Calendar of AMS Meetings

THIS CALENDAR lists all meetings which have been approved by the Council prior to the date this issue of Notices was sent to the press. The summer and annual meetings are joint meetings of the Mathematical Association of America and the American Mathematical Society. The meeting dates which fall rather far in the future are subject to change; this is particularly true of meetings to which no numbers have yet been assigned. Programs of the meetings will appear in the issues indicated below. First and supplementary announcements of the meetings will have appeared in earlier issues.

ABSTRACTS OF PAPERS presented at a meeting of the Society are published in the journal Abstracts of papers presented to the American Mathematical Society in the issue corresponding to that of the Notices which contains the program of the meeting. Abstracts should be submitted on special forms which are available in many departments of mathematics and from the headquarter's office of the Society. Abstracts of papers to be presented at the meeting must be received at the headquarters of the Society in Providence, Rhode Island, on or before the deadline given below for the meeting. Note that the deadline for abstracts for consideration for presentation at special sessions is usually three weeks earlier than that specified below. For additional information, consult the meeting announcements and the list of organizers of special sessions.

<table>
<thead>
<tr>
<th>MEETING #</th>
<th>DATE</th>
<th>PLACE</th>
<th>ABSTRACT DEADLINE</th>
<th>ISSUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>835</td>
<td>June 18–20, 1987</td>
<td>Tacoma, Washington</td>
<td>April 17</td>
<td>June</td>
</tr>
<tr>
<td>836</td>
<td>August 5–8, 1987*</td>
<td>Salt Lake City, Utah</td>
<td>May 29</td>
<td>August</td>
</tr>
<tr>
<td>837</td>
<td>October 30–November 1, 1987</td>
<td>Lincoln, Nebraska</td>
<td></td>
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<tr>
<td>838</td>
<td>November 14–15, 1987</td>
<td>Los Angeles, California</td>
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<td></td>
<td>January 6–9, 1988</td>
<td>Atlanta, Georgia</td>
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<tr>
<td></td>
<td>August 8–12, 1988 (94th Annual Meeting)</td>
<td>Providence, Rhode Island</td>
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<td></td>
<td>January 11–14, 1989 (AMS Centennial Celebration)</td>
<td>Phoenix, Arizona</td>
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<tr>
<td></td>
<td>January 17–20, 1990 (96th Annual Meeting)</td>
<td>Louisville, Kentucky</td>
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</tbody>
</table>

* Preregistration/Housing deadline is June 1.

DEADLINES


Other Events Sponsored by the Society

April 30–May 7, 1987, AMS-SIAM Summer Seminar on Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation, University of Minnesota, Minneapolis. Details: This issue.


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Volume 34, Number 3, April 1987

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597 AMS Membership Application
The NSF Budget Request for FY 1988 is examined for those areas of interest to the mathematics community. The analysis reflects the change in structure for some directorates and the slowdown in inflation. This is the first budget to incorporate the goal of doubling NSF funding within five years and, as such, new programs and directions are proposed. Page 435.

Funding Sources for Mathematicians is an article designed to inform mathematicians of the broad spectrum of programs currently supporting research. The article concludes with a comprehensive list of government agencies with the research areas they support and contact persons. Page 449.

The Boston Computer Society, in Richard Palais' column, presents the third and final segment of this year's report on Technical Wordprocessing for the IBM PC and Compatibles with a review of over twenty software packages. Page 462.

Kenneth Hoffman, in his regular column, asks the mathematical community to be patient with Erich Bloch's FY 1988 budget request for mathematics and to remember that if his plan for increased funding at the NSF is successful, then mathematics will receive its fair share. Page 492.

The Board on Mathematical Sciences reports on the proposed funding levels in the FY 1988 budgets for the various agencies that support mathematics. Page 499.

Sloan Research Fellowship Awards are announced with twenty fellows in mathematics. Page 494.

The AMS encourages the submission of manuscripts to its publications in electronic form. Page 495.

Letters to the Editor section contains a number of letters that address the defense issue and either support or oppose the motions presented at the San Antonio Business Meeting. Page 502.

1987 Summer Meeting in Salt Lake City, August 5–8. The First Announcement of the meeting contains a list of invited speakers, a timetable for major sessions and lectures, and registration forms. Page 519.
National Science Foundation Budget Request for Fiscal 1988

Since April 1973, Notices has published an annual report outlining the proposals contained in the White House's budget request to the Congress for the needs of the National Science Foundation (NSF). Last year's report in Notices appeared in the June 1986 issue, pages 450–461.

The NSF budget request for 1988 was sent to Congress with a letter (see the following) in which NSF Director Erich Bloch highlights the Foundation's proposed initiatives and refers to his efforts to double the NSF budget by 1992.

We have incorporated the FY 1988 request into Tables I–III, which are published in this annual report, but rearrangements in the directorates of the NSF, together with decreasing inflation and a more optimistic outlook for the Foundation's budget, have prompted some changes in the tables. The nature of these changes will be explained in the course of this article.

Last year, the NSF began a new initiative entitled Computational Science and Engineering. This initiative was the outgrowth of several years of policy studies and recommendations made by the scientific community, and in particular by the mathematical community: reports by mathematicians Peter Lax and Werner Rheinboldt were especially influential. As a result of this initiative and the growing need to consolidate various computer-related activities, the NSF formed a new directorate, Computational and Information Science and Engineering (CISE), by incorporating various programs that were in other directorates. Some of these programs have subsequently been reworked, expanded, or combined with other programs, and new programs have been added. This reorganization has prompted a reevaluation of the way in which the budget is analyzed in this annual report. For example, the Information Science and Technology (IST) program, formerly within the Biological and Behavioral Sciences directorate, supported various cross-disciplinary information services provided by the Foundation. While in previous years IST funds were separated in Table I from research and related activities in item (2), now that IST has moved to the research-oriented CISE directorate, it seems reasonable to include the IST funds in item (2). Table I has been adjusted for prior years to incorporate this change.

Table II reflects some changes in the Mathematical and Physical Sciences (MPS) directorate where Computer Research, now in CISE, has been replaced by Astronomical Sciences. It will be interesting to track the development of the CISE directorate. This article includes, in addition to the annual budget and activity report of the Division of Mathematical Sciences (DMS) and the Science and Engineering Education (SEE) directorate, the reports of those divisions in CISE that have a significant mathematical component. When more data is available in future years, we will analyze those portions of the CISE budget that are germane to mathematics.

In previous years, Table III has consisted of a ten-year compilation of the NSF budget. The reason for compiling this data over such a long period of time was to make the point that, during the high inflation of 1973–1981, the Foundation's budget, while increasing in actual dollars, was

<table>
<thead>
<tr>
<th>National Science Foundation</th>
</tr>
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<tbody>
<tr>
<td>Washington, DC 20550</td>
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<tr>
<td>January 28, 1987</td>
</tr>
</tbody>
</table>

I am pleased to submit the President's budget request for the National Science Foundation for Fiscal Year 1988. We request a total of $1.893 billion, an increase of almost 17% over last year. The President's budget message also projects significant strengthening of university basic research through a doubling of the Foundation's budget by 1992.

How can we justify these increases in a period of serious fiscal constraints? The answer, in a word, is competitiveness.

Ultimately, our economic strength depends on people coming together to generate ideas and create products that keep us ahead of our competitors. The Foundation's research and education programs are an important part of creating economic strength.

The Foundation's proposed FY 1988 budget offers three important initiatives to improve our future competitive position:

- It will provide a broad range of incentives, including fellowships and research opportunities, for our best students to choose science and engineering careers, and to broaden participation in research.
- It will extend the proven concept of partnerships between industry and universities to establish new Science and Technology Centers, which will support scientifically exciting and economically promising basic research.
- In keeping with NSF's fundamental mission, it will continue strong support for all the science and engineering disciplines.

The Foundation can contribute much to maintaining scientific and technical leadership in an increasingly competitive world. I look forward to working with the Congress to ensure that the Nation's long term goals in research and education are achieved.

Sincerely,

Erich Bloch
Director
actually decreasing in constant dollars. Since 1982, however, the NSF budget has been keeping pace with inflation and has increased in constant dollars. Therefore, it seemed more appropriate to focus on this current trend by restricting our attention to the most recent six years of data.

In a political arena currently concerned with the United States’ ability to compete in the world market, the politically astute Bloch has made the NSF attractive to Washington policymakers by persuading them that supporting academic research enhances the Nation’s economic strength. Bloch’s ambitious plan to double the NSF budget by 1992 has won the support of President Reagan, and this year’s 17% increase in the Foundation’s budget is a strong first step. But even with presidential backing, obtaining a guarantee of budget increases for five years is difficult, given tight budgets and the yearly cycle of congressional budgeting.

The response in Congress seems to be hesitantly supportive. It appears that the Congress regards the NSF’s mission as an important one and respects the quality of its scientific output. However, in the current climate of constrained budgets, the magnitude of the increase the NSF is requesting has increasingly forced the Foundation to justify its activities in terms of their usefulness to the Nation and to its taxpayers.

In Bloch’s letter to Congress presenting the NSF budget, he tells of proposed increases in the budget and writes, “How can we justify these increases in a period of serious financial constraints? The answer, in a word, is competitiveness.” Bloch has tied the Foundation’s diverse activities to the notion of strengthening economic competitiveness and, in his letter, indicates three activities that will receive increased emphasis in 1988. The first of these initiatives, development of human resources, addresses the shortage of scientific talent by improving science and engineering education, making careers in science and engineering more attractive, and tapping the talent of underrepresented groups, such as minorities and women. Funding for Science and Engineering Education has nearly doubled since 1983, when it was practically terminated and was only supporting previously contracted Graduate Research Fellowships. In addition, several cross-directorate activities will enhance support for education. As part of this initiative, the Mathematical and Physical Sciences directorate will be increasing its support for graduate students by 10% to $7.5 million, supporting fifty new Presidential Young Investigators ($3 million), and increasing the funds for undergraduate research by $8 million. Within the DMS, there is a new $2 million program aimed at revising the calculus curriculum.

This increased emphasis on education has not satisfied some lawmakers and educational organizations, who say that in recent years the NSF has increased spending on research while neglecting education. They believe the NSF’s proposed increases for educational activities are not large enough to address the acute needs of precollege and undergraduate education, and they would like to see a larger proportion of any NSF budget increase go into education.

The second initiative is the NSF’s plan to establish a number of interdisciplinary science and technology centers to support, as Bloch puts it in his letter, “scientifically exciting and economically promising research.” The idea of research centers is prompted by the need for interdisciplinary attacks on many long-standing problems in science and engineering research. One example of the move toward the interdisciplinary approach is the NSF’s initiative in computational science and engineering, which often requires the collaboration of researchers from several disciplines.

The third initiative calls for maintaining the strong support of the NSF’s fundamental mission: support of the individual investigator. Indeed, the DMS’s 13.4% increase, while not as large as in recent years, is a substantial one. However, not every DMS program will receive such a large increase. Computational Mathematics and Special Projects will receive increases of 53.3% and 42.7%, respectively, while the other programs will receive increases of 4-5%. FY 1987 funds were reallocated to create the Computational Mathematics program and to provide for some new NSF-wide initiatives administered by Special Projects. (This is why, in the DMS’s budget report, their FY 1987 “request” differs from their FY 1987 “current plan.”) As a result of the reallocation, in every case but one, the FY 1988 budgets of the other programs, though larger than their budgets in the FY 1987 current plan, represent a decrease from the original FY 1987 request. The increases they are to receive in FY 1988 really amount to restorations of their original FY 1987 budgets. However, the increases in Computational Mathematics and Special Projects will benefit the entire division: the Computational Mathematics program now supports researchers previously supported by other programs and will supplement the support of computationally oriented research in other programs, and the increase for Special Projects will support the DMS’s programs to provide computing equipment, to revise the calculus curriculum, and to involve undergraduates in research.
Table I. National Science Foundation

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<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>(1) Mathematical Sciences Research Support</td>
<td>$41.2 15.8%</td>
<td>$47.7 8.8%</td>
<td>$51.9 15.2%</td>
<td>$59.8 13.4%</td>
<td>$67.8 13.2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Other Research Support (Note A)</td>
<td>1137.2 14.5%</td>
<td>1302.6 -1.4%</td>
<td>1283.8 8.0%</td>
<td>1385.8 16.6%</td>
<td>1615.2 13.4%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Education, Foreign Currency Program (Note B)</td>
<td>60.3 40.5%</td>
<td>84.7 1.2%</td>
<td>85.7 16.5%</td>
<td>99.8 15.2%</td>
<td>115.0 13.1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Program Development and Management (“Overhead”) (Note C)</td>
<td>66.3 8.6%</td>
<td>72.0 -0.3%</td>
<td>71.8 10.2%</td>
<td>79.1 20.1%</td>
<td>95.0 19.9%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) Totals</td>
<td>$1305.0 15.5%</td>
<td>$1507.0 -0.9%</td>
<td>$1493.2 8.8%</td>
<td>$1624.5 16.5%</td>
<td>$1893.0 17.8%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) (1) as % of (1) and (2)</td>
<td>3.50%</td>
<td>3.65%</td>
<td>3.89%</td>
<td>4.14%</td>
<td>4.00%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(7) (1) as % of (5)</td>
<td>3.16%</td>
<td>3.17%</td>
<td>3.48%</td>
<td>3.68%</td>
<td>3.58%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note A. Scientific research and facilities (excluding mathematics). National and special research programs, and national research centers. Support for mathematics has been excluded, cf. items (1) and (3).

Note B. The programs in this group are ones in which there is some support in every field, including mathematics. The foreign currency program involves both cooperative scientific research and the dissemination and translation of foreign scientific publications. Foreign currencies in excess of the normal requirements of the U.S. are used.

Note C. This heading covers the administrative expenses of operating the Foundation; the funds involved are not considered to constitute direct support for individual projects.

Table II. Directorate of Mathematical and Physical Sciences

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Mathematical Sciences Research Support</td>
<td>$41.2 (10.3%)</td>
<td>$47.7 (10.8%)</td>
<td>$51.9 (11.9%)</td>
<td>$59.8 (12.9%)</td>
<td>$67.8 (13.2%)</td>
</tr>
<tr>
<td>Astronomical Sciences</td>
<td>77.3 (19.4%)</td>
<td>82.8 (18.8%)</td>
<td>80.2 (18.4%)</td>
<td>85.1 (18.3%)</td>
<td>92.6 (18.0%)</td>
</tr>
<tr>
<td>Physics</td>
<td>104.4 (26.2%)</td>
<td>115.8 (26.3%)</td>
<td>113.2 (26.0%)</td>
<td>117.2 (25.3%)</td>
<td>131.3 (25.6%)</td>
</tr>
<tr>
<td>Chemistry</td>
<td>79.4 (19.9%)</td>
<td>87.6 (19.9%)</td>
<td>85.8 (19.7%)</td>
<td>93.5 (20.2%)</td>
<td>102.8 (20.0%)</td>
</tr>
<tr>
<td>Materials Research</td>
<td>96.3 (24.2%)</td>
<td>107.0 (24.3%)</td>
<td>104.3 (24.0%)</td>
<td>108.6 (23.4%)</td>
<td>119.6 (23.3%)</td>
</tr>
<tr>
<td>Totals</td>
<td>$398.6</td>
<td>$440.9</td>
<td>$435.3</td>
<td>$463.4*</td>
<td>$514.0</td>
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</table>

* This total has been reduced by $7.7 million, which will be transferred to the Professional Development and Management activity, in accordance with the new Federal Retirement System and the 1987 government-wide pay adjustment.

Table III. Compilation of the NSF Budget, 1983–1988

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<tbody>
<tr>
<td>(1) Mathematical Sciences Research Support</td>
<td>$34.8</td>
<td>$41.2</td>
<td>$47.7</td>
<td>$51.9</td>
<td>$59.8</td>
<td>$67.8</td>
<td>49.1%</td>
<td>94.8%</td>
</tr>
<tr>
<td>1967 dollars*</td>
<td>11.5</td>
<td>15.3</td>
<td>15.5</td>
<td>17.3</td>
<td>17.3</td>
<td>17.3</td>
<td>50.4%</td>
<td>50.4%</td>
</tr>
<tr>
<td>(2) Other Research Support</td>
<td>966.2</td>
<td>1137.2</td>
<td>1302.6</td>
<td>1283.8</td>
<td>1385.8</td>
<td>1615.2</td>
<td>32.9%</td>
<td>67.2%</td>
</tr>
<tr>
<td>1967 dollars</td>
<td>518.8</td>
<td>966.2</td>
<td>428.0</td>
<td>428.0</td>
<td>428.0</td>
<td>428.0</td>
<td>84.5%</td>
<td>84.5%</td>
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<tr>
<td>(3) Education, Foreign Currency Program</td>
<td>19.1</td>
<td>60.3</td>
<td>84.7</td>
<td>85.7</td>
<td>99.8</td>
<td>115.0</td>
<td>348.7%</td>
<td>95.2%</td>
</tr>
<tr>
<td>1967 dollars</td>
<td>6.5</td>
<td>19.4</td>
<td>27.4</td>
<td>28.6</td>
<td>28.6</td>
<td>28.6</td>
<td>354.0%</td>
<td>354.0%</td>
</tr>
<tr>
<td>(4) Program Development and Management (“Overhead”)</td>
<td>65.7</td>
<td>66.3</td>
<td>72.0</td>
<td>71.8</td>
<td>79.1</td>
<td>95.0</td>
<td>9.3%</td>
<td>44.6%</td>
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<tr>
<td>1967 dollars</td>
<td>21.7</td>
<td>21.5</td>
<td>29.8</td>
<td>24.0</td>
<td>24.0</td>
<td>24.0</td>
<td>10.6%</td>
<td>10.6%</td>
</tr>
<tr>
<td>(5) Totals</td>
<td>$1085.8</td>
<td>$1305.0</td>
<td>$1507.0</td>
<td>$1493.2</td>
<td>$1624.5</td>
<td>$1893.0</td>
<td>37.5%</td>
<td>74.3%</td>
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<tr>
<td>1967 dollars</td>
<td>558.8</td>
<td>480.2</td>
<td>488.8</td>
<td>498.7</td>
<td>498.7</td>
<td>498.7</td>
<td>89.2%</td>
<td>89.2%</td>
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</table>

* Current dollars are converted to 1967 dollars using the wholesale/producer index.
The following text was prepared by the staff of the Division of Mathematical Sciences of the NSF and was submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1988.

Mathematical Sciences Subactivity
$67,800,000

<table>
<thead>
<tr>
<th>Program Element</th>
<th>FY 1986 Actual</th>
<th>FY 1987 Plan</th>
<th>FY 1988 Request</th>
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<tbody>
<tr>
<td>Classical Analysis</td>
<td>$5.01</td>
<td>$5.52</td>
<td>$5.78</td>
</tr>
<tr>
<td>Modern Analysis</td>
<td>5.09</td>
<td>5.50</td>
<td>5.77</td>
</tr>
<tr>
<td>Geometric Analysis</td>
<td>5.02</td>
<td>5.59</td>
<td>5.86</td>
</tr>
<tr>
<td>Topology &amp; Foundations</td>
<td>6.15</td>
<td>6.69</td>
<td>7.01</td>
</tr>
<tr>
<td>Algebra &amp; Number Theory</td>
<td>8.52</td>
<td>9.33</td>
<td>9.79</td>
</tr>
<tr>
<td>Applied Mathematics</td>
<td>7.00</td>
<td>7.57</td>
<td>7.90</td>
</tr>
<tr>
<td>Statistics &amp; Probability</td>
<td>6.27</td>
<td>6.82</td>
<td>7.13</td>
</tr>
<tr>
<td>Computational Mathematics</td>
<td>0.00</td>
<td>3.00</td>
<td>4.60</td>
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<tr>
<td>Special Projects</td>
<td>8.87</td>
<td>9.78</td>
<td>13.96</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$51.93</td>
<td>$59.90</td>
<td>$67.80</td>
</tr>
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</table>

Summary of Request
The FY 1988 Budget Request of $67.8 million for the Mathematical Sciences Subactivity represents an increase of 13.4 percent over the FY 1987 Current Plan.

Scientific Overview
The Mathematical Sciences Subactivity fosters the creation and development of mathematical ideas, methods, and techniques and promotes their use in improving our understanding of physical, biological, engineering, and social phenomena. To achieve these objectives, support provides for significant research in the mathematical sciences, and serves to ensure the continuing vitality and long-range health of the discipline. Each subdiscipline of the mathematical sciences, from those with the sharpest intrinsic focus to those that reach out to other areas of knowledge, is supported in such a way as to encourage its interaction and to provide a healthy balance among them.

The core of the Foundation's program of research support in the mathematical sciences has been the individual investigator awards. Within this activity, significant emphasis has been given since FY 1984 to increasing the level of support for the young mathematicians to whom the field owes so much for its vitality.

The new program in Computational Mathematics provides support for the increasing use of computation both within mathematics and in its interface with other disciplines. A focus of this program is the formation of interdisciplinary teams involving mathematicians and researchers from other disciplines interested in developing mathematical models and the computational methods used to study those models.

Such models have extremely diverse applications, and are critical when physical testing is impossible, dangerous, or extremely expensive.

The increased use of computation opens unprecedented opportunities for closer interactions between advanced mathematical research and other areas of science and engineering. For example, recent work of Andrew Majda and Ronald DiPerna develops a new concept for solution of the differential equations of fluid mechanics. This highly theoretical work promises more efficient computational methods in the future.

The Special Projects Program provides support for various activities which are not connected to specific parts of the mathematical sciences. Included is a program of postdoctoral fellowships, support for research conferences and workshops, and an equipment program. The Special Projects Program houses a major portion of the subactivity's effort in the Research Experiences for Undergraduates effort.

Also included in the activities sponsored by the Special Projects Program is the support for research institutes at the University of Minnesota and in Berkeley, California, and for postdoctoral and visitor support at two other research centers. The concentration of research effort in a specific area at one of these centers provides a synergism that enhances research output. The current program on number theory and related algebraic geometry at the Mathematical Sciences Research Institute (MSRI) in Berkeley has already led to a major result in the investigation of elliptic curves. These curves, derived from cubic equations, play an important role in areas of mathematics ranging from number theory to mathematical physics due to the interplay of their arithmetic, geometric, and analytic characteristics. Karl Rubin, visiting MSRI from Ohio State University, has exhibited an infinite family of elliptic curves with striking arithmetic properties. The result provides information concerning the rational solutions to the associated cubic equations, a problem as old as mathematics itself. Although it has been conjectured that all elliptic curves have these properties, Rubin's results provide the first known examples.

During the last few years, patterns of support for research in the mathematical sciences have been adjusted in an attempt to deal with major structural problems, documented initially in the 1984 report from the National Research Council (NRC) entitled, "Renewing U.S. Mathematics: Critical Resource for the Future." As the only federal agency with responsibility for support of research across the entire spectrum of the mathematical sciences, NSF has taken the initiative in addressing these structural problems. Significant gains have been made since FY 1984 as described in the 1986 NRC report, "Mathematical Sciences: A Unifying and Dynamic Resource."

The chart below illustrates the crucial role played by NSF in the federal support of academic
basic research in the mathematical sciences. Percentages are based on a total federal expenditure of $114.3 million in FY 1986. Included in this figure is $12.2 million from the University Research Initiative (URI) at the Department of Defense. In all areas of the mathematical sciences, Foundation-supported research generally involves a broader range of topics than the more project-oriented research sponsored by the mission agencies. NSF coordinates its support of research in the mathematical sciences with its counterpart federal agencies through the Interagency Committee for Extramural Mathematics Programs.

Federal Academic Mathematics Funding (FY 1986 Total = $114.3 Million)

<table>
<thead>
<tr>
<th>Agency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF/MATH</td>
<td>45.4%</td>
</tr>
<tr>
<td>OTHER</td>
<td>24%</td>
</tr>
<tr>
<td>ONR</td>
<td>13.4%</td>
</tr>
<tr>
<td>DARPA</td>
<td>9.6%</td>
</tr>
<tr>
<td>ARO</td>
<td>8.6%</td>
</tr>
<tr>
<td>AFOSR</td>
<td>13.2%</td>
</tr>
</tbody>
</table>

Changes Between the FY 1987 Budget Request and the FY 1987 Current Plan

<table>
<thead>
<tr>
<th>Program Element</th>
<th>FY 1987 Request (Millions of dollars)</th>
<th>FY 1987 Plan (Millions of dollars)</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classical Analysis</td>
<td>$ 5.77</td>
<td>$ 5.52</td>
<td>-4.4%</td>
</tr>
<tr>
<td>Modern Analysis</td>
<td>5.50</td>
<td>5.77</td>
<td>4.9%</td>
</tr>
<tr>
<td>Geometric Analysis</td>
<td>5.59</td>
<td>5.86</td>
<td>4.8%</td>
</tr>
<tr>
<td>Topology &amp; Foundations</td>
<td>6.69</td>
<td>7.01</td>
<td>4.8%</td>
</tr>
<tr>
<td>Algebra &amp; Number Theory</td>
<td>9.33</td>
<td>9.79</td>
<td>4.9%</td>
</tr>
<tr>
<td>Applied Mathematics</td>
<td>7.57</td>
<td>7.90</td>
<td>4.4%</td>
</tr>
<tr>
<td>Statistics &amp; Probability</td>
<td>6.82</td>
<td>7.13</td>
<td>4.5%</td>
</tr>
<tr>
<td>Computational Mathematics</td>
<td>3.00</td>
<td>4.60</td>
<td>53.3%</td>
</tr>
<tr>
<td>Special Projects</td>
<td>9.78</td>
<td>13.96</td>
<td>42.7%</td>
</tr>
</tbody>
</table>

Total, Subactivity: $59.80 (FY 1987) $67.80 (FY 1988) 13.4%

NSF will maintain Mathematics at the FY 1987 Request level to redress infrastructure problems. Mathematics remains a priority for NSF due to its importance as a foundation for all of science and engineering.

The FY 1987 Current Plan reflects two major emphases: computational mathematics and infrastructure. The $3.0 million budgeted for computational mathematics has been focused into a single new program element. “Computational Mathematics” was established in 1987 to emphasize and better coordinate the Foundation’s initiative in Computational Science and Engineering. Funds for this activity in FY 1987 were initially distributed to the various programs according to expected use, for example in applied mathematics and statistics and probability. They have been removed from the programs and collected in the new program in the same fashion. Adjustments for support of graduate students and postdoctoral researchers created minor changes in distribution across program elements.

Stipends for the Mathematical Sciences Postdoctoral Research Fellowships and the reallocation of funds for the Research Experiences for Undergraduates activity account for the increase in the Special Projects Program.

