments was 89th. It is perhaps surprising and disturbing then, that the NRC study ranked CSU 96th. There are, however, two rather simple explanations for the discrepancy between the objective measures of the Department's productivity and the Department's position in the NRC survey. First, the NRC reputations are rather well correlated with faculty size. Figure 14 indicates the NRC reputation ranks and the faculty sizes of the Departments used for comparison in this report.

Figure 14: Faculty Sizes and NRC Ranks

Second, the NRC surveys are dominated by opinions of pure mathematicians. This dominance is due to the fact that a high percentage of practicing academic researchers are in areas of pure mathematics. Departments with a heavy emphasis on applications of mathematics such as Texas A&M, Arizona, and Colorado State are thus underrated in such surveys. This problem has been recognized by the Society for Industrial and Applied Mathematics in its recent *Newsletter*. Obtaining reliable ratings of applied mathematics programs is difficult because applied mathematics is difficult to define.

As another measure of the quality of the Department's research faculty, two 1995 graduates of the Ph.D. program received prestigious post-doctoral appointments--Caryn Werner at Michigan and Johannes Tausch at MIT.

Applied/Computational Mathematics. The Department's emphasis on applications of mathematics is more than two decades old and is consistent with CSU's excellence in pure and applied science. This emphasis has placed the Department in a good position to participate in the growing area of information intensive science. This is an area involving the analysis and visualization of enormous quantities of data.

A year ago the Department solicited letters from 9 well-known mathematicians to support the nomination of the Applied/Computational Mathematics Program as a Program of Research and Scholarly Excellence. The reviewers were provided copies of faculty vitae together with a list of current projects. The reviewers and their principal comments were as follows:

P.M. Anselone (Oregon State University) Former Chair, Humboldt Fellow. "A valuable attribute of the research program at Colorado State is the healthy interplay between modern theory and concrete applications...It is not all that common in the United States".

Kenneth Atkinson (University of Iowa) Editor of several journals in numerical analysis and computation. *"You provided the vitae of those faculty and I have read over them. It is an impressive record. Everyone in the group has strong accomplishments and a number are distinguished"*.

Ciro Ciliberto (II Universita' Degli Studi Di Roma) Geometry Chair, One of three Italian geometers appointed to Alta. *"Rick Miranda is one of the most active and versatile algebraic geometers in our generation"*.

John Dillon (National Security Agency) Senior Scientist, Office of Mathematical Research. *"The Department of Mathematics at Colorado State University has a long tradition of excellence in its research and scholarly activities in the areas of applied and computational mathematics"*.

Werner Rheinboldt (University of Pittsburgh) Mellon Professor, Member of the David Commission, Humboldt Fellow, Past President of SIAM. *"I can say without hesitation that your department has a very fine unit in applied and computational mathematics which ranks favorably among similar groups around the country."*

Klaus Schmitt (University of Utah) Former Chair, Humboldt Fellow. *"I feel that your department has done a tremendous job in developing a broad research program in modern applied and computational mathematics and gained a very high national and international standing in the process"*.

E. E. Shult (Kansas State University) Humboldt Fellow, Regents Distinguished Professor. *"I can say it in one word: impressive! . . . This group is a wonderful asset to your University. Robert Liebler is the most original combinatorist in the world today"*.

Michael Todd (Cornell University) Leon C. Welch Professor, Dantzig Prize. *"To conclude, I would just like to reiterate that this is an outstanding group of mathematical scientists who have made excellent contributions on a wide range of important problems. Allgower and Georg are probably the world experts on efficient means to carry out the solution to systems of nonlinear equations by continuation"*.

Wolfgang Walter (University of Karlsruhe) Former President of GAMM. *"The research activities are highly impressive by their sheer quantity and variety of subjects. . . The department deserves full support for its research activities, even when the most critical standards are applied"*.

The Department's strength in applied computational mathematics has presented opportunities for interaction with industry. As indicated earlier, the faculty has received funding from IBM and Glaxo for computational projects. These opportunities will be pursued even more vigorously as federal funding shrinks.

STRATEGIES.