FY 1988 Budget Request

<table>
<thead>
<tr>
<th>Program Element</th>
<th>FY 1987 Request (Millions of dollars)</th>
<th>FY 1987 Plan (Millions of dollars)</th>
<th>FY 1988 Request (Millions of dollars)</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
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<td>4.7%</td>
<td></td>
</tr>
<tr>
<td>Modern Analysis</td>
<td>5.50</td>
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<td>4.9%</td>
<td></td>
</tr>
<tr>
<td>Geometric Analysis</td>
<td>5.59</td>
<td>5.86</td>
<td>4.8%</td>
<td></td>
</tr>
<tr>
<td>Topology &amp; Foundations</td>
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<td></td>
</tr>
<tr>
<td>Computational Mathematics</td>
<td>3.00</td>
<td>4.60</td>
<td>53.3%</td>
<td></td>
</tr>
<tr>
<td>Special Projects</td>
<td>9.78</td>
<td>13.96</td>
<td>42.7%</td>
<td></td>
</tr>
</tbody>
</table>

The Subactivity continues to play a major role in computational science and engineering. The Computational Mathematics program highlights the importance of computation in the mathematical sciences, although all programs participate in the activity. Within the Computational Mathematics program, there are two major efforts. The first emphasizes the formation of interdisciplinary groups developing computational methods. The second is on the increasing use of computation as a tool to further the study of mathematics itself. The training of graduate students and postdoctoral researchers is an integral part of this activity.

Since FY 1984, the primary emphasis of the Mathematical Sciences Subactivity has been the research infrastructure. Significant increases have been made in the support of graduate students, postdoctoral researchers, equipment and computational access, and in the number of senior investigators. In FY 1988, the requested increases allow the subactivity to continue to make progress in meeting goals for the support of the research infrastructure as illustrated below.

- The increase for computer equipment and access to computing facilities is in response...
to the increasing need for this resource in all of the areas of the mathematical sciences.

- The number of Mathematical Sciences Postdoctoral Research Fellowships awarded by the Special Projects Program will remain constant as will the number of postdoctoral investigators at the research institutes in the mathematical sciences.

- Support of graduate students will increase and more of the students will be supported as full-time research assistants.

- Funds for the support of senior investigators include support for Foundation-wide activities such as the Presidential Young Investigator awards, Research Opportunities for Women, Research in Undergraduate Institutions, Minority Research Initiation, and the Experimental Program to Stimulate Competitive Research. Effort will be directed toward increasing the number of female, minority, and disabled researchers participating in all phases of the programs.

In FY 1988, the subactivity will initiate a major effort in curriculum development aimed at the first two years of college mathematics. Since calculus is the gateway to all areas of science and engineering, it will be the focus of this activity. Instruction in calculus is provided in a sequence of courses that contain a mixture of theory, practice, and application. The increased use of computation has changed the demands on this sequence at the same time that computer technology delivers the possibility of new instructional capabilities. A careful review of the calculus sequence is long overdue. The activity will provide support for demonstration projects in a variety of institutions and for appropriate means of communication and dissemination of results between the individual projects, the mathematical sciences community, and the user community which includes all areas of science and technology.

The requested increase will permit a substantial enhancement of the subactivity's participation in the Research Experiences for Undergraduates effort through support of undergraduates on research grants, and other special programs.

Changes in Budget Structure
In order to emphasize and better coordinate the Foundation's initiative in Computational Science and Engineering, a new program in Computational Mathematics has been formed.

The following text was prepared by the staff of the Division of Computer and Computation Research in the directorate of Computer and Information Science and Engineering at the NSF and was submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1988.

Computer and Computation Research
$43,351,000

Summary of Request
The requested increase is $7.91 million or 22.3 percent over the FY 1987 Current Plan of $35.44 million.

<table>
<thead>
<tr>
<th>Program Element</th>
<th>FY 1986</th>
<th>FY 1987</th>
<th>FY 1988</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer &amp; Computation Theory</td>
<td>$5.24</td>
<td>$5.50</td>
<td>$6.50</td>
</tr>
<tr>
<td>Numeric &amp; Symbolic Computation</td>
<td>1.48</td>
<td>2.50</td>
<td>3.50</td>
</tr>
<tr>
<td>Computer Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Architecture</td>
<td>3.16</td>
<td>3.20</td>
<td>3.85</td>
</tr>
<tr>
<td>Software Systems</td>
<td>4.99</td>
<td>5.40</td>
<td>6.40</td>
</tr>
<tr>
<td>Software Engineering</td>
<td>2.11</td>
<td>2.31</td>
<td>3.10</td>
</tr>
<tr>
<td>CISE Institutional Infrastructure</td>
<td>14.26</td>
<td>14.30</td>
<td>17.00</td>
</tr>
<tr>
<td>CISE Instrumentation</td>
<td>2.24</td>
<td>2.23</td>
<td>3.00</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$33.48</td>
<td>$35.44</td>
<td>$43.35</td>
</tr>
</tbody>
</table>

Scientific Overview
While the discipline of computer research has its roots in the mathematical sciences, electrical engineering, and logic, the use of computers stimulates the growth of computer research as a discipline and, in turn, computer research builds the knowledge base for improving computer technology. In general, computer and computation research discovers the concepts and laws which govern problem-solving procedures and develops computing systems which test and utilize them. The overall universe for study consists of strategies and algorithms for solving problems, methods of representing and transforming information, programs for carrying out computational procedures, and machines for executing programs.

Parallelism is a basic theme for much of the research supported in the Computer and Computation Research subactivity. The recent and rapidly developing introduction of massively parallel computer architectures has intensified the
need for major new software approaches, algorithms, languages, tools, and systems to make parallel machines effective and competitive. Before the inherent gains in parallelism can even be approached, much work in theory, problem solving, design, and implementation is required. To achieve this goal, support for fundamental research on the nature of parallel computing in such areas as computational complexity, algorithm design and analysis, performance analysis, programming-language semantics, compilers, operating systems, programming environments, program development, and debugging tools is being significantly expanded in the FY 1988 budget.

Both academic and industrial computer and computation research are supported by several agencies of the federal government and, with the DOD Strategic Computing Initiative, federal investment has risen rapidly. However, with the exception of NSF, most federal programs support directed research that is primarily relevant to their respective missions. As with industrial support, in most of these federal programs there is concentration at a few academic centers on limited, selected topics. In decided contrast, NSF responds to unsolicited proposals in all areas of computer and computation research from all research performing institutions. As a result, NSF support plays a unique role in discovering new knowledge and strengthening the Nation's long-term scientific potential.

The budget request for FY 1988 reflects a major increase in research on the design and use of parallel computing systems. The CISE Instrumentation program is increased by $0.77 million or 34 percent to support interdisciplinary research groups that are studying new problem solving strategies and algorithms for the application of parallel computers to science and engineering. The core science research project support programs are also increased to support more projects which will contribute to the advance of parallel computer technology, and a major research center for parallel processing will be initiated.

A major thrust of the subjectivity is providing support for research instrumentation and infrastructure in the Nation's computer and information science and engineering departments. Both the Instrumentation and Infrastructure programs are being expanded so as to substantially improve access to parallel computers by computer researchers and, in conjunction with other units of CISE, to sponsor at least one major center equipped with a variety of new parallel computer systems, work stations, communications, administrative, and technical support staffs. At this center, research will be carried out on many of the important algorithmic, software, and systems problems related to parallel computers.

Another important feature of the FY 1988 budget is the addition of support for increasing the number of undergraduate and graduate students in the computer field. The CISE Institutional Infrastructure subelement (formerly the Coordinated Experimental Research subelement of the Division of Computer Research) has been highly successful in stimulating the growth of graduate education and research at the institutions which have received awards. This program will be expanded by $2.7 million or 18.9 percent to initiate the parallel processing research center and
to increase the number of centers of excellence in computing research. In addition, more graduate and undergraduate students will be supported in science research projects.

The following text was prepared by the staff of the Division of Advanced Scientific Computing in the directorate of Computer and Information Science and Engineering at the NSF and was submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1988.

**Advanced Scientific Computing**

**$48,200,000**

**Summary of Request**

The FY 1988 Budget Request for Advanced Scientific Computing is $48.20 million, an increase of $5.31 million, or 12.4 percent over the FY 1987 Current Plan of $42.89 million.

<table>
<thead>
<tr>
<th>(Millions of dollars)</th>
<th>FY 1986 Actual</th>
<th>FY 1987 Plan</th>
<th>FY 1988 Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supercomputer Centers</td>
<td>$34.92</td>
<td>$39.29</td>
<td>$46.60</td>
</tr>
<tr>
<td>New Technologies</td>
<td>1.55</td>
<td>3.60</td>
<td>1.60</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$36.47</td>
<td>$42.89</td>
<td>$48.20</td>
</tr>
</tbody>
</table>

**Scientific Overview**

The Advanced Scientific Computing subactivity provides access to advanced computational facilities for all segments of the science and engineering basic research community through support of Supercomputer Research Centers. These house the most advanced scientific computation facilities available to the U.S. academic research community, support software required to maximize productivity and train users.

State-of-the-art computers are intrinsic to leadership in contemporary scientific and engineering research. They permit researchers to solve previously unmanageable problems. Today's supercomputers, operating at millions of instructions per second, are, in addition to use in data analysis, rapidly becoming the instruments of simulation of theoretical processes at levels of complexity and detail that rival our most advanced notions of reality. With the ability to realistically model phenomena ranging from the surfaces of viruses to the dynamics of thunderstorms, supercomputers are beginning to change the very approach that researchers in many fields bring to their problems, from passive observer to active manipulator of otherwise unmanipulable theoretical events.

Hundreds of times faster than conventional mainframe computers, supercomputers can deal with quantities of data and information made available by modern instrumentation which would overwhelm conventional machines. These wholly new capabilities have begun to prove as effective as systematic theorizing and physical experimentation in many scientific and engineering domains, and is frequently more efficient and less costly. More importantly, such large scale computing is often the only way to approach many forefront problems ranging across the entire research spectrum.

The subactivity also supports work, and coordinates cross-divisional work required for progress in advanced research computing. This includes research on applications software, operating system standards, methods of massive data storage and retrieval, user interfaces and environments, networking technology, new computing devices (particularly parallel processors and special purpose processors), and the assessment of the performance of supercomputer class machines and more limited purpose devices. Working with advanced machines and software, often provided by industry, the program is a partner in the maintenance of industrial competitiveness in supercomputing.

NSF activities in this area are coordinated with the more mission-oriented activities of other federal agencies, most notably the Department of Energy, Department of Defense, the National Oceanic and Atmospheric Administration, and the National Aeronautics and Space Administration. This cooperation is maintained to take advantage of their experience in operations and management, and to optimize facility utilization.

**Changes Between the FY 1987 Budget Request and FY 1988 Current Plan**

<table>
<thead>
<tr>
<th>(Millions of dollars)</th>
<th>FY 1987 Actual</th>
<th>FY 1987 Plan</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supercomputer Centers</td>
<td>$34.92</td>
<td>$39.29</td>
<td>-8.6%</td>
</tr>
<tr>
<td>New Technologies</td>
<td>1.55</td>
<td>3.60</td>
<td>+0.0%</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$36.47</td>
<td>$42.89</td>
<td>-8.0%</td>
</tr>
</tbody>
</table>

The reduction of $3.71 million takes into account delays in the development of innovative hardware and software system upgrades targeted for installation in the Supercomputer Centers. Such delays are unavoidable in state-of-the-art supercomputer technology, and systems acquisition will be stretched to manage the delays. All of the centers are fully operational at levels of support consistent with orderly growth of demand for supercomputer services.

**FY 1988 Budget Request**

<table>
<thead>
<tr>
<th>(Millions of dollars)</th>
<th>FY 1988 Plan</th>
<th>FY 1988 Request</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supercomputer Centers</td>
<td>$39.29</td>
<td>$46.60</td>
<td>+18.6%</td>
</tr>
<tr>
<td>New Technologies</td>
<td>3.60</td>
<td>1.60</td>
<td>-55.6</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$42.89</td>
<td>$48.20</td>
<td>+12.4%</td>
</tr>
</tbody>
</table>

442
The requested increase will maintain support at planned levels of activities at the centers, allowing for delays in systems acquisition. The thrust in computational science and engineering, supported at $2.00 million in New Technologies in FY 1987, will be funded at the same level through distributed funding in other CISE subactivities.

In FY 1985–86, NSF acquired services from six organizations to fill the immediate large-scale computational needs of researchers. These initial phase activities have been terminated in accordance with the plan developed when the overall program was established. In 1985 NSF funded the establishment of four national supercomputer centers: the San Diego Supercomputer Center (University of California at San Diego, CRAY X-MP/48); the National Center for Supercomputing Applications (University of Illinois, CRAY X-MP/24); the John Von Neumann Center for Scientific Computing (near Princeton, CYBER 205 interim machine which will be replaced by an ETA-10); the Pittsburgh Center for Advanced Computing in Engineering and the Sciences. In addition, a center for experimental supercomputing at Cornell University was established, which, with an IBM 3090-400, is planned to become a national center.

In FY 1988, the national centers will be maintained at the present level and the John von Neumann Center will carry out the planned upgrade from a four processor to an eight processor ETA-10. Special computing services not available at the national centers, such as graphics, massive memory availability, and access to specialized data resources will be supported on a limited basis.

Efforts at standardizing scientific supercomputer software will be expanded. Workshops will be supported to introduce investigators to the unique capabilities afforded by the networked facilities. There will be a greatly increased emphasis on understanding parallelism, both by providing access to new experimental systems and developing new algorithms.

The following table summarizes prior support for the centers, and planning estimates for FY 1987:

<table>
<thead>
<tr>
<th>Supercomputer Centers Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Millions of dollars)</strong></td>
</tr>
<tr>
<td>Program Element</td>
</tr>
<tr>
<td>JVN C (Princeton)</td>
</tr>
<tr>
<td>San Diego</td>
</tr>
<tr>
<td>Illinois</td>
</tr>
<tr>
<td>Pittsburgh</td>
</tr>
<tr>
<td>Cornell</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

This subactivity will also be the focal point for participation in the Foundation-wide Com-putational Science and Engineering thrust to develop innovative software, numerical methods, and graphical techniques to meet the needs of the scientific and engineering communities. Included are user-friendly and transparent interfaces between the user and the computer, transportable computer programs, and more efficient computational methods.

Of the FY 1988 request, $1.0 million will be used for 1. undergraduate education in the use of advanced computational facilities, and 2. training researchers who are inexperienced in the use of these facilities. This will be accomplished through the support of educational courses at participating universities, training institutes at supercomputer centers, augmentation of the user services function at the centers, and grants of access time for educational purposes and start-up projects.

Changes in Budget Structure

The new subactivity, Networking and Communications Research and Infrastructure, was created by moving the networking program activities previously contained in Advanced Scientific Computing. The Advanced Scientific Computing subactivity continues to include the Supercomputer Centers and New Technologies programs. Since the Cornell University supercomputer center developed into a national center, providing services, access, and training, its funding is now displayed under the Supercomputer Centers program element, rather than the New Technologies program element.

The following text was prepared by the staff of the Division of Networking and Communications Research and Infrastructure in the directorate of Computer and Information Science and Engineering at the NSF and was submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1988.

Networking and Communications Research and Infrastructure

$13,365,000

Summary of Request

The requested increase is $3.52 million, or 35.7 percent over the FY 1987 Current Plan of $9.85 million.

<table>
<thead>
<tr>
<th>Network &amp; Communications Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Element</td>
</tr>
<tr>
<td>NSFNET</td>
</tr>
<tr>
<td>Total, Subactivity</td>
</tr>
</tbody>
</table>
Scientific Overview

The Networking and Communications Research and Infrastructure Activity supports projects ranging from the development and operation of a general purpose computer network for supercomputer access to fundamental scientific and engineering research on communications theory and network design. Integrating the research and service functions in this rapidly changing area creates the mechanism for fast translation of research into practice, and drives work toward new problems based on operational experience. Operational activities are strongly innovative and developmental in the sense that they provide a vehicle for confronting and testing research results. It provides a natural opportunity for university-industry collaboration among hardware and service vendors, and computer and electrical engineering researchers. In addition to stimulating the academic research field in a highly leveraged way, this approach affords the use of new technology, such as high bandwidth fiber-optic communications lines, at low marginal cost, overcoming major "start up" impediments inherent in networks.

NSFNET, a network of computer networks, or internet, was developed to provide access to the NSF Supercomputer Centers for the growing computational science community. Parts of it have been operational for a year. Rapid progress is being made to link most of the nation's research campuses. While fulfilling its primary role in supporting supercomputing, NSFNET has also begun to play a larger role, linking researchers to unique resources such as radiotelescope arrays and biotechnology databases. If the experience of other research networks, such as ARPANET, is an indicator, NSFNET, by enhancing scientific and technical interaction among researchers, will affect research productivity and enhance the Nation's research capabilities significantly.

Although operational and pilot networks are the most visible part of the subactivity, real progress is contingent on the development of an aggressive program of research in communications sciences and engineering. Research, ranging from coding theory to experimentation with innovative electronic media, feeds directly into practice in this fast moving area, and academic effort has a substantial effect on industrial competence.

Changes Between the FY 1987 Budget Request and FY 1987 Current Plan

<table>
<thead>
<tr>
<th>Program Element</th>
<th>FY 1986 Actual</th>
<th>FY 1987 Plan</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSFNET</td>
<td>$6.45</td>
<td>$6.35</td>
<td>- 2.3%</td>
</tr>
<tr>
<td>Networking &amp; Communications Research</td>
<td>2.10</td>
<td>3.50</td>
<td>-20.5%</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$8.55</td>
<td>$9.85</td>
<td>- 9.6%</td>
</tr>
</tbody>
</table>

The reduction of $1.05 million resulting from the unspecified Congressional Appropriation reduction minimizes disruption of NSFNET implementation and slows planned expansion of the Research program.

FY 1988 Budget Request

<table>
<thead>
<tr>
<th>Program Element</th>
<th>FY 1987 Plan</th>
<th>FY 1988 Request</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSFNET</td>
<td>$6.35</td>
<td>$9.37</td>
<td>47.6%</td>
</tr>
<tr>
<td>Networking &amp; Communications Research</td>
<td>3.50</td>
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<td>14.3%</td>
</tr>
<tr>
<td>Total, Subactivity</td>
<td>$9.85</td>
<td>$13.37</td>
<td>35.7%</td>
</tr>
</tbody>
</table>

NSFNET implementation is accelerated to construct the regional network segments selected by merit review in FY 1987, and operate and upgrade the "backbone" network that connects the regional segments. The upgrade, from communication speeds of 56 thousand to 1.5 million bytes per second, increases the capacity of the network and reduces unit communication costs.

Experimental or "pilot" service projects will be expanded to further encourage university-industry collaboration and to assure the transfer from research to operational innovation. Fundamental research will be increased. Today's computer/communications networks have reached levels of complexity which go beyond the capabilities of analytical and design tools by which they may be designed, understood and economically and robustly operated. The proliferation of these networks outpaces the supply rate of qualified analysts and engineers. The requested increase for research will begin to strengthen the ability of U.S. research institutions and industry to meet the needs of this dynamic area.

Changes in Budget Structure

The new subactivity, Networking and Communications Research and Infrastructure, was created by moving the networking program activities previously contained in Advanced Scientific Computing.

Science and Engineering Education

$115,000,000

Summary of Request

The FY 1988 Budget Request for Science and Engineering Education (SEE) is $115.00 million, an increase of $15.96 million or 16.1 percent over the FY 1987 Current Plan of $99.04 million.
The responsibility of the Science and Engineering Education (SEE) Activity is to define and fund programs and projects that support the educational aspects of the Foundation's mission. Throughout its activities, SEE plays a major role in efforts to develop human resources for science and engineering. The magnitude of the educational effort in the United States and the long lead times needed for new programs, materials, and methods require a continuing and significant involvement in this area. Sustaining this level of commitment, visibility, and continuity expresses the serious national concern with science, mathematics, and engineering education and will draw the best, most creative people into the process.

SEE fulfills this responsibility by conducting leadership activities that inform and stimulate other sectors, and by support of original work and other merit-based high-leverage activities that serve as prototypes and models of excellence for the Nation. A major objective is to encourage appropriate cooperation among academic scientists, engineers, educators, and the private sector for intellectual partnerships as well as for leveraging funds.

The role of SEE is to help insure that:

- a high-quality precollege education in science and mathematics is available to every child in the United States, sufficient to enable those who are interested and talented to pursue technical careers, especially in science and engineering, as well as to provide a base for understanding by all citizens;
- those who select scientific and engineering careers have available the best possible professional education in their disciplines; While other NSF programs provide apprenticeship training for the next generation of scientists and engineers through research support, SEE concentrates, in addition to graduate fellowships, on the educational structure leading to this stage; that is, the teachers, students, laboratory, and classroom resources that remain important through undergraduate and graduate studies;
- opportunities are available at the college level for interested nonspecialists to broaden their science, mathematics, and technology backgrounds. The great majority of students need a technical perspective and understanding to give them insights into and acquaintance with the principles, practices, techniques, and limits of science;
- informal science education programs are available to maintain public awareness of and interest in scientific and technological developments that may affect their lives.

One of SEE's major concerns is precollege education—an area of great complexity and one in which the scope of the problems is great and diverse. A federal leadership role is particularly important to stimulate well-coordinated solutions.

At the precollege level, NSF support is now targeted toward resolving problems of:

- inadequate subject area preservice teacher preparation;
- inadequate subject matter competence of current teachers;
- classroom materials that are outdated or poorly adapted to the needs of school age populations;
- ineffective use of advanced technology;
- poor exchange of information about successful techniques and programs;
- insufficient opportunities for many talented young men and women to gain firsthand experiences that are critical to their early understanding and appreciation of science and mathematics;
- underrepresentation of women, minorities, and the disabled in the areas and levels of study that could prepare them for careers in science, mathematics, and engineering; and
- the dearth of efforts to maintain and increase the interest in such careers of talented and gifted young men and women as they approach the difficult transition from high school to college.

Precollege efforts address teacher preparation and enhancement, materials development, informal science education, and outreach to students. Precollege teacher preparation and enhancement activities are designed to support: model preservice and inservice teacher education programs, networks that provide support for teachers who are attempting to implement innovative science and mathematics programs, and a program of teacher awards. Support is also provided for enrichment activities for talented high school students and for school level projects that increase the number of women, minority, and disabled students who enroll in curricula that will support a later choice to pursue college work in mathematics, engineering, and the sciences.
Materials development and informal science education activities engage in a concerted effort to improve the quality and quantity of mathematics and science education, both in school and through informal learning. The activities are particularly focused toward cooperative development that will combine the skills of scientific, research, and educational experts with the real-world interests and knowledge of school systems and publishers. Attention is given to the development of advanced educational models and technology that provide benchmarks of quality and science education potential, and to development of a rich and stimulating environment for informal learning through such means as television and museums. Because of the cooperative emphasis, most of the activities enjoy a high degree of leverage, in terms of both finance and impact.

At the undergraduate level, the goal of the SEE Activity is to achieve a permanent high quality NSF presence in undergraduate education that will work to assure the long-term health and vitality of this integral part of the U.S. scientific and technological enterprise. Undergraduate education is particularly significant because it is the vital link between secondary schools and graduate education, as well as the world of work. It constitutes the primary instructional training for engineers and future scientists, and the last and deepest exposure to instruction in science and technology for future leaders of business, government, and the professions.

The March 1986 National Science Board report, “Undergraduate Science, Mathematics and Engineering Education,” clearly established the importance of this area and the role and responsibility of the NSF. Building on recommendations outlined in the report, undergraduate efforts in SEE will concentrate in FY 1988 on three critical issues:

- laboratory improvement: to generate more effective and efficient approaches to laboratory instruction. The College Science Instrumentation Program involves substantial cost sharing and is proving effective in stimulating the improvement of laboratory instruction in the Nation’s nondoctoral degree granting colleges and universities;
- faculty enhancement: to develop model programs for college faculty members, to stimulate diffusion of recent scientific and technical advances into undergraduate instruction; and
- women, minorities, and disabled: through efforts coordinated with those at the precollege level, to stimulate and increase the capability of colleges and universities, emphasizing minority institutions, for increasing the numbers of these groups choosing careers in science, mathematics, and engineering.

These efforts are part of the overall emphasis on undergraduate support in all NSF Activities.

At the graduate level, SEE promotes the development of young scientists and engineers, and thereby helps assure a steady flow of talented students through the educational and research training systems of the Nation. Within SEE, the principal component is the NSF Graduate Research Fellowship Program. These fellowships are the federal government’s most effective means of identifying excellence in science and engineering potential among young citizens, of rewarding that excellence with national recognition and a measure of financial support, and of underscoring the importance that the Nation places on encouraging students to consider careers in science and engineering.

To serve all of the levels of education in which it is involved, SEE supports research in the processes of teaching and learning and conducts studies and program assessments that provide information to assist the Foundation in designing initiatives to strengthen science and engineering education in the U.S. Activities include policy studies of national trends in science education, and studies to assess, on an ongoing basis, the quality and impact of NSF science education programs, and the tradeoff among alternative programmatic initiatives.

SEE has a special role in the NSF with regard to increasing the participation of women, minorities, and the physically disabled in science and engineering. Better educational opportunities and conditions at all levels are ways to success in this important area, and these are sought by SEE in all phases of its mission.

SEE coordinates its activities closely with other relevant areas of NSF and with other agencies, e.g., NASA and the Departments of Energy (DOE) and Education (DoEd). Such coordination is intended to promote maximum use of expertise in the agencies, to minimize program overlap, and to optimize the use of limited federal resources. NSF and DoEd, for example, have collaborated in supporting a number of projects, including the International Study of Mathematics, the broadcast series “3-2-1 Contact” and “The Voyage of Mimi,” and the new “Square One” mathematics series which began national broadcasting in January 1987.

Changes in Budget Structure
Two subactivities are to be reorganized in FY 1988. Efforts focused on research in teaching and learning will be transferred to the Studies and Program Assessment Subactivity, which is renamed Research, Studies, and Program Assessment. The Materials Development, Research, and Informal Science Education Subactivity is renamed Materials Development and Informal Science Education. This transfer consolidates within the Research, Studies, and Program Assessment Subactivity the SEE components that provide formative information to all other SEE programmatic areas. The
The $99 million for FY 1987. This represents an increase of the Plan request of $89 million. The activity ($36 million) will continue to focus on Teacher Preparation and Enhancement; Materials Education; and Development, Research, and Informal Science.

The table below provides the funding history of the reorganized subactivities.

<table>
<thead>
<tr>
<th>Subactivity</th>
<th>FY 1987 Request</th>
<th>FY 1987 Plan</th>
<th>FY 1988 Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials Development and Informal Science</td>
<td>$22.00</td>
<td>$26.03</td>
<td>$26.00</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research, Studies, and Program Assessment</td>
<td>5.20</td>
<td>5.71</td>
<td>7.50</td>
</tr>
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</table>

Changes Between the FY 1987 Request and the FY 1987 Current Plan

<table>
<thead>
<tr>
<th>Subactivity</th>
<th>FY 1987 Request</th>
<th>FY 1987 Plan</th>
<th>FY 1988 Request</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Preparation and Enhancement</td>
<td>$27.00</td>
<td>$30.50</td>
<td></td>
<td>13.0%</td>
</tr>
<tr>
<td>Materials Development,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research, and Informal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science Education</td>
<td>25.00</td>
<td>29.53</td>
<td></td>
<td>18.1</td>
</tr>
<tr>
<td>College Science</td>
<td>7.50</td>
<td>9.50</td>
<td></td>
<td>26.7</td>
</tr>
<tr>
<td>Instrumentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research Career</td>
<td>27.30</td>
<td>27.30</td>
<td></td>
<td>0.0</td>
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<tr>
<td>Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Studies and Program Assessment</td>
<td>2.20</td>
<td>2.21</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Total, Activity</td>
<td>$89.00</td>
<td>$99.04*</td>
<td></td>
<td>11.3%</td>
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</table>


The SEE Activity received an appropriation of $99 million for FY 1987. This represents an increase of $10 million above the FY 1987 budget request of $89 million. The FY 1987 Current Plan of $99.04 million provides increases for Teacher Preparation and Enhancement; Materials Development, Research, and Informal Science Education; and College Science Instrumentation, in accordance with stated congressional priorities.