1. Continue to seek designation for the Program in Applied/Computational Mathematics (or a subset thereof) as a Program of Research and Scholarly Excellence.
2. Enhance research in the mathematics of information intensive science. Hire an additional faculty member in this area. Enhance the computing environment to accommodate research in this area.

3. Enhance the research program in the combinatorial and geometric aspects of algebra. Hire an additional faculty member in this area.
4. Continue to bridge the gap between the Department's accomplishments and its reputation by encouraging travel to professional meetings, hosting of conferences, and visiting professorships.
5. Conduct a long term research plan to be implemented beginning in five years.
6. Pursue industrial contacts more vigorously.

GOAL 3: OUTREACH

Objective. The department should play a leadership role in the improvement of training of secondary school mathematics teachers.

Connections with K-12 mathematics education. The teaching of mathematics is undergoing reform at both the K-12 and post-secondary levels. Three guiding principles of the reform movement are:

1. Students should learn mathematics by applying mathematics to problems in real world contexts.
2. Students should use computing hardware and software to explore, discover, and visualize mathematical concepts.
3. The student should be at the center of learning activities in the classroom.

Because applications and computation are key strengths of our department, because we have an undergraduate concentration in mathematics education, and because the College of Natural Sciences is committed to instructional development through CSMATE, it is natural that our faculty members have taken a leadership role in the reform of mathematics instruction in K-12.

As indicated earlier in this report, members of the CSU mathematics faculty have initiated or participated in several projects involving K-12 teachers. Members of the CSU faculty have held high level offices in organizations promoting improvement of teaching at all levels.

STRATEGIES

1. Hire two faculty in mathematics instruction. One of these would replace Professor Clow when he retires. The other would be a leader in the reform of the Department's calculus curriculum.
2. Explore the development of a program through which a secondary teacher might pursue a Ph.D. in Mathematics Education but be in residence at CSU and engage in research involving CSU instructional projects.
3. Create a Colorado State University Mathematics Consortium through which secondary teachers might become affiliated with CSU and assist in mathematics placement.

GOAL 4: UNIVERSITY COMMUNITY

Objective. The Department of Mathematics Faculty should collectively be encouraged and supported to pursue a broad range of activities in teaching, advising, research, and outreach. Each individual faculty member should have a job description which makes the best possible use of the faculty member's interests and abilities.

The typical teaching assignment for a member of the Mathematics Faculty is two courses per semester. However, the Department exercises a great deal of flexibility in teaching assignments. Teaching assignments are sometimes increased to accommodate student demand, to compensate for reduced activity in research, or to compensate for a lighter assignment in another semester. On the other hand, teaching assignments are sometimes reduced to accommodate heavy research loads, special administrative assignments, outreach activities, or major instructional development projects.

Objective. The Department should strive to increase the percentage of female graduate students and female faculty to 50%.

As indicated earlier in Table 12, substantial progress has been made in increasing the percentage of female graduate students. Of the current 28 faculty members, 4 are women. Two of these were hired in the period under review. One female faculty member is scheduled to retire at the end of 1995-96.

STRATEGIES.

1. The Department should continue to pursue a broad range of departmental missions.
2. The Department should continue a policy of flexible job descriptions.
3. The Department should aggressively recruit female graduate students and faculty members.

GOAL 5: PHYSICAL AND FINANCIAL RESOURCES

Objective. The Mathematics Faculty, Staff, and Graduate Students should be provided with office, instructional, and research space commensurate with its personnel and programmatic needs.

In general, the Department's facilities are much shabbier than those of other departments.

Faculty Offices. Faculty offices were designed approximately 30 years ago, before most department faculty members were active in research and before the advent of work stations. Mathematics faculty members conduct almost all of their research in their offices and have no alternative work space in laboratories. The average faculty office size is approximately 90 sq. ft. Some offices are so crowded that it is difficult to conduct discussions with students--particularly if there is more than one student. Faculty members engaged in scholarly activity need offices which are 150 square feet.

Instructional Computing Laboratories. Department and College of Natural Sciences plans include an instructional computing laboratory to be shared with the Department of Statistics. At this date, the University planners have yet to offer a suitable location for this laboratory. The Department obtained a grant from the National Science Foundation which provided 25 computers to support instruction in calculus and differential equations. These computers are currently housed in the NESB building in a room accessible to students only on a limited basis.