The Research Career Development Subactivity ($9.5 million) will continue to support instrumentation-based strengthening of teaching laboratories at nondoctoral degree granting colleges and universities. Emphasis will continue on excellence in undergraduate laboratory instruction at these institutions and on the appropriate use of technology, especially computers, in undergraduate laboratories.

In addition, two new efforts will be initiated: one, to attract more women, minorities, and disabled persons to careers in science, mathematics, and engineering, and another, to assist college faculty to include instruction on recent scientific and technical advances in their disciplines.

The Materials Development and Informal Science Education Subactivity ($26 million) will continue to focus on the problem of fragmented elementary and secondary school curricula, on the inability of teachers to upgrade their own knowledge and skills, and on the need for an enriched informal learning environment. Special emphasis will be placed on efforts to develop and demonstrate the use of modern technologies to address these problems. Attention will also be given to activities designed to increase awareness and interest in science and engineering careers. The development of partnerships among the science community, publishers and entrepreneurs, major school systems, museums, and the Foundation will be continued.

The College Science Instrumentation Subactivity ($9.5 million) will continue to support instrumentation-based strengthening of teaching laboratories at nondoctoral degree granting colleges and universities. Emphasis will continue on excellence in undergraduate laboratory instruction at these institutions and on the appropriate use of technology, especially computers, in undergraduate laboratories.

The Research Career Development Subactivity ($36 million) will increase the number of new three-year graduate fellowships from 560 to 760. This increase represents a major investment in the advanced training of outstanding students, to meet national demands for scientific and engineering talent. Stipends to new fellows will continue to be adjusted to avoid erosion of net worth due to income tax changes. The increase will also permit initiation of a program for high ability high school students who may be candidates for careers in mathematics, engineering, and the sciences.

The Research, Studies, and Program Assessment Subactivity ($7.5 million) will expand its efforts on research in the processes of teaching and learning, its study of national trends relevant to science education, and its assessment of the results of NSF education programming.

The Teacher Preparation and Enhancement Subactivity ($36 million) will continue to focus on the needs of elementary school science and mathematics teachers for more adequate support mechanisms, the needs of secondary schools for teachers who give instruction in more than one physical science, the needs of all precollege science and mathematics teachers for assistance in incorporating technology into their teaching, and the needs of all science educators for better information about the results of efforts to improve the techniques, materials, apparatus, effectiveness, and vitality of instruction.

Science Policy Committee Recommendations

The Committee on Science Policy has formulated four recommendations for presentation to the Council of 25 April 1987.

1. That the Council instruct the Managing Editor of the Notices and the Chairman of the Notices Editorial Committee to open its pages for comment related to two motions considered at the business meeting of 22 January 1987. The motions can be found in the January 1987 Notices, page 76, or February 1987, pages 398–399.

2. That the Council declare its intent to hold a referendum after the 1988 Annual Meeting on the substance of the two motions or on broader issues of the federal funding of research in mathematics.

3. That the Council invite the sponsors of the two motions to support the referendum by moving to table the two motions in favor of the referendum.

4. That the Council charge the Committee on Science Policy to supervise the formulation of the motions on the referendum for presentation to the Council for its approval.

Committee on Science Policy

Hyman Bass
Columbia University

Felix E. Browder
Rutgers University

Carl-Wilhelm R. de Boor
University of Wisconsin

Ronald G. Douglas (Chairman)
State University of New York at Stony Brook

Frederick W. Gehring
University of Michigan

Ronald L. Lipsman
University of Maryland

James W. Maxwell
American Mathematical Society

George Daniel Mostow
Yale University

Robert Osserman
Stanford University

Judith D. Sally
Northwestern University

David A. Sanchez
Lehigh University

William P. Thurston
Princeton University

Guido L. Weiss
Washington University

EDITOR'S NOTE: The Managing Editor of the Notices and the Chairman of the Notices Editorial Committee will carry out the first recommendation without waiting for formal instruction. Items submitted for publication in this forum should not exceed 1,000 words.
Support for research in the mathematical sciences comes from a variety of government sources. While most mathematicians have some familiarity with the different kinds of grants available and how the different agencies operate, it is useful to occasionally present an overview of the complete funding picture.

This article provides such an overview and is organized as follows. First, we give a brief description of the relevant funding agencies. Next, we describe the grants available in three categories: individual and group awards, awards for equipment and computer time, and special programs. The special programs section includes information about cross-disciplinary programs and visiting positions at laboratories and institutes. This article addresses only research grants and, therefore, does not include information about educational funding, such as fellowship programs.

Funding Sources for Mathematicians

DARPA cuts across these boundaries and supports research of more general interest to the DOD, and the NSA’s mission is communications security and intelligence. There are other important differences among the DOD agencies. First, DARPA and the NSA are similar in that their main functions are to formulate, contract, and supervise research projects, while the other DOD agencies sponsor a variety of activities besides research. These activities include educational programs from the high school to the graduate school level and programs to support research by certain groups such as young investigators and investigators from historically black colleges. Of course, the individual grants from DARPA and the NSA do support graduate students and post-doctoral associates, but these agencies do not have programs specifically designed to provide funds to these groups. Second, DARPA’s Applied and Computational Mathematics Program (ACMP) tends to fund larger research projects involving many investigators, while the other DOD agencies concentrate a greater proportion of their funds for mathematics research in individual investigator grants. Finally, while the universities, corporations, and government laboratories participating in ACMP receive individual contracts, they collaborate to achieve specific objectives across the five ACMP research areas.

The NSA develops codes that are used to ensure the security of communications for a variety of purposes, from crime prevention to diplomacy, as well as for military purposes. While the NSA may be unfamiliar to the mathematical community, it is one of the nation’s largest employers of mathematicians, having more than 500 mathematicians (over 70 of them with Ph.D.s) on its staff. This staff performs the agency’s classified research, while the agency’s OCREAE program contracts the unclassified research. (OCREAE is not quite an acronym. It is the plural form of “ocrea,” a botany term referring to a kind of sheath or legging on plants. NSA chose this name for their program because it provides “seed” money for Outside Cryptographic Research.)

Federal funding of mathematics research began with the establishment of ONR in 1945. The DOD’s emphasis shifted to applied mathematics after the founding of the NSF, which awarded its first mathematics research grant in 1952. In addition, the Mansfield Amendment, passed in 1969, stipulated that DOD funds could support only research that directly served defense purposes. As

Descriptions of the Agencies

Eight agencies supply nearly all the federal support for mathematics research. They are:

- Air Force Office of Scientific Research (AFOSR)
- Army Research Office (ARO)
- Defense Advanced Research Projects Agency (DARPA)
- National Bureau of Standards (NBS)
- National Security Agency (NSA)
- National Science Foundation (NSF)
- Office of Energy Research (OER)
- Office of Naval Research (ONR)

In addition, the National Aeronautics and Space Administration (NASA) and the National Institutes of Health (NIH) will occasionally fund mathematics research that directly applies to specific problems, but they do not have established programs to contract mathematics research. The yearly report, “Mathematical Sciences in the FY 1987 Budget,” states that AFOSR, ARO, DARPA, ONR, and NSF provided about 94% of the total funding for academic mathematics research in fiscal year 1986. (The report appears in For Your Information in this issue of Notices and gives budget figures for the mathematics programs in most of the agencies listed above.)

Five of those agencies in the list—AFOSR, ARO, DARPA, NSA, and ONR—are agencies of the Department of Defense (DOD). AFOSR, ARO, and ONR each focus on the needs of their own branch of the armed forces. By contrast,
a result, the mathematics programs in the DOD agencies tend to focus on goal-oriented research having specific application.

Because of this focus, the DOD agencies are often referred to as the “mission” agencies. The NSF, an independent government agency, sponsors research in a broader range of science and engineering disciplines, and therefore is usually not called a “mission” agency. However, it is necessary to keep in mind that any federal agency that funds scientific research is a mission agency: the government always wants something in return for its investment. Indeed, the NSF’s mission as specified in its charter is the support of research in science and engineering “to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes.” Because of the breadth of its charge, the NSF is able to justify funding more areas of mathematical research than the DOD agencies can. Nonetheless, according to an NSF program officer, the mathematical research funded by the DOD agencies does not differ significantly in quality or topic from some of the research funded by the NSF’s Division of Mathematical Sciences (DMS).

The NSF sponsors a wide variety of educational and research programs from fellowships for women and minorities, to support for research in undergraduate institutions, to a program for exposing undergraduates to scientific research. Many of these kinds of programs are cross-disciplinary, but are administered through the disciplinary divisions, including the DMS. The DMS plays an especially important role in the support of mathematics research for, according to the same report cited above, “[the] NSF provides about 80% of the support in core mathematics and an overall total of over 50%.”

The OER and NBS are responsible for a significant amount of mathematical research, but only a small percentage of their budgets go to mathematicians in academia. The OER manages research for projects initiated by the Department of Energy (DOE). The OER’s Applied Mathematical Sciences Research (AMSR) Subprogram, managed by their Scientific Computing Staff, supports basic mathematics research relating to the models of physical processes encountered in the DOE’s research and development programs. The AMSR has been particularly influential in stimulating research at the interface of mathematics and computer science. Much of their support goes to scientists at DOE laboratories. The NBS provides the Department of Commerce with scientific and technical support and runs the Center for Applied Mathematics (CAM), which seeks to provide the NBS with current methods and tools of applied mathematics and computing. Most of the mathematics research funded by the NBS is conducted by mathematicians either on the CAM staff or participating in their visitor program. CAM also manages NBS’s central computer.

**Individual and Group Awards for Research**

The federal agencies fund a broad spectrum of mathematical research based on the proposals they receive. The various areas of mathematics supported by these agencies are listed at the end of this article. More detailed information can be obtained from the program directors and by consulting the program guides that the agencies publish. These grants typically cover a wide range of research-related expenses such as travel, equipment, computer time, and graduate student support.

While all the agencies cover the same kinds of expenses, if one looks at the typical mathematics research grant for each agency, some differences are apparent. For example, NSF grants start at $14–15,000 for junior investigators and the average NSF grant in fiscal year 1986 was about $31,000, while the typical grant at the AFOSR, ARO, and ONR is $60–$70,000. The typical grant from DARPA and OER is even larger, but also tends to support larger groups of investigators, students, postdoctoral associates, and other personnel, as well as costlier equipment. According to a program officer at the Division of Mathematical Sciences (DMS), the NSF has a responsibility to support a wide variety of areas of mathematics, particularly those that would not receive funding from any other source. Consequently, while the DMS has the largest budget of any of the mathematics programs, it spreads its resources among a much larger group of researchers.

Because the agencies generally try to support as many investigators as possible, there are usually formal or informal limits on the total amount of support an individual can receive from an agency. The Interagency Committee for Extramural Mathematics Programs (ICEMAP), which coordinates the functions of various government agencies having an interest in mathematics research, has discussed imposing a limit of 4 and a quarter months of combined salary support an investigator may receive from all the agencies. Although no firm policy has been endorsed by all the agencies, some of them do abide by this limit.

NSF regulations prohibit an NSF grant in any discipline from providing more than two months of summer support. The other agencies do not have this kind of formal limit, but their budgets usually dictate that typical grants provide between two and two and a half months of summer support. Academic year support is not prohibited at the NSF, but is granted only very rarely. The other agencies are more flexible and, while budgetary restrictions often limit academic year support, they will provide even full year support if they feel the research merits it. Sometimes
investigators will submit a proposal to the NSF to ask for summer support and to other agencies to ask for academic year support.

The mathematics programs at the non-NSF agencies also tend to provide support for more graduate students and postdoctoral associates than the DMS does. The directors of the mathematics programs at the DOD agencies estimate that they support about one graduate student per investigator, and at the OER the figure is two, while at the DMS the figure is one-half. Again, the discrepancy exists because of the DMS's responsibility to wide support of the field: the amount of money needed to support a graduate student full time (stipend plus tuition and overhead costs) is greater than some of the smaller DMS grants given to investigators. As a result, the DMS often chooses to support more investigators. However, in response to the recommendations of the David Report ("Renewing U.S. Mathematics: Critical Resource for the Future," published in 1984 by the National Research Council) the DMS is making efforts to expand and increase its support for graduate students and postdoctoral associates.

Grants in mathematics usually provide rather limited funds for equipment; a personal computer is a common piece of equipment purchased on a grant. But there are exceptions. The OER's Applied Mathematical Sciences Program, which focuses on applications of mathematics to computers and computing, and DARPA's Applied and Computational Mathematics Program do fund a significant amount of computing equipment. The mathematics programs at the DOD agencies and the DMS often rely on special equipment programs to provide more expensive equipment. Two examples of this type of program are the University Research Instrumentation Program (URIP) at the DOD and Scientific Computing Research Equipment for the Mathematical Sciences (SCREMS) at the DMS. While the grants can also provide for computing time if an investigator needs to do a large amount of computing, it is often more economical to simply purchase the necessary equipment through an equipment program.

Another alternative is to utilize the supercomputer access program at the NSF. OER has a similar program for OER grantees, and DARPA's mathematics program can also provide access to supercomputers. (These programs are described in more detail in the section of this article entitled "Equipment and Computer Time.")

The program directors at the agencies are good sources of information about funding because they are knowledgeable not only about the mathematical subjects their programs support, but also about the way the agency operates. When asked what advice they would give a prospective grantee, the program officers at the non-NSF agencies consistently recommended that the investigator discuss the research ideas with the relevant program officer before submitting a proposal so that he can better understand the agency's research interests. (At the DMS, such preliminary discussion is unnecessary because the DMS funds research in all areas of mathematics, while the other agencies concentrate on specific areas.)

There are many other ways in which a program officer can help proposal writers. For example, a program officer can help investigators decide if their research ideas could receive "split-funding" from the mathematics program and a program in another discipline, such as computer science, biology, or physics. One NSF program director remarked that often prospective grantees do not understand the procedure for split-funding. In the case of the NSF, regulations prohibit submitting the same proposal to two different programs, so if a proposal is to be evaluated for split-funding, one program officer must receive the official proposal, and he or she provides the program officer in the other discipline with an unofficial copy. The two officers then confer, and if split-funding seems appropriate, they decide upon a mix of reviewers from both disciplines.

Another way in which a program officer can assist investigators is by keeping them informed of special programs at the agency. The topics the agencies support on an ongoing basis are usually called "core" programs. In addition, special programs, called "initiatives" or "thrusts," funnel additional funds into areas that show exceptional potential. While the agencies generally accept proposals for their core programs at any time, initiatives are often short-term programs with deadlines. The program officers are good sources of information about new initiatives that may be coming up. News items in Notices, mailings to mathematics departments, and materials in university research and development offices that administer government grants are other sources that can help an investigator understand trends that are developing in the funding agencies.

One example of a current trend is the move toward interdisciplinary research centers. NSF director Erich Bloch, in his letter presenting to Congress the NSF's proposed budget for next year, specifies the establishment of research centers as an initiative for fiscal year 1988. (His letter appears in "National Science Foundation Budget Request for Fiscal 1988," in this issue of Notices.) This initiative has been popular in Washington: the Chronicle of Higher Education reported on October 25, 1986, that top science officials in the Reagan administration have promoted the idea of research centers, and President Reagan even referred to the idea in his State of the Union address last January.

The burgeoning of computational science, which often brings together researchers from different fields to work on a single problem, is also influencing the trend toward centers. The Rheinboldt Report ("Future Directions in Com-
computational Mathematics, Algorithms, and Scientific Software" published in 1985 by the Society for Industrial and Applied Mathematics) made a persuasive case for establishing interdisciplinary teams utilizing computational mathematics. This report was influential in the NSF's establishment of a new program in computational mathematics at the DMS (see NSF News & Reports, Notices, January 1987), and of an NSF-wide initiative entitled Computational Science and Engineering. As part of this initiative, the NSF has established a new directorate, Computer and Information Science and Engineering. While the focus of the directorate is on computation, some of its programs do have a significant mathematical component and may be a source of support for mathematicians doing research in certain areas.

Washington policymakers are increasingly justifying federal funding of scientific research as a means of enhancing the nation's economic competitiveness. This way of thinking is an important reason behind the current popularity of the idea of research centers. While this idea is not new in Washington—the DOD agencies have established some large centers, and the NSF engineering centers are often cited as the prototypes for other kinds of centers—it is rather new to the mathematical community and presents new challenges and concerns that need to be addressed.

Another new development in Washington is the NSA's efforts to expand and strengthen their support of basic mathematics research. The OCRAE program, which has supported research in basic cryptology and mathematics, as well as in computer science, physical sciences, and engineering, has found that basic mathematics research has been the most useful for their purposes. As a result, the NSA plans to increase the OCRAE budget incrementally to $5 million by 1991, and shift its focus to be almost exclusively mathematical. The fiscal 1987 budget may even be increased before the fiscal year is over. To better reflect the program's new direction, its name will probably be changed to Mathematical Sciences Program. OCRAE is now accepting proposals for research in all areas of mathematics; areas of particular interest are included in the list at the end of this article.

**Equipment and Computer Time**

Most individual research grants will provide for equipment and computer time needed for the research proposed. In addition, there are special programs that provide for more expensive equipment or larger amounts of computer time that might be difficult to obtain on an individual grant. These programs are included in the list and described below.

Scientific Computing Research Equipment for the Mathematical Sciences (SCREMS) is a DMS program that provides funds for groups of two to five investigators to purchase equipment that they need for their research, but that none of them could justify purchasing on an individual grant. The equipment should be necessary for the pursuit of specific research projects, rather than intended to provide general computing capacity. The total cost must be at least $20,000.

The DOD's University Research Instrumentation Program (URIP) is similar to SCREMS in that it provides funds for equipment that would be difficult to justify on an individual grant, but the URIP is intended for purchase of equipment in any scientific discipline. Also, the URIP is a five-year program, and 1987 is the last year in which awards will be made. No new program is planned to take its place.

For investigators requiring large amounts of computing time, the NSF and OER have supercomputer access programs. The NSF program provides time on supercomputers located in NSF supercomputing centers at five universities. To provide remote access, the NSF is now building NSFnet, a network that will link the five centers and incorporate existing networks into a single system. Researchers presently holding NSF grants can obtain computing time from their program officer; requests of ten to fifty hours of supercomputing time are routinely granted at no cost to the NSF program supporting the researcher. Those not holding NSF grants must submit proposals. (For more information, see "Supercomputers and the NSF," Notices, January 1987.) The OER program, available only to OER grantees, provides about 24,000 hours of supercomputing time on machines at Livermore National Laboratory in California and at Florida State University. The OER sends out requests for proposals for computing time once a year; the time can also be requested in a research proposal. In both programs, the supercomputers are available through ARPAnet, CSnet, MFEnet, and other major networks.

**Special Programs**

In addition to providing grants for research by individual investigators, the funding agencies have a variety of programs to promote and expand scientific research. Included in this category are programs to promote research by women and minority researchers and researchers at four-year colleges: to assist young investigators starting their careers; and to provide opportunities to visit laboratories and other research centers. The names of the programs are included in the list and some of them are described below.

**Women.** The NSF has two cross-disciplinary programs to promote the participation of women in science and engineering research: Visiting Professorships for Women (VPW) and Research Opportunities for Women (ROW). VPW gives established women scientists and engineers oppor-
opportunities to serve as visiting professors at academic institutions where, in addition to research and teaching, they will be available to offer advice and act as mentors to women students and faculty. Therefore, applicants will be judged not only on the scientific merit of their proposals and the quality of their past research, but also on their ability to successfully encourage other women in science and engineering. Those eligible are women holding doctorates in fields normally supported by the NSF (or who have equivalent experience) and those with independent research experience in academic, industrial, or public sectors. The ROW program supports research by women who have not previously been principal investigators or who are reentering research careers. Each ROW grant application will be evaluated and funded by the relevant NSF discipline program.

Minorities. The NSF has two cross-disciplinary programs designed to increase the participation of minorities in science and engineering research. One of the programs is Minority Research Initiation (MRI), which provides support for minority faculty members who are United States nationals and who wish to develop their potential for high quality science and engineering research. Intended for groups underrepresented in the science and engineering career pool, MRI supports research projects lasting a maximum of five years. Follow-up proposals requesting continued support are not eligible under MRI, but may be submitted to other NSF programs. To be eligible, an applicant must have a full-time position at a college or university having programs in the sciences or engineering and must not have previously received federal research support as a faculty member. The other program, Research Improvement at Minority Institutions (RIMI), supports faculty research and acquisition of equipment at predominantly minority institutions. Proposals are submitted by researchers at qualifying institutions, which must have either graduate programs in science or a graduate or undergraduate program in engineering.

The ARO and ONR each sponsors a Historically Black Colleges (HBC) program, designed to strengthen the research capabilities of historically black colleges (and, in the case of ARO, of predominantly minority colleges in general). Both programs seek to accomplish this goal by funding researchers at the targeted institutions. In addition, the ONR’s HBC program has other activities, such as soliciting the participation of these institutions in the agency’s other programs (e.g., fellowship program, laboratory visitor programs).

One example of HBC activities is a program that is supported by both ARO and ONR and involves a consortium of six colleges, led by Atlanta University. The program will support multidisciplinary research in stochastic analysis and operations research, and will draw investigators from the departments of mathematics, computer science, business, and physics. Part of the grant from ONR will be used to establish a Ph.D. program in computational mathematics.

The Handicapped. The purposes of the NSF’s Facilitation Awards for Handicapped Scientists and Engineers (FAH) are (1) to remove or reduce barriers to participation in research and training of physically disabled individuals by providing special equipment and assistance under NSF awards and (2) to stimulate the development of such equipment. The need for special equipment or assistance must be specific to the research project proposed; the NSF will not provide support to compensate in a general way for a handicapping condition. Funds will be provided under FAH only in conjunction with awards resulting from the regular NSF competition. Those eligible for FAH support include principal investigators, other senior personnel, postdoctoral associates, other professionals, and graduate and undergraduate students.

Predominantly Undergraduate Institutions. Researchers at predominantly undergraduate institutions often face special limitations on their research. The NSF has two programs aimed at overcoming these limitations: Research at Undergraduate Institutions (RUI) and Research Opportunity Awards (ROA). The purposes of RUI are to strengthen the research environments of non-doctorate granting departments that are primarily oriented to undergraduate science and engineering education and to promote the coupling of research and education in such departments. Therefore, in addition to describing the research problems to be addressed, RUI proposals must describe the expected impact of the proposed research on the research and training environment of the department. This aspect of RUI proposals will receive special consideration in proposal evaluation, which is performed by the NSF disciplinary programs. RUI makes two kinds of awards: (1) Research Project Awards for research at the home institution, at a research university, or at a government or industrial laboratory and (2) Research Instrumentation Awards, which support the acquisition of equipment essential for faculty research.

Under the ROA program, faculty at institutions with limited research opportunities can participate in research conducted by NSF investigators at research universities or laboratories. Faculty members make their own arrangements with investigators who have been awarded, or are applying for, an NSF research grant. Prospective grantees who wish to employ faculty under the ROA program should include their requirements in the proposal budget. In the case of ongoing grants, grantees should contact the appropriate NSF program officer and ask for necessary changes in project budget allocations, or, if required, sup-
Supplemental funds to permit participation by the ROA researcher.

Young Investigators. The Mathematical Sciences Postdoctoral Research Fellowships are administered through the Special Projects section of the DMS, which makes awards to approximately thirty new fellows each year. Each applicant will be required to submit a research plan for the tenure period requested. Because they are intended to support only new research, the fellowships may be used neither for the preparation of prior research results for publication, nor for the writing of textbooks; however, an instructorship option is available. To be eligible, an applicant must (1) be a citizen or national of the United States as of January 1 of the year in which he or she applies; (2) have earned by the beginning of the fellowship tenure a doctoral degree (or have had equivalent research training and experience equivalent to a Ph.D.) in one of the mathematical sciences; (3) have held the doctorate for no more than five years as of January 1 of the year after applying; and (4) not previously have held any other NSF postdoctoral fellowship. The fellowship currently provides a total of $66,000 for eighteen academic months and six summer months over a three-year period.

The ONR's Young Investigator Program is a cross-disciplinary program that annually makes twelve awards of no less than $50,000 per year for three years, with the possibility of greater support through matching funding. To be eligible, an applicant must be a United States citizen who holds a tenure track position at a United States university or college and who has held a doctoral degree (or its equivalent) for no more than five years as of January 1 in the year in which he or she applies. The applicant's institution must provide at least one-third of his or her nine-month salary. Participants who are particularly creative and productive during the first two and a half years in the program may be selected for an extension of up to two more years.

Programs for Visiting Institutes and Laboratories. Grants are not the only means of supporting one's research. Mathematical institutes and government laboratories have a variety of programs to support short- and long-term visitors.

There are several major mathematics institutes in the United States: the Courant Institute for the Mathematical Sciences at New York University; the School of Mathematics at the Institute for Advanced Study in Princeton, New Jersey; the Institute for Mathematics and its Applications (IMA) at the University of Minnesota; the Mathematical Sciences Institute (MSI) at Cornell University; and the Mathematical Sciences Research Institute (MSRI) in Berkeley, California. These institutes provide financial support and facilities for mathematicians to devote time to research without teaching (or with a reduced teaching load), to work in groups on specific problems, and to participate in workshops and conferences. Each institute has a program for postdoctoral associates (those who have held their doctorates for five years or less) to spend a year at the institute. Depending on the institute, 75-100% of the associate's salary will be supported, and sometimes summer support is included. For other visitors, such as professors on sabbatical, the length of stay can vary from a few days, to an academic term, to a full year. The amount of support available depends upon the length of stay and the institutes' budgets. Full-year visitors and postdoctoral associates must apply nine to twelve months in advance; for shorter visits, the time between application and visit may be shorter or more flexible, and depends upon the institute. When available, information about the conferences and workshops held at the institutes is published in Notices.

This year, MSI began a program that provides travel grants for graduate students and postdoctoral associates to attend workshops at the MSI. In addition, the NBS's Center for Applied Mathematics has a visitor program, and some of the large centers established by the University Research Initiative have postdoctoral and visiting positions available (for more information, see "The University Research Initiative," Notices, October 1986).

AFOSR, ARO, ONR, and DOE all have programs through which investigators in science and engineering can do research at government laboratories. These programs provide a means for academic researchers to make contact with their counterparts in the laboratories and to become familiar with the topics and problems in which the laboratories are interested. This familiarity can be useful in formulating research projects of interest to these agencies. While the research at the laboratories tends to be in applied areas of mathematics, the laboratories still need mathematicians and often have mathematics as a designated area of interest.

Through the DOE's University Laboratory Cooperative Program, faculty and students can spend a summer or a year at a DOE laboratory to work on a DOE research project. The program is quite large: 1,283 students and faculty members participated in fiscal year 1985, and about 10% of them were from mathematics. Many of the DOE laboratories have mathematics divisions which conduct highly theoretical work relating to problems of interest to the DOE. The program provides salary support and travel expenses to and from the laboratory.

The AFOSR's Research Initiation Program provides a formal mechanism by which an academic researcher can continue, at his or her home institution, research begun at an Air Force laboratory. To be eligible, the researcher must submit a proposal during or shortly after participation in the AFOSR's Summer Faculty Research Pro-
program (SFRP). The AFOSR's Graduate Student Summer Support Program is an adjunct program to the SFRP and provides funds to graduate students to work at an Air Force facility with a supervising professor holding an SFRP appointment. In addition, the AFOSR sponsors the University Resident Research Program (URRP), which enables university faculty to spend one to two years at Air Force laboratories or at the AFOSR working on research of interest to the Air Force.

Similar to the URRP is the Resident Research Associateship (RRA) program, sponsored by the National Research Council. All government laboratories participate in this program, through which scientists and engineers can pursue research at the laboratories. The RRA is intended to be analogous to fellowships, associateships, and similar temporary programs at the doctoral level in universities and in other organizations. There are two categories for awards: regular (for those holding a Ph.D. for less than five years) and senior (for all others).

NASA does not have an established mathematics program, but it does contract mathematics research through its research centers. Some of their areas of interest are included in the list. The principal way mathematicians establish contact with these centers is by participating in NASA's summer research program, which is conducted at the Institute for Computing Applications in Science and Engineering (ICASE) at the NASA-Langley Research Center in Hampton, Virginia. Through this program, thirty to forty mathematicians spend one week to three months working on a problem of interest to NASA. The program provides an opportunity for mathematicians to become familiar with the kinds of research NASA is interested in funding; in fact, most of the proposals for mathematics research NASA receives are from mathematicians who have participated in this summer program. The proposals are evaluated and the funding granted by the center staff. The total amount of grant money awarded is estimated to be about $2.5 million. The centers also employ mathematicians for in-house research and have some visiting positions for postdocs and professors.

Other Programs. The Special Projects section of the NSF's DMS supports activities different from the usual research project, including, for example, working research sessions (conferences, symposia, colloquia, special years, etc.), two research institutes (MSRI in Berkeley, California and IMA at the University of Minnesota), the SCREMS program, and the Mathematical Sciences Postdoctoral Research Fellowships. In addition, Special Projects supports the regional conferences operated by the Conference Board of the Mathematical Sciences. These conferences feature a principal speaker who gives ten one-hour talks on a subject during a week-long session. Proposals for conferences and special years should be submitted twelve months prior to the proposed starting date.

Last year, Congress passed the Small Business Innovation Research (SBIR) Act, which extended the SBIR program for another five years. The act requires every federal agency with an external research and development budget of more than $100 million to set aside 1.25% of that budget for awards to small businesses. The aim of the program is to support high risk, potentially high payoff research in science or technology based firms with 500 or fewer employees in order to accelerate the conversion of federally supported research into commercial applications with private investment. In 1986, nine businesses received SBIR awards from the NSF for research in the mathematical and computer sciences. While almost all the federal agencies discussed in this article participate in the SBIR program, in many cases their SBIR requirement is fulfilled in disciplines other than mathematics.

The NSF sponsors several programs that come under the heading International Cooperative Science Activities and that support the work of American scientists cooperating with scientists of other countries in research and related activities. The programs are divided by country or region and differ in their deadlines, their eligibility criteria, and the areas of research and types of activities they support. However, there are three activities they all support: (1) cooperative research projects designed and conducted jointly by investigators in the United States and in a foreign country; (2) research-oriented seminars or workshops to exchange information, review the current status of a specific field, and plan cooperative research; and (3) scientific visits for planning cooperative activities for research.

The National Institutes of Health (NIH) supports a small amount of extramural research in mathematics and statistics relating to biomedical areas; some of the topics are included in the list. Because each institute usually has a group of statisticians and mathematical statisticians on its staff, much of the necessary mathematics research is done in-house. Also, because the NIH does not have a mathematics program serving all the institutes, the grants are scattered among the institutes, so precise information about the number of grants and total funding is difficult to obtain. For research relating to a specific disease, grants are administered through the individual institutes; for example, the Mathematical Statistics and Applied Mathematics section of the National Cancer Institute contracts mathematics research applied to cancer research. By contrast, the Institute for General Medical Sciences (IGMS) contracts research that cuts across the disease boundaries of the other institutes. Most of the IGMS grants for mathematics research are administered through the Biophysics and Bioe-

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neering section. The section currently has twelve active grants totalling about $.25 million. Reviews are made in three “rounds” each year, and it is estimated that about twenty-five proposals in mathematics are received each round, and one to two of them are funded. The proposals are peer reviewed by academic specialists chosen by NIH.

Allyn Jackson
Staff Writer

The following is a list of information about the agencies discussed in this article. For each agency, the list supplies the agency’s address and telephone number, the name of the director of the mathematics division, the research areas the agency supports, and the names of the special programs it sponsors. Also listed are the addresses, telephone numbers, and names of the directors of the mathematical institutes.

AFOSR
Air Force Office of Scientific Research
Directorate of Mathematical Sciences
Bolling AFB, DC 20332-6448
Acting Director: James Crowley
202-767-5025

Research Areas
Applied analysis
Artificial intelligence
Computer science
Finite mathematics
Mathematics of Computation
Mathematics of dynamics and control
Mathematical optimization
Mathematics of physical, chemical, and biological systems
Mathematics of signal processing and communication
Statistics and probability

Special Programs
Graduate Student Summer Support Program*
Research Initiation Program*
Summer Faculty Research Program*
University Resident Research Program*

*For information on these programs, contact:

Richard W. Kopka
Program Manager
Special Faculty Programs
AFOSR/XOT
Bolling AFB, DC 20332-6448
202-767-4971

ARO
Army Research Office
Mathematical Sciences Division
P.O. Box 12211
Research Triangle Park, NC 27709
Director: Jagdish Chandra
919-549-0641, ext. 254

Research Areas
Applied analysis and physical mathematics
Numerical analysis and computing
Operational mathematics and logistics
Probability and statistics
System theory, control, modeling, artificial intelligence

Special Program
Historically Black Colleges Program

DARPA
Defense Advanced Research Projects Agency
Applied and Computational Mathematics Program
1400 Wilson Blvd.
Arlington, VA 22209-2308
Manager: Helena Wisniewski
202-694-5800

Research Areas
Computational algorithms
Harmonic analysis
Image/data compression
Nonlinear dynamical systems
Turbulent flow in fluid dynamics

NSA
National Security Agency
Program OCREAE
Attn: RSA
Fort George G. Meade, MD 20755-6000
Director: S. Brent Morris
301-859-6438

Research Areas
Algebra
Cryptology
Discrete mathematics
Number theory
Probability and statistics

NSF
National Science Foundation
Division of Mathematical Sciences
1800 G Street N.W.
Washington, DC 20550
202-357-9764
Director: John Polking
Research programs

NOTE: The Division of Mathematical Sciences supports research in all mathematical topics, so it is impossible to list them all in more detail than given below. Each of the mathematical programs listed below has a program officer who can supply more detailed information. A list of the names and telephone numbers of the program officers is in NSF News & Reports in this issue.

Algebra and number theory
  Applied mathematics
  Classical analysis
  Computational mathematics
  Geometric analysis
  Modern analysis
  Topology and foundations
  Statistics and probability
  Special projects

Special Programs
  Facilitation Awards for Handicapped Scientists and Engineers
  International Cooperative Scientific Activities
  Minority Research Initiation
  Postdoctoral Research Fellowships*
  Research Improvement for Minority Institutions
  Research Opportunity Awards
  Research Opportunities for Women
  Research in Undergraduate Institutions
  Scientific Computing Research Equipment for the Mathematical Sciences*
  Supercomputer Access
  Visiting Professorships for Women

*These programs are within the Division of Mathematical Sciences; the rest are NSF-wide programs.

**For more information on this program, contact:

Larry L. Barker
Office of University and Industrial Relations
Department of Energy
Washington, DC 20545
202-586-8947

ONR

Office of Naval Research
Mathematical Sciences Division, Code 1111
800 N. Quincy Street
Arlington, VA 22217-5000
Director: John Cannon
202-696-4310

Research Areas
  Applied analysis
  Decision sciences
  Discrete mathematics
  Mathematical statistics and probability
  Numerical analysis
  Operations research
  Statistical signal analysis

Special Programs
  Historically Black Colleges Program
  Summer Faculty Research Program
  Young Investigator Program

NASA

National Aeronautics and Space Administration
Washington, DC 20546
Aerodynamics Division, Computational Methods
Manager: Randolph A. Graves
202-453-2828

Research Areas
  Algorithms
  Computation
  Control theory
  Finite elements
  Geometry of complex shapes
  Modeling
  Numerical analysis
  Partial differential equations

Special Program
  Summer Research Program at the Institute for Computer Applications in Science and Engineering

OER

Office of Energy Research
Applied Mathematical Sciences Program
Scientific Computing Staff
Department of Energy
Washington, DC 20545
Director: Don Austin
301-353-5800

Research Areas
  Analytical and numerical methods
  Information analysis techniques
  Advanced computing concepts
  Energy sciences advanced computing

Special Program
  University-Laboratory Cooperative Program*
NBS
National Bureau of Standards
Center for Applied Mathematics
A438 Administration Bldg.
Gaithersburg, MD 20899
Director: Francis E. Sullivan
301-975-2732

Research Areas
Algorithm design
Classical and numerical analysis
Computational geometry
Mathematical modeling
Optimization
Statistical signal analysis
Stochastic processes

NIH
National Institutes of Health
Bethesda, MD 20205
Main switchboard: 301-496-4000
Institute of General Medical Sciences:
301-496-7301
Head of Biophysics and
Physical Sciences Program: Marvin Cassman
301-496-7463

Research Areas
Biostatistics
Computer science
Mathematical modeling
Mathematical statistics
Statistics

NRC
For information on the National Research Council
Resident Research Associateship Program, contact:

Associateship Programs
National Research Council
2101 Constitution Ave.
Washington, DC 20418
202-334-2760

Institutes
Courant Institute of Mathematical Sciences
New York University
251 Mercer Street
New York, NY 10012
212-660-7100
Director: Cathleen S. Morawetz

For information on visiting positions at Courant,
write to The Visiting Membership Committee, and
for information on instructorships, write to The
Committee on Instructorships.

Institute for Advanced Study
School of Mathematics
Princeton, NJ 08540
609-734-8100
Chairman of School of
Mathematics: Enrico Bombieri

Institute for Mathematics and its Applications
514 Vincent Hall
206 Church St., S.E.
Minneapolis, MN 55455
612-624-6066
Director: Hans Weinberger

Mathematical Sciences Institute
Cornell University
294 Caldwell Hall
Ithaca, NY 14853
607-255-8005
Chairman: Anil Nerode

Mathematical Sciences Research Institute
1000 Centennial Drive
Berkeley, CA 94720
415-642-0143
Director: Irving Kaplansky
SEARCH FOR AN EXECUTIVE DIRECTOR
for the
AMERICAN MATHEMATICAL SOCIETY

Position: The post of Executive Director of the American Mathematical Society will become vacant on a date to be established in 1988 upon the retirement of William J. LeVeque from that position. The Executive Director is employed by the Trustees of the Society, who now seek a replacement. Employment could begin at a date of mutual convenience in 1988 and might include overlap with the term of the incumbent, though this is not a requirement. The central office of the Society is in Providence, R.I.

Duties: The duties of the position are summarized in Article VI of the bylaws of the Society as follows:

Section 1. There shall be an Executive Director who shall be a paid employee of the Society. He shall have charge of the central office of the Society, and he shall be responsible for the general administration of the affairs of the Society in accordance with the policies that are set by the Board of Trustees and by the Council.

Section 2. The Executive Director shall be appointed by the Board of Trustees with the consent of the Council. The terms and conditions of his employment shall be fixed by the Board of Trustees.

Section 3. The Executive Director shall work under the immediate direction of a committee consisting of the President, the Secretary, and the Treasurer, of which the President shall be chairman ex officio. The Executive Director shall attend meetings of the Board of Trustees, the Council, and the Executive Committee, but he shall not be a member of any of these bodies. He shall be a voting member of the Committee to Monitor Problems in Communication but shall not be its chairman.

Note: In the above statement, "he" is the sexless third person singular pronoun, used to avoid the awkwardness of repeated "he or she" or the barbarism "he/she."

The purpose of the Society is described in this quotation from the charter:

The particular business and objects of the Society are the furtherance of the interests of mathematical scholarship and research.

The Society accomplishes its purpose through meetings and conferences and through publication. There is a diversity of other activity.

The annual budget of the Society exceeds thirteen million dollars, about one fifth being in the general fund and four fifths in the publication fund. There are about 150 employees in Providence and 75 in Ann Arbor. Mathematical Reviews is a semi-autonomous operation in Ann Arbor under the direction of the Executive Editor.

There are about eight general meetings per year and as many as twelve to fifteen specialized conferences.

The Society publishes at least sixteen journals of various kinds. It publishes about a dozen series of books. All of the operations, except for the printing of a couple of journals with very large print runs, are done in-house.

Both the office operations and the publication are highly computerized.

Qualifications: Candidates should have a Ph.D. in mathematics (or the equivalent), published research beyond the Ph.D., and significant administrative experience. Desirable qualifications include experience in mathematical publication, fiscal management, and computer utilization.

Applications: A search committee, with Frederick W. Gehring as Chairman, has been formed to seek and review candidates. Persons who wish to be considered or to make a nomination should provide supporting documentation to

Professor F. W. Gehring
Department of Mathematics
University of Michigan
Ann Arbor, MI 48109

before 1 September 1987 to receive full consideration.
An AMS-MAA-SIAM Congressional Fellow’s Report

Mathematics on Capitol Hill

James Murphy

This report is a brief description of my year as a AAAS Congressional Science Fellow under the sponsorship of AMS, MAA, and SIAM.

In my year with the Congress, everything that crossed my desk had some quantitative component. The numbers are there. Opinion polls are readily available on the Legis computer system. The Congressional Budget Office provides critical estimates of cost for every major piece of legislation. Estimates of the number of people affected by the new tax bill or other legislation, or the number of Russian missiles capable of carrying nuclear warheads, or the magnitude of the health risk associated with certain levels of toxic waste are continually being asked for and discussed. Predictions and forecasts about the impact of new legislation are being developed. Yet in all of this activity, the professionals whose training makes them the most competent in dealing with polls, models, forecasts, etc., are conspicuously absent. When congressional staff think of modelling, estimates, predictions, etc., they think of econometricians and social scientists and not of mathematicians or statisticians.

I applied for the Congressional Fellowship in order to find out how policy makers dealt with quantitative data. During the year that I spent in Senator Pete V. Domenici’s office, I initiated three pieces of legislation, all of which have now become law. The most original was National Mathematics Awareness Week. The other two concerned extended medicaid coverage for the severely disabled, and changes in federal food stamp regulations to allow homeless individuals to use food stamps to buy prepared meals.

Throughout my entire year, I was impressed with the motivation and expertise of congressional staff whom I met. Many staff people are lawyers, but there are a larger number of Ph.D.s in the physical and natural sciences than I had expected. The general level of mathematical knowledge is what you would expect among well-educated nonmathematicians. Quantitative information is handled in a common sense way that is not seen as mathematical. What do these people think of mathematics and of mathematicians? Mathematics is seen as an arcane and irrelevant exercise that has something to do with strange numbers and bizarre spaces and that is practiced by people who are antisocial and can’t speak English. Legislators hope that very soon computers will make mathematics unnecessary.

From this, it is clear that formal education, general information, and public relations systems have all failed to convey the richness of mathematics to the general public. I suspect that we have also failed to convey this richness to a large percentage of our own students. Unless we can improve this communication we will find ourselves in an evolutionary cul de sac, and we may become an extinct species, at least in the political arena.

The focus of this article is on Congress, but communicating the importance of mathematics must take place on both the federal and the local level. Lobbying efforts can be effective, but ultimately it is constituent concern that motivates Congress. A recent report in Science indicates that parents in the United States are far more concerned about literacy than about their children’s ability to understand mathematical concepts. In Japan, on the other hand, parents’ concern is about equal in both of these areas. If we cannot engage constituent interest in what we want to achieve, we will be perceived as a narrow special-interest group with very little legitimate claim on congressional attention.

The long range solution to this problem is education. At the primary and secondary level, we need textbooks and teachers that can teach the problem solving and communication aspects of mathematics as well as the techniques. We must define what a mathematically literate person should know and make the need for this basic material clearly evident to the public. Then we must see that undergraduate curricula include this material for every college graduate. At the gradu-

James Murphy, an associate professor of biostatistics at the University of Colorado, was the 1985-1986 AMS-MAA-SIAM Congressional Science Fellow (Notices, October 1985, p. 592). The Congressional Science Fellowship Program has been supported by the AMS, MAA, and SIAM since its inception in 1978. Previous recipients include Edmund G. Lee, Robert T. Smythe, Cheryl Griffiths Tropf, J. T. Chu, Charles G. Bird, and T. Christine Stevens.
ate level, quantitative reasoning and mathematics should be a requirement for advanced degrees in the same way that foreign languages are today.

In short term, we need to increase our ability to communicate with Congress in order to compete for what will probably be a decreasing supply of funds. On this issue I admit bias, I think that the Congressional Science Fellowship Program is a very effective way of increasing this communication. All of the professional societies that sponsor a fellow reach a stage where they ask about the cost effectiveness of the fellows' program as opposed to a lobbying effort. To date, many societies have found a way to fund both, and I hope that the mathematics societies will not be the exception to this general rule. I think both efforts are needed. Comparing these two programs is very much like comparing the need for basic research with the need for research and development. The lobbying effort is like research and development. It is focused on a specific goal and defined result, establishing communication with congressional staff to further legislation in the interest of the mathematics community. The Congressional Science Fellowship Program is like basic research, it has broader goals—to expand the knowledge of Congress about the various professions represented and to develop a group of professionals who are knowledgeable about the workings of Congress. The program aims at the goal of establishing a long-term communication between Congress and its professional constituents. In terms of giving mathematics a lasting hold on the minds of congresspeople and their constituents, this long-term effort will be the most effective. On occasion, it also produces visible results like National Mathematics Awareness Week. Even congresspeople who don't care at all about mathematics want to know more about any group that could mount a campaign to put something like that together, and this curiosity can be the beginning of communication.

APPLIEDATIONS OF ALGEBRAIC K-THEORY TO ALGEBRAIC GEOMETRY AND NUMBER THEORY

Spencer J. Bloch, R. Keith Dennis, Eric M. Friedlander and Michael R. Stein, Editors

These two volumes of forty papers present a state-of-the-art description of some of the exciting applications of algebraic K-theory to other branches of mathematics, especially algebraic geometry and algebraic number theory. As the proceedings of a 1983 AMS-IMS-SIAM Joint Summer Research Conference, they include current and important work by some of the best researchers in the field. The diverse scope includes the following topics: the matrix/vector bundle tradition of concrete computations for specific rings, the interaction with algebraic cycles, and the generalization of the regulator map for units in an algebraic number field to higher K-groups of varieties over number fields.

Of particularly high research value are the ideas of Beilinson, which are presented here for the first time, the work of Merkurjev and Suslin relating K-theory to the Brauer group (as reported by Merkurjev and Wadsworth), and the papers by Kato on algebraic cycles.

Directed towards mathematicians working in algebraic K-theory, algebraic geometry, and algebraic number theory, this volume is also of interest to the algebraic topologist. The reader should be familiar with basic K-theory and interested in its applications to other areas of mathematics.

1980 Mathematics Subject-Classifications:
18, 16, 19
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This month's column is the final portion of the Boston Computer Society's report on “Technical Wordprocessors for the IBM PC and Compatibles.” Part I appeared in the January 1987 issue of Notices, pages 15–32. Part IIA, which appeared in the February 1987 issue of Notices, pages 262-281, gave a collection of summary tables for comparing individual programs. Part IIB, which appears below, gives individual reviews of each program.

Technical Wordprocessors for the IBM PC and Compatibles
Report by the Boston Computer Society
Part IIB – Reviews

Richard Goldstein, James Loomis, and Avram Tetewsky

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ChiWriter, Version 2.05
Reviewed by Richard Goldstein

ChiWriter is a WYSIWYG-type wordprocessor, written by a pure mathematician, and aimed at those users who want to write fairly short, journal-length papers. Pure mathematicians tend to write papers that are short and have few equations that need to be referenced. At least partly because of this historical orientation, many of the fancier manuscript and/or layout features discussed in the first half of our article, or listed in the tables, are not included in this program. The other important item to note is that this WYSIWYG program works entirely in graphics mode. As with all other products that use graphics mode heavily, use of a CGA provides barely tolerable display quality. Display quality on an EGA or Hercules is excellent.

The program is heavily keyboard driven, but there is no keyboard template supplied with the program. There is an extensive on-disk tutorial, and fairly extensive on-line help, but referring to these does slow one down. The user is supplied with a sizable number (more than 10) of on-screen and printer fonts, which are called via function keys and function key combinations.

Although nominally a WYSIWYG system, a number of things do not normally show on-screen, including headers, footers, footnotes, etc. These can be looked at and edited, but I found the procedure to be quite awkward, especially when using different headers for odd and even pages or when customizing in some other way. The awkwardness arises because, rather than use a dot command for headers/footers, etc., one enters the header in a special edit window that then disappears. During normal operation of the program, one never sees the header, or even any indication that there is a header; there is an indication of the existence of a footnote.

As a WYSIWYG system, ChiWriter, of course, does both editing and print formatting. In examining a number of manuals, it is clear that many vendors have problems covering these two aspects in a nonconfusing manner. ChiWriter is no exception to this. Further, it appears to be impossible to have both an excellent editor and an excellent formatter within the same product. Some programs deliberately choose which element to emphasize and which to downplay; ChiWriter appears to have emphasized those things that are important for small documents only. Both global and selective search and replace are there, as well as many other standard editing commands. However, the editor is also missing a number of things that I consider important, e.g., pointers such as goto markers, backward searches, and an “undo” ability.

Equations and other technical constructs are entered and edited using a special half-line mode (too restrictive for my taste, but common among WYSI-
WYG systems) with an optional special nonsynchronization mode, so that inserts can either move all rows or just the current row as the user desires. For many constructs, macros must be built unless the construct is only to be done once. Without a macro, the "painting" procedure used rapidly becomes exceedingly tedious, especially for large symbols and characters. Presently, the way in which one does large symbols is through vendor-supplied macros. Since one of the vendor-supplied fonts is small sized, it is very easy to design reasonable-looking mathematical structures, including summations with either top or side limits. There is also an add-on to ChiWriter containing a library of chemical structures.

Since you can have various combinations of insert (on/off) and synchronization (on/off), it is relatively easy to enter and/or edit virtually any equation once you learn what combination puts you in the correct environment for entering/editing such constructs. Unfortunately, the manual is of minimal help here. An example, discussed below, is the procedure for entering boxes.

ChiWriter includes a font designer. This is on top of the 5 different groups of fonts that either come with the program, or as an option: 2 groups of screen fonts (CGA and Hercules), and 3 groups of printer fonts (9-pin, 24-pin, and laser). There are numerous fonts in each of these groups; for example, there are 15 CGA fonts. There are a maximum of 20 fonts in any font group. Although time prevented me from attempting much with the designer, it does have some nice features. For those like me who have trouble visualizing what a character should look like in the design stage, ChiWriter allows one to call up 2 fonts at a time so that the second can be used for comparison and guidance. It is even possible to overlay 2 characters (from the same or different fonts) to see how they match up.

ChiWriter supports a minimal level of organizational and layout features: if you want a header, you must ensure that the last line of the header is blank—otherwise the header and text will have no space between them. Further, special headers (or footers) can only be set for the first 9 pages, or for even and odd numbered pages. For external graphics, a block of blank space of any desired size can be left, but only by hitting the return key for each line to be left blank. Tables of contents, indexes, multicolumn formatting, etc., can only be accomplished manually.

I really like the fact that the entire WYSIWYG file is completely ASCII markup—i.e., mainframe installation sites could interface with this product. This also means that add-ons such as spell checkers will work without any problem. On the other hand, file importing is only easy with ASCII files (even then it is only easy if the ASCII file does not have a carriage return at the end of each line). It is possible to import files from other wordprocessors, but only if the user can determine what the format of the file from the other wordprocessor is. For example, the vendor, Cay Horstmann, told me that some users have successfully imported files from "Brit Scientex," a WYSIWYG TWP that has a documented format.

The documentation for ChiWriter is only fair: the implications of many issues are not spelled out or even hinted at. For example, in doing this year's benchmark, I had some problem getting the "boxed table" to print correctly. I was told to use the "glue" command. The only mention of this in the manual says, to "combine adjacent lines to a single line, highlight them and use the glue command in the mark menu." (p. II - 23) This hardly is a clear instruction to use this to keep boxes vertically aligned on printing (when they are already vertically aligned on the screen). The on-disk tutorial was very helpful when I printed it out to have it available while working on my own files. Rather than a "tutorial," it is really an extension of the manual, even though there is some example key hitting for the user to do. One excellent part of the manual is a final chapter of technical information, including file formats for documents, parameters, fonts, and printer drivers. When combined with information about the screen (available from the vendor), this is an excellent font of technical information. The manual also includes a very helpful "menu tree" to greatly ease one's way in finding the correct menu (something that the on-screen help system, which is context sensitive, does not do at all). Of course, some things are not there at all, including importing other Ch1writ files, cross-referencing of items in the manual, and full discussions of many issues that are only hinted at.

If you like WYSIWYG systems and only want to do fairly short documents, then this is quite a reasonable program, if you have one of the printers they fully support. That the output file is 7-bit ASCII is another very desirable feature. However, if you are looking for a program that handles very long or highly structured manuscripts, then this is not the program for you.

Hockney's Egg (The Egg), Version 4.2
Reviewed by A. Tetewsky

Hockney's Egg was written by a physicist for physics journal articles. It offers fast WYSIWYG operation for equations, and most page layout functions, with the exception of n column printouts. (Formatting commands are issued for n columns, then all pages are wordwrapped to 80/n columns.) The software comes on 2 copy-protected floppy disks and is comfortably run on a PC with CGA, EGA running as a CGA, or HGA card. Although Hockney's Egg was written for physics, a separate set of chemical fonts is available. On the other hand, the product has almost no organizational features (e.g., automatic indexing or footnoteing). Editing is limited to files with less than 2,000 lines, and data interchange is limited to ASCII and WordStar files.

Hockney's Egg has a very strong interface for quickly accessing different mixtures of character sets and attributes. Using mixtures of character sets and attributes in equations is easy, but takes a bit more time to learn. With additional refinement of the manual, the learning time could be reduced.