Department Computing Laboratory. The Department provides majors and faculty a small computing laboratory in E102 Engineering. This facility is unpleasantly hot throughout the entire year. Last Summer's air-conditioner failure exacerbated this problem as well as causing computer failures elsewhere in the Engineering E-Wing.

Intensive Technology Classrooms. The Department needs three classrooms which are equipped for multi-media presentations and computer demonstrations. The classrooms should also be equipped for wireless exchange of information.

Objective. The Department must have personnel sufficient to meet its instructional responsibilities and its research mission.

Current enrollments. Current demand for mathematics instruction is being met adequately except for the use of large lectures without recitations in M141. To bring M141 to adequate levels of support would require the hiring of two postdoctoral teaching fellows at a cost of \$70K per year.

Enrollment Growth. University enrollment is expected to increase by about 15% over the next review period. We can expect that university enrollment increases will bring at least proportional enrollment increases in mathematics. This would mean an increase of approximately 3600 student credit hours spread across the various levels of the undergraduate curriculum.

Increases in enrollment in the IMP mini-courses would amount to approximately 1600 student credit hours per academic year. These can be accommodated with only minimal increases in undergraduate hourly staffing (\$20K).

The precise blend of calculus enrollments is difficult to predict although it appears that enrollments in the biological science calculus courses (M155, M255) will be strong. We would expect increases in calculus enrollments of about 1300 credit hours per year, which would require four additional sections per semester. We would cover this with two postdoctoral teaching fellows (\$70K). Increases in enrollment at the upper division level of 600 student credit hours would require two additional sections. These would be covered by hiring an additional junior faculty member (\$45K).

Retirements. Professor Clow will retire at the end of academic year 1996-97. As indicated earlier in this report, the Department's outreach efforts to K-12 will require that Professor Clow be replaced by a specialist in mathematics instruction. While there are no other announced retirements, the ages of the current faculty members would suggest that at least two other retirements will occur.

Support for Student-Centered Learning and Other Instructional Reforms. The Department proposes to continue the process of reform of undergraduate mathematics instruction. In particular, features of the CUE course (M180: Algebra in Context) will be incorporated into the IMP system. This will require facilitators for small-group assignments, evaluators for written assignments, and additional instruction in technology use.

Although the Department has a well-established history of developing creative and efficient means to deliver instruction, the teaching methods and of the reform movement require that calculus classes be taught in formats where there are student/facilitator ratios of no more than 35. Reform methods also require increases in the use of technology. To proceed with the necessary reforms we will need to hire additional undergraduate assistants and two additional graduate teaching assistants (\$80K).

Support for Research Excellence. The recent hiring of Professors Danglemayr and Kirby in pattern analysis has given the Department an excellent program in a cutting edge area of applied/computational mathematics. The Department's program of research and scholarly excellence in applied/computational mathematics can be enhanced with a modest additional investment of one new junior faculty position in this area. Such a faculty member will cost approximately \$45K per year and will play a role in covering additional enrollments.

Research in this area of the mathematics of information intensive science will require increased use of technology to recognize and visualize patterns in massive quantities of data. The Department will need to acquire additional high end graphics workstations, software and support staff is likely to cost an additional \$80K per year. This support is the subject of a proposal recently submitted to NSF for infrastructure support.

STRATEGIES

1. Seek University and State support for the consolidation of the Department's faculty and programs in remodeled space in the Weber Building. Ideally, this would be coordinated with remodeling of the Engineering Building. Estimated Cost: \$2.3 M (one time)
2. Seek designation of the Program of Applied/Computational Mathematics as a Program of Research and Scholarly Excellence. Provide additional support in the form of one junior faculty position. This addition would accommodate part of the estimated enrollment increases. Estimated Cost: \$45K
3. Seek four postdoctoral positions. Two of these positions would be filled in such a way as to enhance the Department's research strengths and at the same time to accommodate part of the estimated enrollment increases. The other two would be filled to enhance the Department's programs of instructional development and outreach to K-12. In particular, these postdoctoral fellows would be involved in the reformation and improvement of M141. Estimated Cost: \$140K.
4. Seek additional funding to support student centered learning and other reforms. These will be used to hire undergraduate students for the IMP to facilitate small groups, assist with instruction in hand calculator use and read written assignments. Student assistants will also be hired for the same purposes in M155 and M160. Estimated Cost: \$80K.
5. The Department will acquire additional high end graphics workstations, software and support staff to enhance its programs of research and instruction in the mathematics of information intensive science. In particular, the department will provide increased support for its emerging center of excellence in pattern analysis. Estimated Cost. \$80K.