The Hockney's Egg user interface is command-driven by special keys and by a trip key that causes a bottom command line to be displayed. The screen layout contains: a top ruler line; line numbers on the left-hand side of the page; a bottom command line; a font line above the command line that contains an overstrike indicator, insert indicator, the ordinary font indicator, and the alternate font indicator. There is also a sub-/superscript line indicator level on the right-hand side of the screen to indicate the relative position of four lines up/down relative to a baseline in 1/4 line steps.
The Egg has some well-written protection features. For example, after a command is issued, the command remains on the command line so it can be reused, except for delete related commands. After executing these commands, the first letter of the command is changed to a “Q” so the user cannot accidentally reissue the command without changing the “Q.” An abort command is not available because, in most cases, a command is issued from the COMMAND line, which can always be stopped. On the other hand, it would be convenient to have an abort command for long searches, and paragraph reforms (or realignments). There is a limited undo command which will undo changes for the last line that was being edited.

Although the printer install instructions are difficult to follow, fortunately all printers are resident at one time. When a file is printed, the PRINT command is issued, and one of the command parameters is the name of the printer to be used, unless one uses the default printer, which does not have to be specifically named. As an interesting aside, to conserve memory space when a file is printed, the screen display memory area is used as workspace and highly amusing screen displays appear as the file prints. The screen is re-stored to normal appearance after a print. The author claims that, although all features are supported by all supported printers, the Toshiba and the Apple LaserWriter printers give the best-looking results.

User feedback on anything but equations is crude; e.g., when saving files, there is no automatic backup. There is no region that displays the current file that is being edited.

The Egg contains most of the basic editing features found in a vanilla wordprocessor. It uses line numbers, offering a number of generalized commands that allow you to specify either a line number, series of line numbers, range of line numbers, columns and range of columns, and search strings for restricting the range of an operation. A number of control keys are used to mark line or column blocks, to perform certain movements or delete operations, and for font control.

Font control is well-handled. Two fonts are always readily accessible from among the 8 presupplied fonts: English, Greek, script, small, APL, general science, stick, and German. There is considerable overlap in the general science and Greek2 symbol sets. Bold, italic, and bold-italic are available for any of these. There are 8 possible sizes, though pagination is lost if these are used for anything but headings. However, there are several variable-sized math symbols that will not confuse the on-screen pagination. Recasting the above information into a more consistent form, the Egg offers you roughly 4 symbol sets with 96 unique characters per set, 4 different font styles—roman, stick, German, italic—an average of 4 different sized enclosures and large math symbol sizes, 8 text/equation sizes (not visible on screen), and support for 10, 12, and 17 cpi spacings if the printer supports it.

“Alt-CapsLock” will toggle the ordinary and default fonts with each other. The “Alt” key combination will only toggle fonts for a single key. Underlining is not well-handled, but is not too difficult to perform. Unfortunately, the manual does not clearly document how to un-underline, although it is possible by doing a search and replace operation on underscores. The user can overstrike characters as many times as desired.

Equations are created by a combination of special commands and a paintinglike action. Equations can move as a unit, or one may move the individual elements, both for in-line text and for offset equations. You can move up or down by full lines, 1/4 lines, or 1/2 lines. “ALT-arrow” key combinations move left and right on various super/sub lines. There are 17 levels, split evenly above and below a baseline. “Alt-function” keys can be used to create a variety of large-sized math symbols.

To build an equation (e.g., a fraction with integrals in the numerator and denominator), move the cursor up a 1/2 line, create an underline of blanks as many characters wide as needed, deleting additional length later, then move the cursor up levels to create each character. The entire equation can be stored as a unit. Editing an equation is not too difficult, but is a bit harder than entering an equation. Documentation of editing could be better. The reference section of the manual should contain a list of general principles for where and how to position the cursor for deleting specific items. One discovers that when large symbols are chosen, it is up to the user to move up the appropriate number of lines to leave room for the large symbol.

An add-on chemistry library is available with over 500 preformed organic chemistry structures and 100 building blocks (in 8 sizes) for building additional structures.

Although tables can be built, the user can not specify the alignment of each element in the table, though this can be done manually.

Hockney’s Egg contains no advanced manuscript/organizational features because the author feels that the prime importance is to get the equations correct—indexes and other organizational features must be done by hand. There are simple headers and footers, and Wordstar-like dot commands (#$ commands for The Egg). Minimum equation support commands are present, and n-column layout at print time is possible. However, with n-column layout, equations that span more than 1 column are difficult. As for graphics, space can be reserved for pasting in a picture. There is no section on data-interchange, and the author states that if a user is going to share data with equations, he/she should use the same product. ASCII data can be imported.

Installation is almost straightforward except for a slight misordering of sections in the manual. Specifically, the installation instructions for the floppy disk were given first, followed by an in-case-of-trouble section, followed by hard disk instructions. The floppy and hard disk install should have been placed on the same page with a separator, preventing one extra hard disk uninstall to correct for first time hard disk mistakes.

The Hockney’s Egg manual was typeset using the Egg, but the index and table of contents were done by hand. Many of the bugs that I ran into with the software were caused by small ambiguities in the manual. For example, I hung the program because on page 11: IF YOU HAVE A HARD DISK AND WANT TO USE SUB-DIRECTORIES, USE THE “CHARACTER INSTEAD OF THE \ . THE “CHARACTER IS WHAT APPEARS IN THE WP CHARACTER SET WHEN YOU TYPE THE \ KEY, AND WILL etc. The first sentence says use “\”, the second sentence says type \ and you will see the “\”, and the reason for both sentences concerns the APL character set op-
EXP

Reviewed by E. J. Saletan
(with comments by A. Tetewsky)

EXP is a command-driven WYSIWYG wordprocessor. Although equations are entered on the command line in a markup language format, they are instantly translated, automatically sized (in most cases), and displayed in WYSIWYG form at the current cursor point. If the markup language is too long for the command line, the equation must be built up in pieces by building all of the outer structures and then updating each level (or box). Thus, EXP is similar to TECH/WORD in that all equations are made up of nested structures. Unlike TECH/WORD, EXP uses a markup language interface to its WYSIWYG display; in addition, EXP is extremely fast. EXP is for mathematicians and others who want to write mathematical documents the way they ordinarily think about mathematics. EXP performs well in this area, and I (EJS) have become a devoted user.

EXP's operation is based on "box" editing. Individual boxes are manipulated and combined to build complicated expressions. For example, a numerator box and a denominator box can be combined to create a fraction, or power expressions could be created by combining a box with a superscript box containing a 2. What goes in boxes is almost unlimited, and boxes can be nested easily to build complicated expressions. Various commands for opening and closing boxes add flexibility. For example, SQR is a box-closing command that places the contents of the entire box under a proportionally spaced square root sign. If more symbols are added to the box, the square root sign adjusts accordingly. Other autoscale symbols are included in EXP. The midline of a fraction is among them: fractions are automatically centered vertically and horizontally, even if the fraction is rewritten.

Three different placements of superscripts and subscripts are available: microspace, halfspace, and hardspace (hard in a different sense from the usual one: it doesn't change size under justification). There are several hyphenlike symbols for ordinary hyphens, minus signs, dashes, and for tiny hyphens. There are positive and negative signs of various sizes. Three dots can be placed on the line, centered just above the line in either of two diagonal directions, or can be placed vertically. There are 11 sets of fonts, which include the mathematical symbols needed to typeset mathematical expressions.

More than 4 full keyboards of one-stroke macros (one key alone or in combination with SHIFT, ALT, or CTRL) are easily constructed. EXP comes with a useful set of factory macros that include many of the symbols used in mathematics. Among them are 2-by-2, 3-by-3, and 4-by-4 matrices. Macros also can be easily designed to do such things as number equations in sequence, with section numbers correctly included, help copy blocks from one file to another (a RAM disk is desirable if this is done often), or write large parts of complicated mathematical expressions.

EXP includes a DOS shell command for performing DOS functions (e.g., displaying a file directory). One gets to DOS with SHIFT F3, carries out the needed operation, and gets back to EXP by entering EXIT.

EXP also works well as a regular wordprocessor. It allows up to four windows, is extremely fast at searching and replacing, and is flexible in formatting (including headers, footers, page numbering, automatically numbered footnotes, etc.). It has eight counters (called variables) that can automatically number equations, sections, and paragraphs (though I (EJS) think those capabilities in wordprocessors are often more trouble than they are worth). EXP does not measure up, however, to fancy wordprocessors with such special features as automatic indexes and tables of contents, list generation, forward and backward referencing, and automatic hyphenation. It has no spell checker, and its plethora of mathematical symbols make using a spell checker a bit problematic.

I (EJS) found EXP extremely easy to learn and to use. When you can't remember how to get an alpha, for instance, you type ALPHA on the command line, and it appears on the screen. The documentation includes a manual that clearly describes all commands and symbols, as well as a type of learner's guide that explains many features, such as how to write most mathematics, build matrices and tables, manipulate boxes, and assemble macros. Both are well written without any of the gibberish or adolescent humor so often found in software documentation. There are also two quick-reference cards (four sides of 8.5″×11″). There is no on-screen help, but the error messages are unusually explanatory, and getting out of errors is easy. The manufacturer was extremely helpful via mail (they have no toll free number). This is the first time a software company has consistently answered my (EJS) letters courteously, informatively, and promptly.

The weaknesses I (EJS) found fall into several categories. (I should mention that a new version is promised for March 1987 with some of these weaknesses corrected.)

1. Fonts. a. A font designer is needed. Although the list of symbols is large, there are still obvious omissions.
Spellbinder Scientific (c) 1984, Version 6.03
with Spellbinder, Version 5.4 (1985)
Reviewed by Zack Deal

Spellbinder Scientific is a repackaging of the basic Spellbinder wordprocessing program and a functional equation writing module. Those who already own and love Spellbinder will find Spellbinder Scientific very comfortable—a natural extension of the system with which they are already familiar.

The Scientific package offers Spellbinder users, used to a typewriterlike approach, real graphic capabilities they have not had before. With the right graphics card and monitor, Spellbinder Scientific supports 8 screen fonts: normal ASCII, math symbols, super-/subscript normal, super-/subscript math symbols, italic super-/subscripts, chemical fonts I and II, and italic characters. Moreover, the program comes with a font editor that permits users with special needs to create new screen and printer fonts.

Documentation for Spellbinder Scientific consists of 2 manuals and several supplements. The Spellbinder User's Guide consists of 11 chapters, 5 appendices (a quick reference to commands, a glossary, function keys on various kinds of computers, special printer applications, Spellbinder messages), and an index. Unfortunately, this guide was typeset using a 7 or 8 point sans serif font, which is extremely difficult to read.

The second manual is the Spellbinder Scientific manual, which only covers the techniques required to enter, edit, and print different scientific formulae and notations. It consists of 12 chapters, 4 appendices (lists of scientific character sets, math and chemistry keyboard guides, additional information on using an IBM computer, and a printer supplement), and an index. Although this work looks like it was printed on a near-letter-quality printer, the normal line spacing makes it easier to read. The new user will find it extremely difficult to learn to use the program without reading these manuals; Spellbinder is the most unintuitive program I have ever seen.

I also received a separate supplement for IBM computers, dated May 22, 1985 (43 pages), and another supplement for the HP LaserJet printer, dated June 24, 1985 (29 pages). The Spellbinder package also included the "Spellbinder Scientific Word Processing System: Quick Start," which is more of a demo than a full tutorial.

Spellbinder Scientific comes on three disks. Disk #1 is copy protected and must be in the A: drive to run the program. A backup copy of disk #1 is included on disk #4. Disk #5 contains files for the Spellbinder word processor. Disk #6 contains Electric Webster, a spelling and grammar checking module.

I encountered problems when I tried to install Spellbinder Scientific. I had hoped to try out this package on my wife's PC Limited AT compatible with a Tecmar EGA Graphics Master card and NEC Multisync monitor. Following the instructions, I configured the program for the setup she has. However, the program always hung up on the opening screen when I tried to run the Scientific program on that machine. I also tried it on my assistant's IBM AT, which has an IBM EGA card and an IBM color monitor. The program never worked even in this vanilla flavored EGA environment. The only machine I could get Spellbinder Scientific to work on was my office IBM XT, which has an IBM monochrome monitor and a Hercules Graphics board. Although the EGA option is one of several graphic options on the setup menu, it seems to be vaporware.

A call to the company gave me the opportunity to speak with a pleasant young man who could not explain the difficulties I was having on EGA-equipped computers. He suggested that I return the key disk, which he thought I might have damaged. He failed to tell me that the package contained a backup copy (disk #4) of the key disk. I sent disk #1 in, but received it back two weeks later unchanged.

The "Quick Start" introduction to Spellbinder Scientific is easy to follow and it quickly introduces you to the basics: entering text, inserting text, editing text, saving files, creating an equation, and printing. For those who are not used to Spellbinder, however, this tutorial leaves a lot to be desired. It does not explain how to do anything more complicated than type in a couple of paragraphs of text. The "practice" equation involves only a 5 line radical, 3 lines of numbers, and a few characters in special fonts.
Spellbinder is a melange of several kinds of commands—a virtual archetypical dig layered with vestiges of the various command styles that have been popular since microcomputing began. To insert text involves making the lower half of the screenful of text disappear; go into Edit Mode and press CTRL E. One feels like Moses parting the Red Sea—a rather ridiculous gesture when you only need to add a tab at the beginning of an existing paragraph. If you delete a word or phrase from a line, type CTRL C to avoid leaving “unwanted gaps in the text following the position of the cursor.” Most of the important commands must be typed on the command line. Moreover, function keys switch you from one mode to another and invoke submenus of other functions and even symbols to type in. It’s never quite clear which it will be. Finally, larger-than-normal symbols are “drawn” by moving the cursor keys to indicate the dimensions.

I tried very hard to find Spellbinder’s user interface, but I ultimately had to conclude that it does not have one: it has several. One deceptively constant feature is the graphic representation of the “soft keys” (read “programmable functions keys”) at the bottom of the screen. These appear in most of the various modes, though in the Command mode the functions I needed most were not the ones assigned to the function keys. This meant that most commands were typed onto the command line either because they were not available on function keys or because they were so many menus deep in the function-key-controlled menu system that it was faster to type them out than to invoke them with function keys.

In addition to typed commands (a vestige of the mainframe era), special key sequences (early WordStar), and function keys, Spellbinder also understands “dot commands” and “in-line commands” implanted in the file. Sometimes the dot commands and the key sequences correspond (e.g., the !B in-line command and the .B both perform a backward linefeed on some printers). At other times, similar commands are unrelated (e.g., the IP in-line command causes the printer to pause until you press a key, but you use the .P command to specify a starting page number).

Spellbinder’s programmers have given users a multitude of facilities. The Quick-Reference guide lists 13 cursor-moving and 22 editing key sequences that work in the Edit Mode. In the Command Mode, the user must know 6 cursor-moving commands, 7 text moving and deleting commands, 9 search and replace commands, 17 different commands for reading and writing files, 14 commands that control previewing and printing, 9 commands that control the printed output during printing, as well as 15 sundry other commands. There are roughly 15 dot commands and 30 in-line commands, too.

Spellbinder works, but it assumes that the user understands how it works. Because I didn’t, I managed to lose an hour’s worth of edits to the benchmark document. Twice! I was editing, so I had not yet read Chapter Five, which explains Spellbinder’s archaic file management system.

I didn’t realize that the user actually is in charge of opening, reading, writing, and closing disk and work files. I mistook the WRITE command for the normal wordprocessing SAVE command. In fact, I should have used GD, a mnemonic for “save all text in write file, close write file, and delete text from workspace.” The organization of the manuals will not help you find and learn the essential commands, hidden in the plethora of functions available. Even if you are willing to read the manual word for word from front to back, you will have difficulty distinguishing the important functions (those you will have to use every day) from those that are anachronistic relics.

Spellbinder was able to print the benchmark file on an Epson printer, but it did not do the highlighting requested via in-line codes. The MX-185 I had access to may not understand the escape sequences of the MX-100—the printer I had told Spellbinder I would use. The program does permit the user to customize a printer definition table, but I did not have time to do that. In addition to the Epson FX-80 and MX-100, the Scientific program supports the Epson LQ-1500, the Toshiba 1300 series, the IBM Graphics Printer and the HP LaserJet 2686A.

Spellbinder’s most serious deficiencies as a technical wordprocessor are its inability:

- to create tables of contents, figures, and tables;
- to number equations, figures, tables, and bibliographic references;
- to build indexes and lists automatically;
- to allow both footnotes and endnotes in the same document; and
- to facilitate forward and back referencing.

The program also has no automatic way of enumerating pages in roman numerals. One would have to type a footer command for each page that is to be numbered with a roman numeral. Without these essential capabilities in the basic wordprocessor, Spellbinder Scientific appears to be a clever equation writing add-on to a dated, second-rate wordprocessing package.

The combined package—Spellbinder plus Spellbinder Scientific—will not break any speed records. When I opened the ASCII version of the benchmark document (21,453 bytes), Spellbinder ruminated for 16 seconds. The ASCII file had carriage return codes at the end of each line. To get rid of these, I marked all double carriage returns (paragraph breaks) with 4 dollar signs ($$$$. Spellbinder spent 28 seconds on that change. When I asked it to change all remaining single carriage returns into a space, the program was spellbound for a full 5 minutes and 48 seconds. When I commanded it to change the $$$$ string back to 2 carriage returns, the program meditated on the problem for 1 minute and 42 seconds.

Spellbinder Scientific includes the font and character-drawing intelligence required to do most of the equations in the benchmark. The designers of Spellbinder Scientific have included a very wide assortment of mathematical and chemical characters. By designing some special characters, one could probably complete benchmarks 4 and 7 (from last year), which I could not do with the existing graphic facilities.

In doing the more complicated equations, I found myself striking many more keys than I thought necessary. I had to press a function key or two constantly to move between super-/subscripts, “normal type,” “math symbols,” and “italic type.” Other function keys call up the automatically sizable enclosures and characters: integral, sigma, radical, brackets, and braces. Although I did not count the keystrokes, it is my impression that, on the average, I typed from 13 to 15 keys to enter 10 characters in the equation.

In my opinion, Spellbinder Scientific might be used profitably by current users of the Spellbinder pro-
gram. The Scientific program would give them equation writing, font editing, and chemical diagramming facilities they need. However, the Spellbinder Scientific package falls short as a word processing package in two key areas: (1) its user interfaces seem to have come about through historical accretion rather than through rational planning and (2) its document-handling facilities are extremely limited. Given these problems, I would only recommend it to experienced Spellbinder users who need the ability to write equations.

**T³ Scientific Word Processing System, Version 2.2**

*Reviewed by Raoul LePage*

T³ is an elegant implementation of the WYSIWYG concept for IBM PC/XT/AT and compatibles, producing attractive real time screen display and technical printing of text, formulas, and character graphics from 19 fonts of 128 characters each, on quality dot matrix and laser printers. While easy to use, T³ is rich in possibilities, the depth and breadth of which can only be suggested. The menu interface, described in more detail below, is especially noteworthy. While there is no practical limit on the size of a T³ document other than available disk storage, books written in T³ are best done as chapter length or smaller documents. There are no provisions for automatic indexing or sending files to a typesetter.

Version 2.2 is the third major release of T³, with new manuals and support for several spelling checkers (a resident version of MicroSpell is provided, and some others such as Turbo Lightning can be used in T³), mail merge, foreign languages, multiple regions on a page, proportional spacing, and accented characters using dead keys. There is also support for PostScript and other laser printers, large monitors, and LCD keyboards.

TCI software has consistently offered very high levels of support for T³, incorporating suggestions from users, keeping up with advances in displays, CPUs, and printers, and maintaining a really useful toll free help line. With version 2.2, use of this help line is not restricted to a given period from the date of purchase.

TCI is readying a version of T³ to run under Xenix in the PC environment. Upgrade of version 2.x to 2.2 is tentatively priced at $95 for registered users, including 1 printer driver. Upgrade for additional printer drivers is not yet established, but may be under $30.

At the top of the screen is a graphic display showing the name of the document under revision; the names of 2 keyboards (one assigned to the regular keys and the other accessed with the ALT key); page number; region of page (there may be up to 9 user defined rectangular regions); column number; line number; subscript or superscript position measured in half-lines; inches to the end of the region (measured vertically); the line format for the current location; and the height and depth of the line spacing in half-lines. This display may be turned off. Immediately below the graphic display is a line showing tick marks (the number of marks varies by display), tabs, margins, and cursor location. At the bottom right of the screen is a smaller graphic with the time, and 8 little boxes that light up to indicate CPU, keyboard, and other activity. To the right of this are the letters ACN “key” which highlight for alternate keyboard lock, caps lock, num lock, and “recording key sequence.”

Text, formula, and character graphics editing are totally integrated and are accomplished on-screen by invoking a rich set of operations, many of which are brought into play by pressing rather obvious key combinations. For example, pressing ALT-S will generate lowercase sigma. Pressing function key F1 will highlight the character at the cursor.

Consistency is built into these operations, for example, ALT + SHIFT + S generates uppercase sigma; F1 + END will highlight to the end of the screen; and F1 + SHIFT + END will highlight to the end of the document. Other operations are less obvious since they branch to many possibilities, and one cannot have obvious key sequences for all of them. For example, once something is highlighted, what can be done with it? We may change face, change font, delete, copy to cursor, move to cursor, and so on. There may be further subchoices, such as change the font to script, italics, chemistry.

T³ deals with branching type operations by menus that attractively splash over a portion of the screen display when the MENU key F9 is pressed, giving the impression of assisting document preparation rather than interrupting it. Holding F9 down the whole time will suspend the actual screening of the menus, so habitual use of T³ can program the user to invoke keystroke sequences that bypass menus. These need not be learned up front, indeed may never be consciously learned, and they can be assigned to key sequences. The menus are always there when needed. Menus can also be bypassed through the use of key-sequences (called macros by other programs).

Cycling through menu options is accomplished by pressing arrow keys or the first letter of a desired entry. Acceptance of any choice offered by the system is made by pressing the ACCEPT key, which is the large plus key on the numeric keypad. In an uncomfortable position? Graceful escape to the previous activity or branch level is always possible by pressing the ESC key. Something badly botched? Press F6, the UNDO key, to retreat to a previous version of the document.

Shell documents are provided which can be copied and customized an unlimited number of times and contain margin settings, key sequences, keyboards, type size, and a host of other characteristics. Copy the BLANK MANUSCRIPT to begin technical typing right away, or make up a shell to be cloned, and a second shell to be used for manuscripts on a particular topic, and so forth. Making a shell is easily accomplished by typing a document, customizing as you go, then blanking out the text (or at least the part not desired for the shell) from a copy of the document.

Users can be assigned logon passwords and IDs, and have individual profiles set up with control over such things as directory paths, key repeat rates, pitch and duration of tones, and so on. These are easy to do by pressing F9, making a menu choice, and filling in the appropriate responses. Even one user may wish to set up different profiles, say with different directory paths. The user interface for T³ deserves to be emulated.

With the MATH keyboard assigned to the ALT key, lowercase sigma appears in the cursor position when ALT + S are pressed. This is the general pattern...
for all symbols from the many keyboards that can be simultaneously active in a document.

At any one time, only one of these keyboards is assigned to the ALT key, but pressing ALT + F2, then the UP arrow, cycles this assignment through up to 8 keyboards of your choice. One may also change a character already typed to a different font. Normally, the regular keyboard will be the IBM, and the alternate will be a technical keyboard, although any 2 keyboards can be assigned these roles. T² employs an insert character (shaped like a thin vertical line which fits between regular characters) invoked with the INSERT key, and removed either by invoking it again elsewhere, or deleting it with the delete key. To insert material, you type up against the insert character. In 2.2, this insert character may be locked to the cursor (i.e., insert mode). Insertions automatically generate reformattting of all subsequent material. If everything following an insertion is one extremely long document, without a carriage return, insertions are faster if a carriage return is typed right at the insert point. That way, continuous reformattting of the entire document is avoided.

Subscripts and superscripts may have up to 12 levels each in half-line increments accessed via the PgUp and PgDn keys on the keypad. Lines of text automatically separate to make room for PgUp and PgDn. The usual editing operations apply to superscripts and subscripts. Highlighting of subscript and superscript portions of built up expressions is now allowed, and these may be moved, centered, and deleted.

Editing operations are many and consistent, e.g., LEFT ARROW + CHARACTER to move the cursor to the closest previous occurrence of the CHARACTER. All the standard operations such as search and replace, automatic or manual pagination, hyphenation, etc., are supported.

Larger symbols are built in pieces, but the sequences of keystrokes required to produce all the typically encountered ones are predefined key sequences supplied with T². With 2.2, there is a drag operation (better thought of as a stretch) that is used to vertically stretch characters built with pieces, such as large integrals which can be made many lines tall by typing the key sequence for a large integral then dragging it up.

Where defined, T²TEX names have been used for key sequences, such as “underbrace” invoked in T² by CTRL + underbrace. T² shows the symbol in its appropriate section on the screen, but does not show the key sequence. In fact, with the exception of the insert point, cursor, and occasional temporary menu overlay, nothing appears on the T² screen that is not to be printed as is.

Line formats may be changed on the fly, and are called by concealed characters on the screen, which may be revealed to the user.

Additional keyboards can be arbitrarily defined as assemblages of the characters already appearing among those fonts provided with the system. This involves making the appropriate menu choice and highlighting keys on an attractive screen graphic depicting the keyboard being built up and the font being used.

 Entirely new screen and printer fonts may also be defined and incorporated in keyboards. This likewise involves menu selection: one sees a rectangular grid with a cursor that can be used to paint in the desired font. Dot matrix printers are best for this, since the separate activity of crafting the printer version of a font is harder for higher resolutions, and laser printers require some additional and nontrivial DOS operations to produce downloadable fonts.

T³ can justify on tab stops, center, or any character (including punctuation), which facilitates tables and other displays such as commutative diagrams (lots of symbols joined by arrows pointing in various directions).

Documentation for 2.2, which is being developed as this is written, is not available for review. The earlier documentation for 2.11, although quite complete, was hard to use because looking up one task tended to require reading other sections on related matters. TCI is aware of this criticism, and claims to have addressed this deficiency in the new documentation, which will reportedly have many self-contained “how-to” descriptions for key tasks.

A test version of 2.2 was used for this review. Installation was like that for earlier versions and, except for new features and some minor changes 2.2, ran about the same as 2.11. On a hard disk system, 7 floppy copies are copied into 2 directories. Screen and printer drivers are installed by running install programs and answering a few questions about the system. The earlier versions (2.1.x) taxed a floppy system, although the reviewer has seen one such system in continual use over several years.

T³ 2.2 requires 640K of RAM, one floppy and a hard disk, and a graphics display. For office use, an excellent system would consist of a high speed machine such as a 386 or turbo 286, Hercules monochrome graphics display, and a Bernoulli dual 20Mb cartridge drive.

TECH/STAR (formerly CharTech)

Version 1.0

Reviewed by A. Tetewsky

TECH/STAR is a MicroPro Wordstar 3.30/3.31 add-on that gives users all the Wordstar features plus the ability to create, edit, and display monospaced equations/attributes/alternate characters/alternate font sets on the screen via a WYSIWYG interface. If a user likes Wordstar, he/she will like creating technical memos with TECH/STAR. With the addition of MicroPro Spell-Star, MailMerge, and some third party add-ons for creating footnotes, index, and table of contents, TECH/STAR is capable of producing some technical papers. However, footnotes, indexes, and tables of contents will not be WYSIWYG, and users may lose the on-screen ability to view page breaks. To appreciate this review, the reader must know something about Wordstar.

Wordstar was one of the first successful wordprocessors for 8 bit computers running the CP/M operating system. The size of the files to be edited is limited only by disk space. The program is command-key driven with menus that can be turned on or off. It can show page breaks on the screen, has block operations for both line and column operations, and has a limited number of format commands (embedded markup language commands—dot commands) for headers, footers, conditional page breaks, changing the number of lines per page, line spacing, and for page layout defaults.

All Wordstar commands are assigned a unique control key code. Some of the more commonly used
commands are assigned to function keys. You can set the help levels to either display all menus, display menus only after there is a pause, or not to display them at all. Wordstar has a general abort command.

Wordstar has a top line that shows the file being edited, current page, line, and column number. Until Wordstar 4.0 comes out, users will have to use the DOS SUBST command to allow Wordstar access to subdirectories, or to its own overlay files. A ruler line is also present showing left/right margins and tab stops. In addition, there is room for an insert indicator and line spacing indicators. Special symbols, shown in column 80, indicate wordwrap, end of paragraph, or a line longer than 80 columns. Users can scroll left or right to see lines which are longer than 80 columns.

Wordstar has a set of printer control codes for setting attributes such as underlining, bolding, and super-/sub-scripting; the control codes can be displayed or hidden. Wordstar also provides 4 other printer control codes that the user can define via a debugger. Unfortunately, Wordstar does not display any of the attributes on-screen. Technical information is available for customizing and rewriting video/printer drivers. Armed with this information, Joel McClure, a physicist, started a company in 1982 to make Wordstar into a scientific wordprocessor. He rewrote the video and printer drivers so Wordstar could access and display special characters on many CP/M machines and the IBM PC.

TECH/STAR is designed for users who want to make Wordstar capable of handling equations. As long as add-on products such as Spell-Star, MailMerge, and Index/Footer only work with the input file, they can also work with TECH/STAR. (In last year's report, TECH/STAR was not reviewed in detail because it used a third party video driver, Star Polish, which gave unacceptable performance for equations. However, the new version of TECH/STAR is completely rewritten and easy to use.)

Printing is the only major difference between TECH/STAR and Wordstar. For some printers, before printing, a special character set is downloaded into the printer. On an Epson FX, printing is still slow.

Several methods of equation editing are available. One method that allows Wordstar to correctly paginate on screen will be described. By setting up the system for double spacing, doubling the page length, and working in 1/2 line mode, it is relatively easy to paint in equations line by line. Although equations do not move together as a unit, users can build up reasonably good-looking monospaced equations. Users can also nest many sets of attributes. TECH/STAR also warns users when they have mismatched control codes by flashing characters in the offending area.

TECH/STAR gives users two default installation options for working with equations and special characters. Users can either press the trigger keys one time to perform an immediate operation on one character, or users can work in toggle mode where they insert a control code at the beginning of a section and another control code at the end of a section. Thus, for toggle mode, "Ctrl-PE" GREEK "Ctrl-PE" out of Greek would work while in nontoggle mode, users would need a "Ctrl-PE" prefix for each letter. Control codes can be nested so that underlined italic Greek is possible.

While users can paint in as many simultaneous/super-/sub-script levels as needed for offset equations, one gets, at best, two levels for in-line equations—a Wordstar limit (except for a few printers with built-in super-/subscripts). Editing equations is as easy/hard as regular Wordstar is for attributes such as underlining. In general, equations can be entered in true WYSIWYG form but, during revision, users typically have to expose the control codes to see what they are doing. When control codes are exposed, all of the special characters are visible, but the horizontal alignment of final output is not displayed. "Ctrl-P" codes are shown before and after each character. Anyone comfortable with Wordstar will find editing equations is relatively easy with TECH/STAR.

Wordstar requires external software add-ons to gain capabilities such as footnotes, indexes, and other manuscript/organizational features. TECH/STAR's manual states that, "as long as the add-on package attaches at the input file point, it should work with TECH/STAR." Thus, Spell-Star, MailMerge, and programs for generating indexes should work, although they were not tested for this review. TECH/STAR supports page layout control as much as Wordstar does, i.e., the bare minimum. If double columns are desired, the user must set the margins equal to the length of one column and paste it up manually. Although moving columns and bringing them together is possible, any major editing changes become almost impossible. In terms of graphic imports, users can leave a number of blank lines and paste the graphics in later.

TECH/STAR does not include an import/export capability for sharing its input files with other wordprocessor systems. Nevertheless, TECH/STAR's input files are not complex, so a knowledgeable programmer would be able to write programs to directly process the input file. The Wordstar part of the file is documented in the Micropro technical manual. At my organization (CSDL), one of the programmers wrote special conversion software for Wordstar files containing equations from an add-on product to obtain output from an EBCDIC mainframe printer.

TECH/STAR's documentation is concise, and the software is easy to learn, assuming a previous knowledge of Wordstar. The documentation was typed and printed using TECH/STAR. Although the review was of a beta test copy, the documentation is similar to previous TECH/STAR (CharTech) manuals in that there is no index. There are no quick-help reference cards, but the tutorial is well-written. If a user is familiar with Wordstar, there is little else to learn. Detailed technical appendices on each supported printer are provided. Although the current version does not permit user-defined characters for the screen, it does permit user-defined characters for printing. Using an advanced display card, like the Hercules Plus, software for user-definable screen characters is planned for the future.

The TECH/STAR software installation is straightforward. The hardware installation requires the user to insert a ROM chip into the IBM monochrome display adapter. No hardware modifications are needed for using TECH/STAR on a Hercules Plus card, or on an EGA card.

In summary, TECH/STAR worked as advertised. The product could easily be recommended for those who want to keep using Wordstar for short technical memos.
Tech/Word 1.09
Reviewed by A. Tetewsky

Tech/Word uses a novel approach to create both inline and offset equations with WYSIWYG feedback for equations and symbols. (A related approach is used by EXP; see that review.) Tech/Word even allows creation of equations with up to 36 different sizes of integrals, summations, products, and other typical math figures. However, Tech/Word has almost no manuscript options and only minimal page layout options. Tech/Word was designed for short documents such as technical memos, chapters of a book, and small manuals in which indexes must be created manually. While the program can run on a minimum-memory PC, it is so WYSIWYG intensive for equations that the current implementation (in PASCAL) necessitates PC-AT (80286) hardware. Despite some rough edges in the current version, and the need for a PC-AT, I believe the product has the potential to be a good equation-oriented WYSIWYG wordprocessor—at least for short technical memos or individual chapters.

Tech/Word's user interface is command-driven using dedicated function keys: control keys, keypad/cursor keys, Alt keys, function keys, and combinations of all of the above. The "text" window is always displayed until a command key is pressed. Similar to WordStar, Tech/Word's screen shows a top ruler line, filename area, page number area, overstrike/insert indicator light, and a special marker symbol in column 80 which signifies whether the line ends with a carriage control, contains wordwrapped text, or contains a math structure.

Two major deficiencies were noted. First, the lack of any type of universal abort command to quit a command (or halt a command in progress). Second, the lack of even a simple undo key to recover from mistakes.

Tech/Word gives you most of the WordStar options for editing text, and the few embedded format commands that are available are patterned after WordStar's "dot" commands (but do not work quite the same as WordStar's). Editing operations are definitely no-frills because the main thrust of the package is for equations. Although Tech/Word displays the current page number, it does not display the current column. In addition, pagination has an interesting feature/annoyance (depending on your preference). On one hand, Tech/Word provides a jump-to-page command. Even if a lot of text is inserted and/or deleted after issuing a jump-to-page command, the user can jump back to the old page number location because Tech/Word must be told to update the page display markers. This is not too bad and many people prefer to maintain old page numbers. On the other hand, when Tech/Word is told to repaginate, it also does a save, a possible pitfall. Fortunately, there is a backup document with a .BAK extension.

Split-screen editing and windowing capabilities are not available. I am not sure what the maximum file size limits are, but I believe a file is limited by available RAM memory. Tech/Word also has the same "null" vs. "space" problem that WordStar has. There are no block column moves.

Tech/Word offers 7 fonts with roughly 90 characters/set: English, math 1, math 2, math 3, Greek, ibm graphics 1 and ibm graphics 2 (selected foreign symbols). One of the fonts offers italic versions of the English character set. Character sizes of 10, 12, and 17 cpi are supported if the printer will support it. Tech/Word does offer a unique way to get large characters for selected symbols.

Equations are created using a series of special commands to build up complex expressions in terms of 9 math structures, math enclosures which are automatically sized, 18 math figures (with 36 sizes), 9 on-line fonts, and 16 attributes. Math figures include integral, surface integral, summation, product, evaluation bar, and the 4 direction arrows. Math enclosures include parentheses, several braces, bars, and boxes. Math structures include super-/subscript, triple-level I- and C-shaped structures (integrals with limits and summations with upper/lower entries to the right side of the summation sign), fraction, square root, and matrix/table form. Equations are built up by nesting combinations of these options together into 1 unit, called a structure.

Equations are started with the outermost expression entered first, then continued to include nested subexpressions. Each time a math structure is created, the left/right arrow keys can be used to move to locations that must be filled in. While in insert mode, the user can keep adding to the same level within the structure. Enclosures and fractions expand and contract in size as needed. There are block commands for deleting, copying, and editing either the structure or expression within the structure. With practice, a user will become proficient. The indicator panel does not tell the user when the cursor is positioned at a "critical location." Therefore, it is not possible to determine if a structure is being deleted or if an expression is being deleted, making it more difficult to learn and master equation editing. This problem could be overcome by including more examples, and by including editing tips for each reference manual entry for each structure.

Tech/Word supports tables and matrices but lacks automatic alignment of entries—i.e., justify left, right, on decimal points, on arbitrary characters, or justification off. Changing the attributes of already existing expressions was also difficult, even though the indicators displayed the current attribute settings. Once again, the documentation could be improved in this area.

Tech/Word's method of creating and editing equations was appealing to me. Although limited to page layout of equations, users are relieved of most of the burden of setting up the equation. However, there are no options for tinkering with the layout of an equation. Tech/Word also comes with TechFont for designing custom symbols.

Tech/Word supports a minimum number of organizational features, such as headers, footers, left/right-justified headers and footers based on even page numbers, margins for the text and headers/footers, and control for restarting page numbering. In terms of graphics support, users can always leave a number of blank lines in documents for manual paste up later. Multicolumn layouts, indexes, and table of contents must also be done manually.

No add-ons, such as spell checkers, are currently available to work in conjunction with Tech/Word. If users need to import files, other than ASCII files, they must call the publisher. The publisher can supply WordStar importing utilities.
Despite problems with the Tech/Word documentation, the basic organization and concept is good. Incidentally, the current manual was created using Microsoft Word because that wordprocessor has automatic indexing and because the manual was being written as the product was being developed.

Tech/Word’s manual contains the necessary components: Introduction, Install, Starting the System, Terminology, Understanding the Screen, Quick Start Tutorial, Reference Guide, Appendices, and an Index. The Index has a key-code section and an alphabetical section. Although it lacks a function index, there is a foldout help card organized by function. Nevertheless, the manual would be improved if it included: a section on all limits (largest file that can be edited, equation nesting levels, etc.), a section on data interchange, better cross-referencing (for example, the ALT X entry in the reference section mentions that users need to alter an entry in PRINTER.COD, but PRINTER.COD is not listed as an index entry), and a section on advanced equation editing/altering of attributes.

Tech/Word comes on two floppy disks and installation is straightforward, even for a novice, as long as the user’s video and printer hardware is supported. Version 1.09 also supports the EGA card.

Tech/Word has a few problems: the current version is painfully slow on a PC or PC-XT, some of the user feedback prompts are poorly done, and users can generate internal error messages. Still, I liked the Tech/Word method for creating equations. With only a modest time investment, users can become proficient at generating and editing equations. With the next update, for short documents with equations, it is definitely worth a trial run. Large organizations may not find this product as useful because data interchange is currently undocumented (although Goldstein Software has written a few data interchange routines as needed).

fomath, Version 2.2
Grant Blank & Peter G. Ford
(with comments by Richard Goldstein)

fomath is a text processing program originally written for IBM mainframes. Its particular advantages are its wealth of sophisticated formatting commands, the modest demands it makes on PC RAM and disk memory, and the existence of compatible fomath formatters on several mainframes; its weaknesses lie in its poorly written documentation and nonintuitive command language. Much of the problem with the command language could be solved with better documentation. However, I (PGF) also think that other changes are needed including the addition of different modes, especially one mode for text and one for equations or other technical constructs. I (RG) disagree—there are advantages to a modeless system including simplicity, ease of use, and consistency.

For Math is a powerful markup language designed to handle an extraordinarily wide range of technical formatting applications, and gives the user control over the appearance of each output page. You can use any font and special capability of your printer. With For Math's rich language, you have access to the full Greek alphabet, a wide range of mathematical, technical and foreign language symbols, multicolumn output, and revision control.

The fomath distribution disk contains a copy of the fnmath.exe program, a set of printer and console definition files, and some test programs. The whole takes up about 300K bytes and is not copy protected; by throwing out what you don’t need, fomath will run on 128K of RAM and a single 360K drive (a PC-junior, even!), although I (PGF) would recommend at least 192K RAM and 2 drives. Installation just requires copying the needed files to your work disk. The version I (PGF) am reviewing (2.08) recognizes about 30 different output devices, covering the technological (and financial) spectrum from dumb CRTs without graphics, through many popular dot-matrix and daisy-wheel printers, to the Hewlett-Packard LaserJet printer. There are also versions of forMath for IBM/370 and VAX/VMS systems. I (PGF) tested the MS-DOS version on 3 machines: an IBM PC-XT with color graphics board and Okidata mu84 printer, a Leading Edge PC with Qume LetterPro printer (WPS and ECS printwheels), and an NEC APC-III with PC emulator, color graphics board, and Toshiba P351 dot matrix and HP LaserJet printers. I (RG) use fomath on a Compaq DeskPro, with a Hercules Graphics Plus Card and a Toshiba P1351 printer. Version 2.2, which came out as we went to press, adds some new abilities with only marginal increases in the size of the program.

The fnmath.exe program ran smoothly on the PC-XT and on the Leading Edge. It also performed adequately with the P351 on the APC-III, but a ROM BIOS problem in the NEC caused some problems, especially with a Hewlett-Packard LaserJet. I (PGF) moved the printer to the PC-XT, where it performed flawlessly.

In the best of circumstances, fnmath error messages are fairly cryptic and they’re not even mentioned in the manual. For Math also gives “warning” messages when you do something not conceived of by the vendor: my (PGF) favorite silly message was “unusual value ‘mn’ for parameter ‘zzz’.” These messages do not stop the program or inhibit its working in any way, though they annoyed both PGF and RG.

Against the growing trend to “what-you-see-is-what-you-get” wordprocessors, here is one that is unashamedly not. For Math does not provide any means of creating or editing its input files. Practically any editor or wordprocessor will do the necessary editing, provided it can save its text as an ASCII file. I (PGF) chose XYWrite II+ and Final Word II because they are very fast and can easily be made to execute the fnmath command internally, without having to return to DOS and back into the editor again. (RG uses KEDIT, a text editor, for many of the same reasons.)

For Math is a pure markup language—the output format of a document is controlled by a series of commands inserted within the text. Major divisions are defined via one line commands; special characters, font changes, etc., are included within the body of the text via cryptic character sequences, usually beginning with a back-quote ‘; a third level of control is available by commands that reset the values of over 200 internal formatting parameters. This multilayer syntax is similar to that of other mainframe markup languages such as runoff, scribe, and troff. For Math permits all the usual document divisions, indented lists, tables of contents, etc., including some really sporty features not commonly available on PCs, such as symbolic for-
ward references and the ability to have several alphabetically sorted multilevel indexes.

Like any markup language, equations, tables, and special formatting tasks use combinations of special symbols and commands. You can position material anywhere up to the resolution of your output device. Formatting commands are straightforward. The size and location of, for example, integrals depends on the other commands and, by default, they are scaled to the size of the integrand. You may override this automatic scaling if you so desire; for example, you may want 2 symbols on one line to be the same size, even though with automatic scaling they would be different sizes. Compared to many other TWPs, forMath’s commands are very terse. They are designed for minimal typing and forMath users quickly become accustomed to them.

Like the other complex TWPs reviewed here, forMath has a tremendous number of commands. First-time users may find this inhibiting until they realize that nearly everything they want to do on a journal-sized article can be done with only a few commands. As they gain experience, users will want to customize forMath. In the past 4 months, I (GB) have set up special versions of forMath to meet the editorial requirements of 2 journals and a book publisher. I (GB) also created a small macro library to simplify some repetitive formatting tasks. More advanced users can write very complex macros. Large organizations can set up macro libraries and set the default parameters to achieve a standard, consistent appearance for all documents.

This program is not for novices. To accurately reproduce our BCS benchmark, I (PGF) needed to use almost all of the possible forMath commands. Those 200+ internal parameters were a nightmare to figure out. I (RG) had much less problem, and believe that those people who are comfortable with markup languages will also generally have little trouble. Here’s a classic example—the command that enables right margin justification is \texttt{ analyze=180.} (These may, of course, be renamed. \texttt{ analyze} can in fact vary from 0 up to 180: 0 means no justification, 180 means fully right-justified, and intermediate numbers provide intermediate levels of justification.) Two particular tasks gave me (PGF) more trouble than everything else put together: font selection and mathematical text. Font commands are device dependent—e.g., font number 6 on an Okidata has nothing in common with font number 6 on a LaserJet. forMath does provide an explicit command allowing the user to map the fonts from one printer to the font numbers from another printer. There are no “higher level” forMath command of the form:

\begin{verbatim}
If the printer has a smaller font, switch to it; if no, never mind.
\end{verbatim}

The new version of forMath (2.2) changes this so that 1. to the user it will appear that the same font numbers are used for different devices, and 2. if a particular device does not have a requested font, then the program will ignore the request.

Novice users will find that the default options are usually well-chosen. This means that parameters can be learned as they are needed. Almost always, I (GB) could simply insert the appropriate commands and the table/formula/equation would be formatted exactly as I wanted. Knowing that you will not have to fight with your formatter to make your text look good is a very comforting feeling.

There is an automatic hyphenation algorithm, but I (PGF) found it unreliable when the minimum number of letters in each part of the split word is set to two, which is quite small. I (RG) have not found this to be a problem. The automatic hyphenation can be turned off entirely, and the user has full control over the size of the split. The user may also amend the hyphenation dictionary.

The 200 page reference manual was itself composed in forMath and printed on a Hewlett-Packard LaserJet printer. It’s a good example of what the program can do, but an even better example of how not to document it. Each topic, e.g., font selection, page numbering, footnotes, matrices, etc., appears in several disjoint segments throughout the manual. A table of contents and a series of multilevel indexes helps some, but not enough. Many of the 200+ internal parameters are given no more than a passing mention, and that isn’t going to satisfy the experienced programmer who needs a precise definition of where, when, and how a parameter change will take effect. forMath’s author is aware of this problem and a new manual is planned now that the major revision to version 2.2 is complete. Until that is written, the new features are documented in a long addendum.

There are, however, lots of examples, especially for equations and matrices. Further, the excellent technical support combined with a toll free number and a BITNET address go a long way to alleviate documentation weaknesses.

Now we come to the principal reason for this review—forMath’s mathematical expression language. Its syntax is powerful: able to represent most of the usual constructs of mathematics, chemistry, and theoretical physics, including matrices, multiring organic molecules, and simple Feynman diagrams. Like other TWPs, the more complicated the figure, the more complex the code required to reproduce it. A couple of examples will convey the flavor:

\begin{verbatim}
Here’s how you would describe these in forMath and also in eqn (a troff preprocessor) and in \TeX—my (PGF) favorite mathematical markup languages:

forMath: \texttt{ T' 131'2i; f(x)dx;} \texttt{ 'm31 n;}
    \texttt{ 'B+1S; i=1; 'M21 x'ui; i'2;}
    \texttt{ eqn: int from 0 to inf f(x) dx}
    \texttt{ sum from \{i = 1\} to n (x sup i) over \{i sup 2\}}
\TeX: \texttt{ \int_0^\infty f(x)dx \sum_{i=1}^n x^i \text{over } \{i^2\}}
\end{verbatim}

In comparison, the forMath commands seem much harder to learn—and easier to forget (in PGF’s view; I (RG) did not find forMath hard to learn; nor, as a user, do I forget the syntax). As the expressions become more complicated, those backquotes and semi-colons begin to pile up, and the language contains no simplifying element (e.g., English keywords) to help the eye (or an intelligent editing program) isolate one part from another. Users who feel that a more verbose language is an advantage can write forMath
macros to make the command language include English keywords like, e.g., the \TeX\ language. The backquote and other characters can also be redefined to any other character(s) you may desire. Thus, for example, one could define \texttt{\textbackslash INT}=`\textbackslash I31, \texttt{\textbackslash SUM}=`\textbackslash M31;\textbackslash B+\textbackslash I31;\textbackslash B, \texttt{\textbackslash SUP}=\texttt{\textasciitilde}u, etc. One would then write the two as follows:

\begin{verbatim}
new forMath: int'2i; f(x)dx; 0;
sUM n@ = 1@ * \texttt{\textbackslash M21} x \texttt{\textasciitilde}UPi; isUP2
\end{verbatim}

The differences are then trivial, and could be made even more trivial by redefining additional characters.

\TeX\ is device dependent, as is every other TWP (except \TeX). I (GB) do most of my work on 3 devices: a Hercules graphics screen, an Okidata 92 dot matrix printer and an HP laserjet+ printer. Switching between devices is transparent because I (GB) have written a separate customization file for each device. These files have grown as my formatting has become more complex and, currently, each contains about 20 commands, relating largely to differences in fonts and resolution. Because of the differing resolutions of various devices, especially screens and printers, I (GB) have not eliminated every difference between the devices: my goal was to simply produce good-looking output on each device without having to rewrite my files. That I (GB) can do this is a tribute to forMath's ability to customize almost everything.

forMath is not a programming language; you can define macros, even macros that are conditional, based on which specific output device is being used, but these macros cannot themselves perform conditional operations (there is no \texttt{if, then} capability). Macros may contain arithmetic expressions and may be nested. A genuine programmable macro facility would be a valuable addition to the language.

forMath shares many of the disadvantages of other sophisticated TWPs like \TeX\ and Lotus Manuscript: It is complex and requires hard work to learn its full power. Organizations using it would benefit from a support person. forMath is not a typesetter, it is not \TeX, but ask yourself, "When did I last typeset an article?" I (GB) find forMath appealing because its simple, terse commands allow me to concisely express sophisticated formatting tasks better than any other TWP.

As you can gather, I (PGF) found this program rather heavy going. It takes a long time to learn forMath, its manual is a disaster, and its input format is hard to browse and is printer dependent. If, however, you feel that the advantages—mainframe compatibility, modest storage requirements, and advanced formatting features—outweigh the disadvantages, go right ahead. With hard work, forMath will let you get the best out of your printer.

I (RG) did not find the program heavy going and found it relatively easy to learn. When considering the possible disadvantages of forMath, remember that it was the ONLY TWP in this year's review that could do all of Test Suite II with no programming external to its own language. Also note that all TWPs (except \TeX) are device dependent. Also, although \TeX\ produces device independent files, \TeX\ requires specific device drivers for each printer, with each driver costing between \$95 and \$275. A program for which everything, including printer drivers for about 30 printers, fits on one floppy diskette, and which has the power that forMath has, deserves any user's serious consideration. I (RG) would certainly recommend this program to individual technical writers who like markup languages, or to those organizations that can afford to designate a support person for the program.

The \TeX\ Markup Language and Two Implementations:

PC \TeX, Version 2.0

and Micro \TeX, Version 1.5

Commentary and Review

by A.G.W. Cameron

and A.K. Tetewsky

\TeX\ is a markup language primarily intended for producing technical text books. \TeX\ allows the user complete control over the appearance of the output page; in addition it also offers device independence, easy data interchange, operation on a wide range of computers (PCs, Macintoshes, IBM mainframes with CMS or TSO, and many Unix machines), a rich programming language, typeset quality output, the ability to automatically coordinate special Greek and math symbols into equations, and a wide variety of fonts. In fact, the product has become the primary text formatter for a wide range of professionals. If you are satisfied with the features and predefined styles provided by add-ons such as \texttt{\textasciitilde}TWP, \TeX\ can be easy to use. But like its high power competitors outside the MS-DOS world, Unix TROFF/NROFF with EQN or IBM Script and GML (with IBM's recently created scientific formatter add-on), if you want to create stylized custom documents, \TeX\ requires a long-term time and cost commitment. In fact, any organization that is considering using \TeX, or other high power competitors, should consider the hiring of a full-time support (\texttt{\textasciitilde}TWP) person.

This review is split into two sections. The first section covers the language, and the other section covers the Addison Wesley (Micro-\TeX) and Personal \TeX\ (PC-\TeX) implementations of \TeX.

Developed by Donald Knuth, of the Stanford Computer Sciences department, \TeX\ was started because Knuth became very dissatisfied with the way in which his books on computer algorithms were being typeset; what was originally a project for a few months became an eight year effort and culminated in a five volume series of books on computers and typesetting. The \TeX\book (Addison-Wesley) is the first book in the series and is the primary reference book for \TeX.

\TeX\ is a standard program which has been implemented on a wide series of computers. In general, only the machine dependent parts of the program are supposed to be changed, so that the device independent output files from the program may to transported between machines and may produce standard printouts from any \TeX\ device driver, differing only in resolution (which is device dependent), but always having the same text appear in the same part of the page. To facilitate such transportability, \TeX\ input files are composed entirely of printable ASCII characters. Implementations of \TeX\ must pass a "torture," or "trip" test successfully, as judged by Donald Knuth. The name \TeX\ has been copyrighted by the American Mathematical Society, and only those versions of the program that have passed the test may use the name.
\TeX's primary task is to enclose characters, words, lines, paragraphs, and anything else that can be printed on a page, in invisible boxes; these are then positioned relative to one another with an invisible binding material called glue. Sophisticated algorithms have been developed to hyphenate words and to break lines into paragraphs in the best available way, so that if possible a "tight" line is not followed by a "loose" one. The primary thrust of the program is to generate book pages, which are generally only one column wide. This is usually also suited for the generation of articles and papers for professional use. Macros have been developed to support double column usage, although they are rather complicated. It is also possible to program the text to fit around an irregularly shaped insert. But the current usage of "desktop publishing" products, which quickly and easily fit different items together on a page and which can be repositioned by manual interaction, is not supported by \TeX in its present form. On the other hand, none of the desktop publishing products break paragraphs into lines or hyphenate as nicely as \TeX, nor do they have commands that understand how to coordinate and typeset mathematical equations as beautifully as \TeX.