APPENDIX A. OUTCOMES ASSESSMENT

The undergraduate degree program in mathematics at Colorado State University aims to provide a liberal and practical education in which education and employment are complementary ends, neither subservient to the other. The liberal component of the program requires students to acquire a broad background in communication skills, humanities, social sciences and natural sciences. The disciplinary component of the program focuses on developing students' knowledge, understanding and appreciation of the mathematical sciences, their problem-solving skills, and their ability to combine their knowledge of mathematics and problem solving skills in productive ways.

The goals and objectives of the liberal component of the program are contained in those of the University Studies Program. The goals and objectives of the disciplinary component are detailed below.

There are four concentrations within the mathematics major: General Mathematics, Mathematics Education, Applied Mathematics, and Actuarial Sciences. Early in his/her program of study, we expect each student to make an informed selection of a concentration within the major. The following objectives are common to all concentrations.

All students completing a B.S. degree in mathematics should

1. exhibit knowledge of single variable calculus by being able to define basic concepts and illustrate them with examples; differentiate and integrate elementary functions; solve routine applied problems using calculus; interpret, prove and apply theorems about limits, continuity, derivatives and integrals; and test conjectures by considering examples.
2. exhibit knowledge of basic linear algebra by being able to solve systems of equations; use the terms "vector space", "subspace", "null space", "basis" and "dimension" to explain relationships among systems of linear equations, matrices and linear transformations; and solve characteristic value/vector problems.
3. exhibit knowledge of basic scientific/technical computing by being able to recognize situations in which the computer can appropriately be used, and to read, write, and debug computer programs in one or more of the standard scientific/technical languages.
4. be able to use the basic techniques of descriptive and inferential statistics to present data in concise and accurate ways, and to make decisions and solve problems in situations involving uncertainty.
5. be able to explain the role of mathematics and mathematical models in the "real" world and use mathematical methods to analyze "real-world" problems.
6. exhibit understanding of the nature of mathematical proof and its role in the discipline, knowledge of types and structures of mathematical proofs, and skill in reasoning abstractly and deductively to devise mathematical proofs.
7. be able to read, write and present mathematical exposition and arguments in a style and at a level appropriate to the audience.

General Mathematics Concentration: This is a liberal arts concentration designed to provide a solid foundation in mathematics with the flexibility to explore and develop expertise in other

academic areas. Because it is flexible, this concentration is well suited for students who plan a career in business, law or other area outside mathematics and those preparing for graduate study in mathematics. In addition to the Core Goals/Objectives listed above, students completing the General Mathematics Concentration should

8. exhibit a working knowledge of multi-variable calculus and analytic methods of solution of ordinary differential equations by being able to represent functions of several variables in rectangular, cylindrical and spherical coordinates; compute partial derivatives, multiple integrals and line integrals; apply basic theorems about vector functions; and to solve first and second order differential equations using standard analytic techniques.
9. exhibit knowledge of fundamental concepts from modern abstract algebra by being able to give examples and read, interpret, apply and prove theorems about groups, rings, polynomials, and fields.

Mathematics Education Concentration: This is a professionally oriented program designed to prepare leaders in secondary mathematics education. In addition to the Core Goals/Objectives listed above, students completing the Mathematics Education Concentration should

10. exhibit knowledge of those topics of modern abstract algebra directly related to and/or appropriate for the high school curriculum by being able to read, interpret, and prove theorems about and to give examples that illustrate applications of groups, rings, polynomials, and other concepts.
11. exhibit knowledge of those topics of the modern geometries directly related to and/or appropriate for the high school curriculum by being able to give examples that illustrate basic concepts and to read, interpret and prove theorems about Euclidean and non-Euclidean geometries.
12. exhibit knowledge of the history of mathematics by describing significant achievements and advances in the mathematical sciences, explaining why they are significant, and describing the times and circumstances surrounding them.
13. exhibit knowledge of curriculum improvement trends and issues in mathematics education.
14. exhibit knowledge of theories of learning by using them in preparing and teaching lessons in secondary level mathematics.