\TeX allows the user complete control over the appearance of the output page, and yet there are a large number of defaults that do not need to be changed under most circumstances. The language is extremely rich in control sequences, often quite lengthy, and you are expected to define your own control sequences at times in terms of other ones. The verbose nature of these may lead to some tiresome typing at times, but I (AGWC) find the long names helpful in remembering what the control sequences are and do. One useful feature of the language is that parameter changes can be confined to a specific region by enclosing that region in braces and doing parameter changes inside the braces; the parameters resume their former values when control passes beyond the closing brace. In fact, \TeX has 4 sets of general purpose registers, each with 256 elements. The language allows for association of a user-defined symbolic name with each register, plus the ability to dynamically allocate unused registers so that each add-on macro package need not worry about the simultaneous allocation of specific registers.

Some major macro packages have been developed for use with \TeX. There is the standard "plain" macro package which is the usual base from which the others start. This is extensively described in The \TeXbook. Other macro packages are usually quite restrictive in their usage, so that if you want to use them you frequently have much less control of the appearance of the page, in return for a little more user friendliness. The best known package is \LaTeX, for which there is a separate manual. \LaTeX defines a specific environment (several are available) and it is difficult to modify the package more than superficially. There are also related special programs called Slides\TeX for use in preparing slides and Bib\TeX for use in preparing bibliographic data bases. In particular, there is no way in which the current BCS benchmark could have been done with \LaTeX, so I used just the standard and least confining plain \TeX. In addition, the graphics part of the benchmark was only possible through the use of a FORTRAN program and the PostScript page description language; all indexes required an external sorting program because \TeX does not come with a sorting program. The American Mathematical Society has sponsored a macro package which outputs manuscripts in the style required by its journals; this is AM\TeX, and its manual is also available as a separate book. Institutions which use \TeX extensively usually prepare an "in-house" macro package, but this is generally much less extensive than the two macro packages that I have just described.

A large number of fonts have been developed for use with \TeX; here again the intent is to make these available for all environments into which \TeX is introduced. These fonts are generally based on the use of raster output devices, including printers and video displays, which have a wide variety of resolutions. These fonts have been generated with a separate program, METAFONT, which has also been developed by Donald Knuth. For several years, while METAFONT has been under development, the font families have been preliminary and have been called "almost modern" fonts. Currently the final set of fonts, now called "computer modern" fonts, are available and a slow transition to them is taking place. There are about 75 of them, but a lot of these are just different point sizes of a given font (but with some changes in basic parameters between different point sizes). For example Computer Modern Roman comes in 5, 6, 7, 8, 9, 10, 12, and 17.28 points for use with 10 point type. These are also available in a series of magnifications with magnification factors of 1.21/2, 1.2, 1.22, 1.23, 1.24, and 1.25. The number of point sizes available generally drops with increasing magnification. Other type styles available include italic, slant, and bold variants of roman, a similar set of sans serif fonts, many distinctive font faces, and a variety of special mathematical fonts.

Now about implementation on PCs. There are two vendors, Addison-Wesley and Personal \TeX; each of these now sells a Macintosh implementation as well.

The Addison-Wesley version is called Micro\TeX; the principal author is David Fuchs, until recently at the Stanford University Computer Science Department. He developed a program to translate \TeX from C. Addison-Wesley also supplies Micro\TeX and AM\TeX. The current version of \TeX supplied is version 1.5, which uses Almost Modern fonts. Micro\TeX relies on an installation guide and The \TeXbook for a manual; a special manual for the product is under development. Addison-Wesley showed a preview of version 2.0 of Micro\TeX at the recent \TeX Users Group meeting; this uses Computer Modern fonts and has a built-in preview feature which allows the document to be previewed on screen as \TeX is processing the document. Micro\TeX version 2.0 is still in the development stage. The Addison-Wesley version of METAFONT is still under development.

The Personal \TeX version of \TeX is version 2.0, and it also comes with \LaTeX and AM\TeX. The user may choose between Almost Modern and Computer Modern fonts. In addition to the installation guide, there is a good manual written by M. D. Spivak. The product is called PCTeX and its author is Lance Carnes who is President of Personal \TeX. He implemented the program in Pascal with sections in assembly language. Personal \TeX also provides a preview program called MAXview which operates separately on the device independent file produced by \TeX; this works on a wide variety of different monitors. Personal \TeX has started selling their version of METAFONT.
Both versions of \TeX have essentially the same user interface: the standard \TeX user interface. One problem for unsophisticated users is that error reporting is rather technical, which can be inhibiting to secretaries trying to learn to use \TeX. The vast mass of control sequences in the language can also be inhibiting, although once one realizes that nearly everything you want to do on a not-very-mathematical document involves the use of only a few control sequences, the program becomes fairly easy to use when trying to write a journal style article. At the other extreme, an advanced user can write macros of very great power. I (AGWC) consider myself to be at an intermediate level, and the processes of producing both the old and the new BCS benchmarks turned into valuable learning experiences for me.

Probably the biggest problem facing new \TeX users is producing tables. This has been rendered easier in L\TeX, at the expense, as usual, of complete generality. This is usually the procedure for which secretaries need the most assistance.

\TeX drivers exist for a variety of output devices. Both major vendors provide some laser printer drivers of their own design and also drivers for the Epson FX series of printers. Personal \TeX provides drivers for the 24-pin Epson and Toshiba dot matrix printers; these are far more practical output devices than the 9-pin FX series because they produce good quality output much faster. ArborText (formerly Textset) in Ann Arbor also produces a variety of drivers for laser printers, including the Apple LaserWriter for which one can merge text with graphics, which is not possible with the other devices (their upcoming revision of this driver will let you choose to use either Almost Modern or Computer Modern fonts). ArborText also provides a \TeX preview program. ArborText products are sold by both Addison-Wesley and Personal \TeX. ArborText and one or two other vendors have drivers for phototypesetters, which allow very high quality output to be produced from \TeX source files. ArborText has done the final typesetting for quite a number of books written using \TeX. Because it is possible to get \TeX device drivers for a wide range of printers, or to write your own, large organizations should be able to interface \TeX to high speed mainframe printers (e.g., Xerox 8700).

In conclusion, screen preview has made both the PC and Micro\TeX versions of \TeX more practical to use. Although the current version of PC\TeX comes with a beginners guide, Micro\TeX is also working on a similar guide; therefore neither version has a clear lead over the other. Most beginners will end up cannibalizing other user’s \TeX input files or using canned style packages to obtain results quickly. However, many large organizations are likely to prefer their own standards to the canned styles. These organizations can develop \TeX macro (style) packages for their publications and make them available to contributors to those publications. However, developing a style or macro package is nontrivial. They will need to commission a TeXpert to write macros for their selected styles and then focus support only on those selected formats. The choice between \TeX and its high-powered competitors (TROFF/NROFF, et al.) is not a clear one for those with mainframe or UNIX resources. For IBM PC compatible or Macintosh-based operation, \TeX currently offers the most capability for demanding technical typesetting applications.

Font sizes, line spacing, indentation, and justification of text within documents are controlled by formats. Unstructured documents are simply given a global format.
overridable for individual blocks. For example, an entire document can easily be switched from single spacing to double spacing. Furthermore, a single block of text can be made single spaced, indented, italic, and centered justified. As blocks are added, they can either use default attributes or inherit the format of the preceding block. Global and local attributes can be changed at will. Separate formats are used for the heading and text blocks within sections.

Equations are entered using a markup language. LMS includes the rudiments of Troff's EQN language, the UNIX markup language. Getting the equations to be properly proportioned with respect to text takes some effort. An equation scale factor, optionally specified for any single equation, can be used to adjust size. The dependency of equation size on printer selection complicates matters. Line-wrapped equations will need to be manually divided for reasonable appearance.

In an interview published in the December 1986 *PC World*, Jonathan Sachs makes a comment that "Software is like fruit, you pick it when it's a bit green." Improved equation handling is one area in need of the ripening process.

Some additional LMS features include document compare, spelling checker, and document import. Document compare is an extremely useful feature. The result of comparing two versions of a document is a printout with inserted text underlined, and deleted text struck out. The spelling checker is excellent. Text from 1-2-3/Symphony files, ASCII files, Document Content Architecture (DCA), and Think Tank files can be imported. Graphics from 1-2-3 and Symphony picture files can be included anywhere in a document by specifying the .PIC file name.

LMS software is contained on 8 diskettes, and requires at least 512K of RAM memory and 2 MBytes of hard disk storage. I would recommend greater than 512K of memory to have space for RAM-resident programs, since LMS uses essentially all the 512K. LMS supports all major display cards and printers. However, levels of printer support are uneven. For example, currently, print wheels cannot be changed during the printing of a document on a daisy wheel printer. Laser printers appear to have excellent support, including support for the PostScript language.

LMS's organizational capabilities do not provide for "front matter," such as the summary section of this year's TWP benchmark. "Back matter," such as appendices, are also neglected. Users lose automated organizational features such as automatic section numbering for complex documents and will have to revert to manual techniques. Some flexibility, such as a provision for restarting numbering sequences at any point in a document would greatly extend LMS's organizational power.

Another weakness noted in the organizational area is that the Manuscript "notes" can either be footnotes, section notes, or endnotes but not all three simultaneously.

A few users may be snagged by a conflict which can arise when LMS and one of the Microsoft "4.0 Version" languages are used on the same PC. Microsoft 4.0 languages (C and FORTRAN) ask their users to define an environment variable "TMP" to point to subdirectory "TMP." Later, LMS will report mysterious fatal errors when the user attempts to perform a memory intensive operation on a document because the file "TMP" is used for spooling memory to disk, by default, though this can be changed.

In summary, Lotus Manuscript offers a definite and welcome advancement for PC wordprocessing. Many functional features and some of the user interface aspects are sure to be eyed with envy by other wordprocessing vendors. Sophisticated features, like
the global and local formats, are well-implemented and easy to use. However, the sophisticated features of Manuscript give it an overwhelming nature, especially for learning, and to a lesser degree, for using. One should have definite need for the extra power of LMS to justify the toughness of learning this product.

Despite its shortcomings, Manuscript has much to offer. Given the large quantity of powerful and thoughtful features included in Manuscript, I hope that strategic improvements get made in the early releases of this product—improved LMS documentation, improved equation handling, full printer support for a broader range of printers, and greater document organization flexibility. LMS would then become a much stronger contender for the TWP marketplace.

Mass-11, Version 6B
Reviewed by Avram Tetewsky

Mass-11 is a technical wordprocessing system available for IBM PC compatibles and DEC VAXs. This review describes the PC version. Mass-11 offers both WYSIWYG and markup language interfaces: WYSIWYG for equations, a markup language for organizational features—using special function keys and a markup command—and a hybrid WYSIWYG/Markup for page layout. Mass-11 also includes simple calculator options, mail merge, and VAX-PC interlinking.

Recommended hardware for Mass-11 is a PC with a fast harddisk, and an EGA or Hercules card. Mass-11 has equation capability with any printer that has the DEC/TECH character set, as well as with Epson FX 80 and 85 printers, IBM ProPrinter, DEC printers, AMT, JDL and QMS printers, HP Laser printers, or Talaris printers. If both the VAX and IBM PC versions are used, a full-time support person is probably needed.

Mass-11 is for the person who wants a WYSIWYG processor for equations and only needs a medium level of capability in page layout and organization features. Screen preview of page layout and organization features would have to be sufficient. The current preview capability is limited to scrolling through the final processed document, although in future releases the ability to jump forward/backward will be added.

The PC version of Mass-11 is entered from a menu which offers Wordprocessing, Manager (Database product), Default Setups, Communications/Terminal Emulation, File/Data Interchange Utilities, Print/Review, and Terminate. After selecting the Wordprocessing option, and a document, work is performed in the text region until a function key is pressed. Entering text is straightforward. To modify the document, you must first exit the text window by initiating a command.

Mass-11 is command-driven by using dedicated function keys to enter all commands and options. In most cases, a minimum of user feedback is given while entering commands. However, the quick-reference cards were clear enough so an experienced PC user could quickly learn and operate the system.

To illustrate Mass-11’s command-driven nature, consider the single letter options, chosen to be as mnemonic as possible, offered after “F1” is pressed (F1 brings up a hidden command prompt): “X” exits and saves, “Q” quits with an “are you sure” prompt, “C” starts a block copy, “K” starts a block cut-and-paste, “M” triggers a menu of options (e.g., preview or split screen), and so on. Pressing “F4” at any time cancels the current command. Although “F4” is the universal abort command, there is only an UNDO for single word deletions.

On-screen pagination and soft page breaks can be displayed, and will be as close as possible to their true position when footnotes and other special constructs are neglected. The basic user interface only shows “insert” or “overstrike,” and italic/bold/underline attributes in the upper right-hand corner. When commands are issued, some of the final prompts will appear at the bottom of the screen. Whether the current page, line, and column number are displayed automatically is up to the user. When changing margins, a new ruler can be embedded at the current line that will cause all following text to obey that ruler. The ruler line also contains the line spacing data.

Mass-11 supports basic Greek and math symbols (DEC technical character set), and a chemical font set. Specifically, you get 1 English and 1 technical set, each with 96 characters. The supplied font styles are limited to italic, and font sizes are limited to printer supported 10, 12, and 17 cpi or selected symbols which can be built up out of smaller pieces (summation and integral signs). However, the user can include printer escape codes in a file. Equations that occur in a paragraph of text can only have one superscript or one subscript level: simultaneous super- and subscripts are not allowed. Super-/subscripts can be displayed with an EGA or Hercules Graphics Card.

Equations that do not occur in a paragraph of text, called offset equations, may have multilevel super-/subscripts. However, the super-/subscripts must be “painted in” during 1/2 line equation mode editing. This allows users to enter offset equations level by level as many levels as needed. Large math symbols are built up out of smaller graphics pieces. Equations are always edited in insert mode, but do not move and edit as a unit. While editing in equation mode, using 1/2 line spacing, each character of an offset equation can be bold or underlined. If these attributes are not initialized ahead of time, the top line indicator fails to show up, even though Mass-11 functions correctly.

Mass-11 also allows block changes of underline and bolding attributes. There is even an Alt-C option for creating special accent characters for Spanish, French, German, Italian, Norwegian, and Swedish.

For those who like WYSIWYG, all of the above features show up on the screen.

Mass-11 supports footers, headers, footnotes, table of contents, indices, and automatic paragraph or section numbering. Mass-11 does not support symbolic backward and forward references.

Footers and headers are created by embedding a markup command. To create footnotes, the text to be footnoted must be surrounded with reverse video F and E markers. This is accomplished by placing the cursor at the beginning of the footnote text and pressing “F3 F”, then moving the cursor to the end of text and pressing “F3 E”. The reverse video codes can be hidden by toggling the “F1 V” command on or off. Footers and headers can be previewed prior to printing by exiting, then invoking the preview mode.

Table of contents, indexes, and automatic paragraph numbering are done with embedded "<c>or "<i>com-
All other features are invoked with embedded marker symbols.

Page layout control is globally set by a default menu. Other changes are done on a per section basis by embedding a ruler line at the point where changes take place. These changes remain in effect until the next ruler line. The ruler line allows for bibliography tabs, center tabs, and decimal tabs that can align on "", ", "$", "=" or "%". MASS-11 contains other forms of special tabs also. There are left, right, and temporary, margins.

In addition to the ruler line, markup commands can be issued to set up n serpentine columns or related column demos. Equations that span columns must be pasted in manually. When creating related columns, alternating ruler lines that define the end of each related n column pair must also be created—typically with one full page ruler. The only page layout feature that appears in WYSIWYG form is the centering markup symbol.

Mass-11 supports screen preview, of both the complete document and of any specified portion of the document, but pages must be viewed consecutively. Pages may be skipped if specifically mentioned during the preview command (e.g., 3, 10, 12). In the future, MEC Corporation hopes to offer a preview option with jump back/forth to any page.

Mass-11 allows custom definition of the 10 key combinations. There is no true command language.

Mass-11 includes the ability to create some graphics on-screen using pre canned box and circle commands, as well as simple vertical/horizontal line drawing using the cursor. Embedded commands can also be used for drawing vectors by specifying coordinates. The ability to include graphics dumps from other programs, even at print time, is not possible. In version 6C, a graphics add-on package will be available.

At print time, the current printer can be overridden and another printer used.

Data interchange is limited to ASCII files with the ability to append/delete carriage returns, line feeds, and permutations of the above.

Mass-11 allows long file names to be specified and has a complete file management system. Mass-11 simply maintains a file that contains a mapping of long names into DOS names, thus it is possible to recover from file management errors.

Mass-11 has a list processing (Mail Merge) option that allows form letters to be filled in from a database file (Dbase III and VAX DCL files are not supported). There is also an on-line spell checking option, which is not customizable. The calculator option allows numbers in rows or columns to be summed, as well as they are tab aligned. Automatic recalculation is not an option, though you can recalculate. Finally, Mass-11 contains a simple file-compare utility called redlining. Simply put, if before editing a document, the user goes into redline mode, all deletions that were made will be shown in strikeout mode.

Although the amount of documentation is overwhelming (a tutorial notebook, an installation guide, a reference notebook, and several quick-help reference cards), I liked it. Mass-11 comes on 10 floppy disks and requires 2 Mbytes of disk space. Due to upgrades and slightly outdated documentation, the relatively straightforward install was ruined. Although with only three sentence fixes, installation is straightforward and the problems will be corrected in a future manual.

In general, the documentation contained all the necessary ingredients, such as a tutorial section and an indexed reference, that are deemed essential by the TWP review committee. In terms of technical information, printer information was quite detailed because, in many cases, the user must create the special characters for his/her printer. The major shortcoming is in the data interchange area—the internal formats used so that Mass-11 can export or import data between other wordprocessing systems.

Mass-11’s tutorial consisted of 10 lessons which take about 3 evenings to learn. I was able to do most of the lessons, and even when I made mistakes, recovery was painless.

Hopefully, MEC will be able to improve upon preview, in-line equation support, file compares, additional symbols, and presupplied complete printer drivers. In terms of audience, Mass-11 is targeted at corporations/universities with DEC VAX equipment. Mass-11 hopes to have PostScript support in the next version (7A). Because the PC product works best with a fast hard disk, home/office workers may not want to invest in it. Because data interchange with other wordprocessors/other markup languages is limited, integration of this product with anything but other Mass-11 systems on PCs or DEC VAXs will be very difficult. However, corporations with DEC VAXs, and moderately advanced needs will be interested in this product because it trades a certain amount of flexibility (e.g., forward/backward references, programming language options, consistent global settings with local overrides) for simplistic operation. I believe that WYSIWYG-oriented people will be comfortable with this system.

PS

Reviewed by A.G.W. Cameron
(with comments by A. Tetewsky)

PS is a technical wordprocessor that offers advanced equations, page layout and organization features, all via a ML with preview interface. Unlike other markup language systems, PS comes with a built-in editor. PS resulted from the marriage of two different products: PMATE (from Phoenix Software Associates), a technical editor, and the Scroller, a text formatting program which was originally implemented in ROM on insert cards for daisy wheel printers.

In addition to normal editing functions, the PMATE editor offers advanced programming power such as the ability to check mismatched enclosures in C, FORTRAN, and other languages. Scroller offers advanced page layout facilities with internal 300 dpi precision. If you are looking for 1 system that can serve as your program editor, wordprocessing editor, scientific wordprocessing editor and page layout typesetter, you should consider PS—especially if you like a product with a rich programming language. On the other hand, unless you are good at programming the PMATE editor, creating your own data interchange and printer hardware command files, you may not be able to use this system to its full potential.

For nonprogrammers, the PS version of PMATE comes with a complete set of macros to make it completely command-key driven. Each function key brings up Lotus/Multiplan-like menus. In addition, control
special keys and displayed escape will always return you to a text window, if you accidentally enter raw PMATE mode, “control C control C” will bring you back. It is best to ignore the manual on this point and use control C to abort all commands.

The basic PMATE interface dedicates the top 2 lines for status information, and the remaining lines for text. The top line contains the file name, the current buffer (there are 11 buffers), the most recent argument evaluation (an advanced PMATE feature that can also do math), and line and column number. The second line contains insert/overstrike indicators or menus or the PMATE command line. Many control keys can be used to bypass menus. For example, control W will delete a word and control R will undo the last delete (you can make buffers large enough to undo the last N deletes). Control X is an instant command to go into command mode, where all commands are entered on the second line and terminated with two escapes or aborted with a control C control C.

To understand how PS can be made to do advanced equations, page layout and organization features, you must understand PMATE command language and its related macro facility. The command language is a true computer programming language since it supports integer arithmetic and has an if, then, else capability. As noted earlier, the editor has 11 buffers. One buffer is for normal text editing and the others can be used for a variety of purposes. An additional buffer is normally used for menu manipulations and some of the others have occasional specialized uses, but all 10 could be used for the benchmark exercise if desired. There are also 100 user available variables, or counters, which can be used in a variety of ways. Execution of commands and command macros takes place in command mode. Macros can be stored in files or internally in permanent macro storage. Macros can also be automatically loaded into buffers and control can be switched to them and back from them as desired (this is the PMATE equivalent of a subroutine). PMATE also has fairly standard insert and overwrite modes. It has never been completely modernized, so that it does not take advantage of all available memory and the screen can show the contents of only one buffer at a time. On the other hand, larger files are efficiently buffered to disk.

You insert control commands or escape sequences into your file to give the scroller its formatting instructions. An escape sequence consists of an escape followed by a character (which need not be alphanumeric) followed by arguments if applicable. There is also a dot command facility in which the dot is a period that must be the leading character on a line and is followed by one or more pairs of characters separated by spaces, with numerical arguments interspersed as necessary. The dot commands are themselves defined in terms of escape sequences, so they are just a convenient form of notation. Dot commands can be used within text lines by surrounding the pair of characters and any argument by backslashes.

Equations are entered using a variety of markup commands except that most special characters are shown on-screen. Thus integrals, fractions, and other large constructs/coordinations are done with markup commands and single height characters are entered via special keys and displayed WYSIWYG style. Because PS is a powerful editor, you can define temporary variables to be text strings and build up equations in pieces. For example, \( de = \frac{F + 3}{(25 - K)} \) defines “de” to be a string and it could be used in an equation to include \( F + 3/(25 - K) \) in multiple places. Thus, for an equation with “de” in two places, \( L = : de + 1/de \) would do the trick.

PS did the older 1985 benchmarks with the exception of three benchmarks which required the drawing of lines. The author of PS indicated that those drawings would normally be pasted into the text. However, he could have done the lines too, using the drawing capability of PS, which can form a line by banging away with the period, shifting the position on the paper by minimum amounts in the vertical and horizontal directions between strikes of the period. The more recent version does the equivalent with much finer control using a laser printer. I (AC) used a somewhat similar procedure to do the first set of benchmarks in TeX.

With the newer 1986-1987 benchmark, I (AC) would carry out a similar tour de force with PS that I actually used with \( \TeX \), although the actual procedure would be quite different. The objective would be to mark up the input document with a combination of scroller commands and PMATE markers. The scroller command markup would be routine and would be concerned with positioning things on the page, including a floating insertion of space for the figures.

A tremendous amount of tedious programming would be needed to do all these things. This is not the way one would choose to do it in practice, any more than the corresponding procedure for the \( \TeX \) benchmark would be used in practice. But the existence of the capability to do all these things with both of these systems demonstrates the tremendous flexibility and power of each of them. Some elements of the procedure are in fact practical ways to do some of the things that the output of a real document would require.

The preview shows on the screen a representation of the text as it will appear when printed. Actually there are three types of preview, only one of which shows the actual positions of line and page breaks, and this one is not quite WYSIWYG, since the font used is an internal one, but all one cares about is where these breaks are. The preview requires either the use of a proprietary PS ROM in a Hercules Graphics Card, or (without a special ROM) using the Hercules Graphics Card Plus.

Because PS does not document its internal formats, you will be hard pressed to find spell checkers, and import/export capabilities for this product. On the other hand, if you can program PMATE, you can implement almost anything but the spell checker.

The PS manual, printed with PS, is organized by the main function keys—edit menu and introduction (with overview), saving/retrieving, searching and replacing, printing/previewing, buffers, user-definable keys, PS/PMATE programming and miscellaneous commands. Although the manual includes several appendices—getting going plus a DOS tutorial, PMATE editing commands, command character summary, dot commands, escape commands, eFont connection, configuration/installation, error messages, and index, the manual we received was one version out of date and failed to tell the first time user that the installation section was in an appendix!

Ease of learning and use of PMATE and the scroller is adversely affected by the terseness of the
There are so many of them that one is constantly consulting the manual to do anything out of the normal routine. On the other hand, the capability of the program is very high. PS suffers from the mechanical constraints imposed by its development for use with daisy wheel printers, and hence from the limitations of the contents of specific print wheels (and currently from the contents of specific laser printer cartridges). However, PS does a very good job of building up mathematical expressions from component elements, including large integral and summation signs.

Documentation for both PMATE and PS is very terse, which makes it difficult to figure out how to use some commands or to understand their limitations. The normal PMATE documentation does not come with PS, which has only a list of the PMATE commands.

On the other hand, the manual is refreshingly honest, and there is even a section that listed bugs that were found in the previous release and those features that have not been extensively tested with selected printers. Despite some of the documentation shortcomings (which can be overcome via the good technical support), this is a very powerful product. Power users will like the editor; however, corporations must be willing to commit to PMATE and a full-time support person for writing custom style files before turning this product over to users. If small size (360K), WYSIYWG with ML+preview, and a powerful editor appeal to you, give PS a trial run.

**SAMNA WORD IV, 1.0**

*Reviewed by Richard Goldstein*

SAMNA WORD IV is a full-featured business wordprocessor with some technical ability. WORD IV is basically a WYSIWYG-type wordprocessor, though elements such as headers, footers, and footnotes do not show on-screen as an integrated part of the document. Unlike many of the other products reviewed here, WORD IV was not designed to be a TWP—its primary market is clerical typists who use the product heavily every day, and who may need the ability to reproduce technical constructs in a document.

Though WORD IV has some technical ability, this ability is somewhat limited by design (e.g., superscript and subscript are limited to half-line movements) and with respect to one's output device. At present, to print the characters from the Greek/math keyboard, one must have a printer that SAMNA supports and that has the ability to accept downloaded fonts. Using a downloadable font that is not recognized by SAMNA means that you must ignore their Greek/math keyboard; the output will be correct, but the screen will not show the same characters at all. WORD IV does not at present, ship bit patterns to the printer. WORD IV does have the ability to download such patterns if the user designs them. With these printers, WORD IV is not able to print out math or Greek characters unless the user designs these bit patterns. Even if you have the correct printer, WORD IV's limited ability regarding technical constructs means that only those who want to use fairly standard equations, and only a few of those in any given document, will be happy with this product.