Actuarial Sciences Concentration: This is a professionally oriented program designed to prepare students to begin careers as professional actuaries. In addition to the Core Goals/Objectives listed above, students completing the Actuarial Sciences Concentration should

15. exhibit a working knowledge of multi-variable calculus and of analytic methods of solution of ordinary differential equations (see 8 above).
16. be able to use numerical methods and common algorithms to perform numerical integration and differentiation and to solve systems of equations, eigenvalue problems, and differential equations.
17. be prepared for the first three actuarial examinations and have a solid foundation for preparing for the remaining examinations.

Applied Mathematics Concentration: This is a professionally oriented program designed to prepare students to begin careers as applied mathematicians in such industries as aerospace, communications, and electronics. In addition to the Core Goals/Objectives listed above, students completing the Applied Mathematics Concentration should

18. exhibit a working knowledge of multi-variable calculus and of analytic methods of solution of ordinary differential equations (see 8 above).
19. be able to use numerical methods and common algorithms to perform numerical integration and differentiation and to solve systems of equations, eigenvalue problems, and differential equations.
20. exhibit knowledge of combinatorial mathematics by solving problems involving counting, graph theory and other discrete structures.
21. be able to formulate mathematical models and investigate them analytically and numerically.
22. be able to work effectively as a contributing member of a problem-solving team in an industrial setting.

PROGRESS TOWARD GOALS

Student portfolios are a central feature of the Department of Mathematics outcomes assessment program. We conducted the first phase of our portfolio studies in Spring 1992 and Fall 1992. The second phase was conducted in Fall 1993 and Spring 1994. The third phase was conducted in Fall 1994 and Spring 1995. This third phase consisted of the following:

- a. A sample of both sophomores and juniors was selected from each of our four concentrations.
- b. Each of these students was interviewed. During the interview each student was asked to prepare a portfolio. The student was largely free to choose the contents, but the following elements were required:
 - i. A resume.
 - ii. A sample of non-technical writing taken in the last year.
 - iii. A sample of theoretical mathematical work.

In addition, each student in the education concentration was required to include a practicum experience report and each student in the actuarial concentration was required to include results of actuarial exams taken. Students in the applied mathematics concentration were required to submit a sample of computer programs involving mathematics.

- c. Portfolios were reviewed by the Department Head and the Committee on Undergraduate Instruction. They will be reviewed by the Mathematics Advisory Committee, a committee of alumni, when that group meets again.
- d. The Department conducts a survey of B.S. alumni every 7 years. The next survey will be conducted in Spring 1996. The questionnaire will be revised, but will retain many of the questions used since 1973. In this way, we are able to assess trends.

USE OF RESULTS

The most striking results of the initial portfolio studies have been in the area of writing experience. We have determined that most of our students get very little writing experience between the freshman and senior years. We are continuing to explore ways of increasing writing activity in our curriculum.

With the assistance of a grant from the National Science Foundation, we have developed a new course for students in our mathematics education concentration which provides more writing activity for the pre-service teacher. These prospective teachers are also given opportunities to critique the writing of students in a companion lower division course.

Beginning in 1993-94, projects requiring laboratory reports were an important activity in all sections of M160--the first course in calculus. Such projects became a part of M161--the sequel to M160--beginning in Fall 1994. In Spring 1996, work on projects is being implemented in M261. Written exercises have also been integrated into M340: Introduction to Differential Equations. and M369: Linear Algebra.

Outcomes assessment discussions with the Mathematics Advisory Committee also have contributed to changes in computing language requirements.

DISTRIBUTION OF RESULTS

The Department plan calls for outcomes assessment results to be reviewed by the Department's Mathematics Advisory Committee on a bi-annual basis. It has been planned that such a review by the Advisory Committee will be conducted concurrent with the seven-year review. The Committee is now scheduled to meet again in October, 1996. The results have been discussed within the CSU Mathematics Faculty and in the Committee on Undergraduate Instruction.