To put in an offset equation, for example, one must define an "equation area" of between 2 and 20 lines. This area is now defined, vertically, in half-line increments, and one proceeds to enter the equation. This process is generally acceptable except when one wants to print in a small font (assuming SAMNA supports this). The usual reason for using a small font, of course, is to get an entire equation on 1 line. If there are more than 78 characters in one's equation, then it will not look even approximately correct on the screen. In fact, since wordwrap is off when in an equation area, you may have some trouble entering the equation. Longer equations can be entered by aborting several of these equation areas. SAMNA WORD IV was able to do the standard equations in this year's benchmark, and the nongraphic benchmarks from last year (see Table 2C in Part II, February 1987 Notices, page 274).

Installation and starting the program were quite simple with no surprises. SAMNA supplies a picture of each of the keyboards that one can use (e.g., Greek/math). This is tolerable, but a physical template that actually fits over one's keyboard would be better. The documentation is generally clear and, after a quick-start section, is all alphabetic by command. There is an index, but numerous page entries are incorrect causing one to flip around a few pages prior to, or after, the page number in the index. (I am told that this is a printer problem—the manual was typeset—and has been corrected.)

SAMNA WORD IV does have the ability to do some of the things requested in this year's benchmark (e.g., table of contents, index), but even these abilities are quite limited (only one index easily, for example). Other abilities tested were not present, including automatic numbering of several different things (equations, tables, figures, list items) and symbolic referencing. One advantage WORD IV has is that the index and table of contents are placed in normal SAMNA files which can be edited to provide you with additional indexes or tables of contents (list of figures, equations, tables, etc.). Thus, with some inconvenience, one can have more than one index, etc.

All wordprocessors that I know of, that do an index, form it in one of two ways: 1. as you go through the text, you mark off individual words or phrases to be included in the index, or 2. you set up a separate list of index words, and the program goes through your file including all instances of that word or phrase. SAMNA uses the second form. Each form has advantages.

With the first form, it is easy to choose just which instances one wants in the index and, more importantly, it is easy to emphasize certain entries. Unfortunately, it is also easy to miss one or more instances that should be included. The second form does not miss any instances, but it is hard to emphasize certain entries and hard to delete certain instances if one does not want them in the index. SAMNA's procedure of putting the index in an editable file largely alleviates these problems, since one can enter the file and delete or emphasize particular entries. Certainly, the second form is easier to use. Of course, with a WYSIWYG program one must ensure that the final formatting and paginating is finished prior to forming the index.

The biggest problem with SAMNA WORD IV for writing technical material is the small number of counters: just 3. Our benchmark called for many more counters (page numbers, footnote numbers, table numbers, equation numbers, figure numbers, chapter/
section numbers, list item numbers, and bibliography [reference numbers], and it is easy to imagine a need for more. In addition, the benchmark included 3 indexes and 4 tables of contents, which some programs handle via individual counters.

If you like WYSIWYG systems and your technical demands are relatively small, then you should definitely look at SAMNA. If the next version of SAMNA were to add more counters (I believe there should be at least 12) and add either downloadable bit patterns or character outlines to ease the printing of technical constructs, then, with its other abilities, this product might be an excellent WYSIWYG type TWP.

Scientific Word Processing Enhancement
Reviewed by Marilyn Horn

Scientific Word Processing Enhancement (SWPE) is an add-on product to facilitate scientific wordprocessing with WordPerfect. SWPE works by replacing the characters in the "extended character set," which are not usually used in wordprocessing, with a set commonly needed for scientific (technical) wordprocessing.

Two major components of SWPE are for the display and printing of these specialized characters. A third component is for the entry and modification of mathematical constructs in WordPerfect; this element uses predefined macros extensively.

The first component of SWPE, the method for displaying the special characters, depends on your display adapter. For those with an EGA card, a scientific font and font generator are provided which use the downloadable character feature of the EGA. For those using one of the other major cards, MDA, CGA, and HGA, a replacement EPROM chip is provided which displays a different set of characters for ASCII values above 127.

The second component consists of custom WordPerfect printer drivers, downloadable scientific printer fonts, and a printer font generator. The third component is a collection of WordPerfect macros to be used in technical wordprocessing with SWPE.

While providing a fairly convenient means to achieve a substantial level of technical wordprocessing capability, there are some accompanying disadvantages.

SWPE is a product deserving serious consideration for several reasons. First, it allows you to use WordPerfect virtually off the shelf; no changes are made to the software. While minor changes to the macros or the printer drivers may be necessary when new versions of WP are released, the main component of SWPE, on-screen scientific characters, is not version specific. SWPE users can take advantage of WordPerfect's full range of features and excellent support without missing out on future WordPerfect enhancements. Second, at $75.00, SWPE is affordable by even the most cost-conscious users. Finally, it is uncomplicated and requires very little extra learning time if you are already comfortable with WordPerfect's basic features.

The obvious disadvantage to using SWPE is the loss of compatibility with the rest of the PC world; however, for many users this is not a problem. Consider the following:

1. Since only the character display is affected, your other software will run, but it will look strange if it uses the IBM extended characters which SWPE redefines.

2. You have gained scientific characters at the cost of the other characters you might need, such as the European foreign language characters and box characters.

3. Third, if you need to exchange scientific wordprocessing documents files with colleagues, all of you must use the same character fonts, or the documents will be incomprehensible.

If you are concerned about compatibility issues, but are intrigued by this product, consider using the EGA version. An EGA is a bigger investment, but if you need to use the standard IBM font you can switch easily.

You should also make sure that your printer is one of the few that are supported (Toshiba, Epson, Panasonic, Proprieter, IBM Graphics, and HP LaserJet with the J cartridge). WordPerfect and SWPE users should choose a printer capable of reverse half line feeds to take advantage of WordPerfect's Line Up and Line Down features.

The method of installation depends on your hardware:

- EPROM (non-EGA) versions: Install the new EPROM on the video adapter board, following the documentation.
- EGA version: Download the EGA font. (Create a batch file to do this, since it must be done with each reboot.)

All versions: Copy SWPE's custom printer drivers and macros into your WordPerfect. (If you have created special WP printer drivers that you want to save, back these up first.) Read the documentation about the macros provided; many of them are near duplicates; for example, there are separate sets of macros for floppy-based systems and hard drive systems as well as for 10 and 12 pitch. You may want to eliminate ones that you don't need. I strongly recommend using the macro editor that comes with WordPerfect Library in conjunction with this product; without the macro editor you cannot view macros on screen or print them out.

Load WordPerfect, define ALT/Control keys for the symbols you need, and start processing.

When you need to create an equation, press the macro invoke key and the name of the equation macro you have chosen (depending on your font and default drive). The macro creates a "window" in your document, changes to half-line spacing, and puts you in typeover mode. It also gives you reference marks on screen so that you can tell if any of your lines are too long. It is important to avoid wordwrapped lines in using a formula painting approach, since they throw off the alignment of subsequent lines. When you finish, toggle the insert/typeover key and continue with your text.

If you forget how the special characters have been mapped to the ASCII number codes, there is a very clever macro that displays a chart in a window in the lower half of your screen (actually in Document 2; you may use this macro even if you have two documents open); another macro restores it.

One of the best set of macros allows you to move a user-designated number of lines of the equation 1 or 5 places to the left or right. This solves the problem of keeping related characters together when you must insert text. Other macros make it easy to use over-
size symbols like summation and integral signs. Since these special symbols are actually composed of 3 characters, they are difficult to position correctly without the macros. Note that these macros are for specific, fixed sizes of these symbols.

I found SWPE (tested with the EGA version) to be a very impressive and worthwhile add-on for WordPerfect. Much thought has been put into its design, and the documentation (stapled sheets of xerox copied pages) is clear, if fragmented.

I would recommend that the several separate pieces of documentation be integrated into one booklet; it is difficult to find information with so many different pieces, especially since addenda paragraphs are just stapled onto the relevant page of the documentation. Descriptions of all the included macros, for example, should be together. Redoing the document (using WordPerfect) would be a simple matter and would make the product much easier to use. The whole is easier when the parts are all (or none) of the endnotes have equations, this does not present a problem; however, creating even a single footnote requiring half-line spacing will require the use of an add-on product like SWPE and TURBOFONTS. (Note: The use of an add-on product like EXACT does not require half-line spacing. However, the EXACT reviewer found that he needed to use an EXACT command in order to create the line separating the footnote from the remainder of the page.) While it is possible to change the line spacing in WordPerfect footnotes and endnotes, I discovered that:

1. Line spacing for all footnotes on a page will always be the same, no matter where on the page the footnote options are changed. If more than one footnote on a page is rarely needed, this is only a minor inconvenience; extra blank lines and hard returns must be inserted in some of the notes.

2. Line spacing for all endnotes in a document will always be the same, no matter where it is changed. If all (or none) of the endnotes have equations, this does not present a problem; however, creating even a single note requiring half-line spacing will require the use of half-line spacing, blank lines, and hard returns in all endnotes.

Still another WordPerfect endnote limitation is that material in endnotes is not included in tables of citations and indexes. Finally, WordPerfect puts the endnotes at the very end of the document, so that if they are needed before the bibliography, for example, page numbering sleight-of-hand will be necessary. Given these considerations, it is best to use WordPerfect's footnotes instead of endnotes, whenever a choice is possible.

In summary, WordPerfect is a full-featured, flexible wordprocessor designed for general wordprocessing. Coupled with an add-on product, applications re-
TechWriter, Version 3.0
Reviewed by D. Curtis Deno

TechWriter is a mature microcomputer technical wordprocessor with a WYSIW interface. The latest version (3.0) is backward compatible with previous versions and provides additional features. Copy protection has now been dropped which makes it easier to run on a wide variety of IBM compatibles. TechWriter smoothly supports a number of common equation, layout, and organizational needs. It is not a typesetting TWP, but it is a solid WYSIWYG implementation that offers some of the features of strong markup TWP's. It can do all this, including on-line help, and run well on a very modestly equipped personal computer (360K dual floppy drive, 256K RAM, 4.77 MHz 8088, CGA graphics screen, i.e., an original IBM PC). It is better, however, on larger, faster personal computers with higher resolution screens, and high end printers (24-pin dot matrix and laser printers).

TechWriter is built around an editor similar to those of many other wordprocessors: a text window and special keys to invoke commands. There is a top status line that displays file name, line, and column number, insert/overstrike/math mode. TechWriter uses the escape key to abort any command, and you can undo the last 10 deletions or replacements.

The editor has 3 display modes: Formatted (margins and all constructs show on-screen), Unformatted (all format commands, escape sequences to turn special attributes on/off, are visible with text around them), and NoMargin (same as Formatted except margins are suppressed on-screen). The editor shifts easily between them. Although the general philosophy is to avoid forcing the user to write in format codes directly, it is sometimes necessary (particularly with complex constructions) to leave the comfort of the formatted screen. A four color keyboard overlay is supplied and special keys on the keyboard are available to invoke commands.

While GNOME is quite powerful, it does not allow you to embed comments in the source code. GNOME is stack oriented, has integer and string variables, global and local variables, math operators, and hooks into DOS file handles/keyboard/screen and print routines. GNOME reference manual is included in the appendix.

TechWriter offers 4 symbol sets with 96 characters/set, 10 and 12 cpi font sizes, and italic or regular font styles.

An equation is entered by typing the BEGIN EQUATION keystrokes (labelled by the keyboard overlay). Then, the user proceeds to "paint in" the equation symbol by symbol. Almost everything shows up on screen as a good approximation to what will be printed. This includes superscript and subscripts, bold, italics, underline, and special symbols. There are Glossary entries to help make large constructions such as summation signs and parentheses. Generally, however, the cursor is moved to the appropriate location and the character typed. This lacks the ease with which a markup language TWP could substitute, for example, an x-sub-1 for an x since additional horizontal and vertical space required by the subscript may throw off alignment elsewhere. In general, parts of equations do not edit or move as a unit. A WYSIWYG strength is to show the results immediately, however. TechWriter is solidly constructed so that when it looks right on the screen, it will print correctly on the paper.

Although page layout may be changed by typing format commands directly, it is easier to summon a status table with the Display Format key. This table may be altered. Many of the standard settings are accessible including tabs, margins, line spacing, page length, indentations, etc.

Similarly, footnotes are made easy to create by using a key sequence BEGIN FTNOTE, entering the contents of the footnote, and finally typing END FTNOTE. Footnotes, equations, and page numbers are automatically incremented but section numbering schemes require the user to deal more directly with the format commands which set up counters, increment, and print them. Symbolic forward and backward references are not supported. Space may be reserved for figures or tables and text can slide or float around these if there isn't sufficient space remaining on the page for the figure or table. Tables are constructed primarily by tabs or may be "printed in" as equations if they are to contain vertical and horizontal lines.

TechWriter can import text in straight ASCII from other wordprocessors or files. This process is quite slow, however (up to 1 hour for 20-40 Kbytes). The vendors have just produced a new conversion utility. A test of this utility on our benchmark file showed that the import time was reduced from about 40 minutes with their old utility to 35 seconds.

TechWriter exports ASCII fast through its "TTY" (teletype) printer driver which assumes the printer is capable of nothing more than simple alphanumerics and punctuation. Although TechWriter's internal document format is binary, the specifications are covered in the documentation and a TechWriter ASCII version may be created which is readable by other TechWriter software.

Two add-ons are offered by CMI Software for TechWriter: a 120,000 word dictionary spelling checker, and a pixel-based font designer. Neither of these were tested in this review, but the spelling checker seems well-integrated and permits a "personal" dictionary as well. Custom characters apparently replace others already defined.

TechWriter is provided with a good user's manual with installation, overview, and technical detail sections. This well-organized manual was written with TechWriter itself and printed on an HP LaserJet Plus laser printer. Although not quite as exhaustive as requested in the BCS document benchmark, the manual shows off TechWriter's good header and footer control, automatic equation and section numbering, table of contents generation, and alphabetized index creation. In addition to the user's manual, a new tutorial guide for version 3.0 is due soon.

TechWriter responds reasonably fast on a 4.77 MHz 8088 based microcomputer, paging through a document (in full graphics) at about 1 page per 2-4 seconds. Printing on a low end dot matrix printer
with graphics can be very slow (minutes per page) but TechWriter will take advantage of downloadable fonts and font cartridges on high end dot matrix printers and laser printers. As a result, about 1-4 pages can be printed in 1 minute. Although TechWriter permits concurrent printing and editing, the editor's speed suffers substantially. At the time printing is to begin, one may request output be directed to a disk file (usually for later printing), change the default printer driver type, or a number of other options. Disk file output facilitates users sharing a single laser printer.

TechWriter is also a robust product—you don't lose data. On the other hand, editing equations can be tricky. In some cases, when you do nested attributes, it may be necessary to enter unformatted mode, exposing all of the on-screen escape codes, to directly manipulate these codes. Thus, the user must understand the basic concept behind escape codes to overcome occasional equation editing problems.

Learning such a TWP is a substantial investment in time. Within a few hours of pondering the manual, a novice could begin to create useful work. Serious skill and comfort with TechWriter is likely to require a few days of use accompanied by frequent referrals to the manual and quick-reference card. Still, my learning curve was shorter with TechWriter than \TeX{} (AMS-\TeX{}, \LaTeX{}). I was favorably impressed with the telephone assistance I received even before I identified myself as a reviewer. On the other hand, unless you talk with the actual software developers, you will not be able to get technical help with GNOME.

TechWriter is a mature, fairly fast product with a highly visual interface. It can run comfortably on a floppy disk-based PC at home and an AT class machine with laser printer at work. Although a WYSIWYG TWP, it supports several features of markup language products, but lacks their elegance. Its spelling checker, table of contents and index generator abilities, and strong header/footer capabilities put TechWriter in the class of good business wordprocessors for general wordprocessing, although TechWriter does not offer split-screen options. The support and documentation are good.

TechWriter is less for those who regard their TWP as a sophisticated program and more for those who think of their technical writing visually. Because TechWriter can run on a minimum PC, home users may be interested in this product. Large organizations may also be interested in this product because the internal formats are documented and a number of data interchange programs are already included.

WordMARC Composer, Version 86.09.08.C
Reviewed by Richard Goldstein

WordMARC Composer is a full-featured WYSIWYG-type wordprocessor that runs on a number of microcomputers, as well as on IBM PC-type machines. You may purchase an optional product (LinkMARC) to ease the transfer of files across the supported operating systems, an important consideration for many organizations. The PC version requires a hard disk, and, if you can afford it, a very fast hard disk is desirable. I used WordMARC with a hard disk that has an average access time of 30ms, noticeably faster than the AT's specification, yet I found myself impatiently waiting for a response more than once. WordMARC has many organizational features that are important for long documents, several very well-written documents, and an excellent safety feature. However, the equation writing ability, although far above that of most technical wordprocessors, is still somewhat weak. In addition, an oddity of WordMARC's system of counters also weakens the program with respect to long documents.

Entering and editing text is fairly straightforward and fairly powerful. Virtually any editing or movement command that one would like is present, though some of them work in unusual ways. For example, when performing a "search and replace" on a word, you can replace entire words or any arbitrary back part of a word, but not just the front part of a word. There are some other inconvenient features: the entire process uses function keys very heavily, but there is no keyboard overlay; errors, or warnings, are announced by a loud, objectionable beep. On the other hand, there are some truly excellent features including RECOVERY, a procedure that automatically saves virtually all your entries to the document in case of a crash.

Entering equations can cause some problems, but is basically straightforward, though tedious. All characters must be entered and there is no automatic sizing of any symbols or enclosures. For some constructs, the tedium could be somewhat alleviated by building macros, but this is inconvenient both to do and to use—imagine having and remembering the names of different macros for each regularly used size of each symbol (summation, integral, parentheses, etc.). There is also a problem with the line that separates the numerator and denominator in a ratio if the numerator has any subscripts or the denominator has any superscripts; the problem is that one has to enter the line last, whereas if there is no subscript in the numerator and no superscript in the denominator, one can enter the line automatically as the ratio is entered. There are some workarounds for this, but I found them inconvenient.

WordMARC Composer sends bit patterns or outlines to some printers, including all supported 9-pin printers and some 24-pin printers. For all other printers, you need the font cartridges or downloadable fonts—fortunately the manual tells you which font from which third-party vendor to use.

The installation process is easy though time-consuming. The installation process does append material to your autoexec.bat and config.sys files (or creates them if they don't exist). You are warned about this in the manual. Being nervous about such things, I first made copies of these files and then installed the program. The two files were smoothly written to, and I found absolutely no problems; the program offers the user the option to modify these files and have the installation program ignore them.

The documentation was generally very clear and well-written and was not patronizing at all. There are several books ranging from very brief quick guides through a tutorial book, a standard reference book, and a fairly detailed technical reference manual. The only problem I discovered was in the tutorial which describes several things incorrectly (some of these are noted in a special insert, "Additional Notes"). The indexes in each of the main manuals are quite good.

Although the tutorial is very helpful, no product of this size is easy to learn. Unfortunately, WordMARC is a little harder to learn than appears necessary. Part of this is due to things that are very
easy to change—a plastic keyboard overlay (actually, a selection of them for various common keyboards) would be very helpful. However, other issues are not so easy to change and are problems primarily for those who have used other wordprocessors. For example, macros are glossary entries and are maintained in glossaries; my dictionary thinks a glossary is actually something one might like a wordprocessor to produce. Another example is WordMARC’s system of counters: there are 9 nondedicated counters available to the user. However, if you want a counter like I.1.1., then this is actually 3 counters in WordMARC’s system. If you want an outline-type counter, such as I.A.1., then this is also 3 counters. It is inconvenient if you only want single levels to show but want to maintain all applicable levels in cross-references. You can easily run out of counters, especially if you actually want to intersperse lists and numbered tables, equations, and figures within numbered sections.

Of the items in this year’s benchmark, WordMARC could do virtually everything, and fairly easily. However, you cannot have both footnotes and endnotes in one document, you cannot incorporate graphics from other programs in the PC version (versions for other systems do have hooks to graphics), only one index is allowed (there is a workaround for this that allows one to have up to 8 indexes, but one must trade-off index levels to get these), and there is no ability to handle bibliographic reference lists. Cross-references are only allowed to counters (automatically numbered items).

The power and flexibility of WordMARC, along with its ability to link to minicomputer versions (this is not a unique capability), make it best suited for organizations, particularly those that can assign a person to be the local expert to write macros and design style sheets for users.

**EXACT, Version 2.5**

Reviewed by Jim Cronin

EXACT is a memory-resident program designed to be compatible with almost any wordprocessor (WP). It occupies 64 to 128k of RAM memory, and requires a monitor and printer capable of graphics display. EXACT is contained on one 360k floppy disk (hard disk not necessary), and comes with documentation bound in a three-ring 9 x 8 inch notebook. The program is not copy protected and is easy to install. Telephone support is available. The product comes with a thirty day money back guarantee.

An understanding of EXACT begins with an overview of its operation. Users enter text as they normally would using their WP, but when they come to an equation or special symbol, they use EXACT’s markup command language (ML) to communicate what is to be done. This may be done directly in the WP or in a special split-screen editing mode to see the expression constructed as they type. When the text is printed, EXACT translates the WP text and creates the desired graphics image.

EXACT has two modes of operation: full page, and part page. All text, as well as equations, are printed by EXACT in the full-page mode. This mode is invoked by inserting commands in the header and footer sections of the page. In part-page mode, the WP does some of the printing, and EXACT is turned on and off via commands embedded in the document. Both modes have advantages and disadvantages. The user’s mode choice depends on writing style and preferences.

EXACT’s ML is both powerful and easy to use. It consists of 39 commands within 6 command categories: Character, Line, Block, Spacing, Document, and Special. As implied, Character and Line commands operate on individual or multiple characters. For example, a subscript might consist of a single character or a series of characters. Block commands generally deal with multiline expressions such as fractions, matrices, and vector columns. The Character, Line, and Block commands may be nested to build complex mathematical expressions. EXACT automatically provides the spacing needed for mathematical expressions and text. Spacing commands are used to indicate where text should be put in situations where default placement is not desired. For example, Spacing commands can be used for making an equation number flush with the right margin. Document commands deal with turning EXACT on and off for portions of text and setting the font styles.

EXACT comes with 19 font files, which include roman, italic, bold, script, and 2 math fonts containing Greek and other symbols. All fonts are proportional, and in general, are pleasing to the eye. Smaller versions of the roman and math fonts, used for superscripting, are also supplied. Up to 10 fonts may be used on one page of text, and the fonts may be changed from page to page. The program has a default convention for referring to fonts, which minimizes keystrokes. A font editor is also supplied for creation of new symbols. The publisher now has Hebrew and ancient Greek fonts which are available to registered users by request.

EXACT has a built-in split-screen editing mode which greatly assists in three areas: learning the ML, experimenting with commands for special effects, and most importantly, correcting situations when what you see is not what you expect. In this mode, the user may type and edit up to six 80-column lines of markup language text and see the results on the screen. Function keys are available for bringing text into the edit window and for pasting text from the edit window into the document. The program also enables output to be directed to the screen for previewing. This can be done within most WPs. This feature is useful when users want to see the effect of more than just 6 lines of ML. The program provides a zooming feature that enhances the viewing in both of these modes. The net result of these two features is fast feedback on the form of the material being created by the markup language.

EXACT has 2 modes of printing: draft and publication quality. The latter is suitable for publication, even when using a dot matrix printer such as the EPSON FX. Page layout is affected by the spacing option selected. The program evenly spaces a line based on the starting and ending points of the line (it arrives at the line length by counting characters, as received from the WP, on a 10 cpi basis). If the underlying WP is in a right-justified mode, the result is right-justified text. EXACT takes care of the spacing between words and does a much better job than most WPs in producing justified text. There is an option called ESPACE that compresses the text to the left. Automatic right-justification is difficult to obtain in this mode, but spacing commands are more intuitive with this option. A broad assortment of dot matrix
printers are supported. Special software to support an HP LaserJet printer is available for an extra charge ($89.95). EXACT supports data interchange among individuals, provided that all are using EXACT and the same underlying wordprocessor.

Installation of the product is simple. First, make a copy of the original floppy disk. Then, load EXACT into memory before running the wordprocessor. Recommendations for using the product are provided for a number of popular wordprocessors. In fact, the product is delivered with a complementary copy of an excellent wordprocessor, PC-Write.

Documentation for EXACT is mediocre. It is adequate as a reference manual for the commands, but does not give much help on advanced techniques such as superposition of blocks. The tutorial is too simplistic. However, a number of useful examples are given in a section following the tutorial. The user may have to rely on telephone support for learning advanced techniques.

In testing EXACT's features, I concentrated on three areas: equation construction capability, compatibility with advanced WP functions, and EXACT's performance in a real-life situation. EXACT demonstrated good equation-handling capability for last year's TWP benchmarks. Since last year, EXACT has been improved and now has a new command that is ideally suited for creating summations and products. This was a problem area earlier.

The advanced features used were centering, footnoting, generating a TOC (table of contents) and index, producing multicolumn text, moving text flush to the right margin, and spell checking. (Note that these are not all part of EXACT; rather some come from the underlying wordprocessor.) Some problems associated with the EZSPACE option were discovered. Without EZSPACE, centering and flush right behaved as expected. But with EZSPACE, the results were incorrect because of the way text is compressed left by EXACT. (It is worth mentioning that EXACT has spacing commands which will easily accomplish these two tasks.)

TOC and index generation worked correctly, but required some spacing commands to make columns of text line up properly. Since these functions typically will be used at the end of a writing project, inserting the spacing commands only one time should not be a burden. The multicolumn mode suffered from the same column alignment problem. EXACT documentation mentions this problem and explains how to deal with it via spacing commands. Equations will not be displayed properly in multicolumn mode since the WP prints the text one line at a time across all columns. The multicolumn mode can still be used for tables, but is not suitable for an entire document.

Footnoting is possible with EXACT. I prefer conventional footnoting: superscripts indicating the notes, and notes at the bottom of the page, separated from text by a line. WordPerfect (see the Addendum to the SWPE review for more on WordPerfect) supports this style, but EXACT, when on, does not allow escape sequences generated by WordPerfect to be passed to the printer. Thus, superscripts and lines are not printed. However, it is easy to insert EXACT commands in the text and first note of each page to get the desired effect. The vendor has suggested that the WordPerfect custom printer install could be used in order to have EXACT markup commands added where needed, but I have not tried this.

Spell checking was not affected by EXACT, and the spell checker ignored most of EXACT's ML. From my testing, I conclude that EXACT will work with most WP features that do not involve sending escape sequences to the printer. In my review of EXACT (then called Superscript) in last year's TWP review, I noted that I would be leery of attempting a large scientific writing task until I better understood the interaction of EXACT with my WP. I no longer have this reservation. The program works well with a power WP and is well-suited for long reports. As part of this review, I used the product on the first few sections of a report which used advanced word-processing features and included some lengthy partial differential and finite difference equations. The work went smoothly, and the final product was impressive.

EXACT is not without some faults, but I find that I can either live with them or work around them. An on-line help facility for either the EXACT ML and its math symbols would make EXACT more convenient to use. I would also be interested to have an option to switch the basis of the text placement algorithm from 10 cpi to 12 cpi and to have a set of fonts tuned for this more compact spacing. TSSI indicated they would consider adding this feature. EXACT offers no practical means to lay out text in multicolumn format. If I had to produce column text for camera-ready mats, I would simply type narrow pages and cut and paste (literally). Or, I would try varying the margins of the narrow pages in an odd/even sequence and type the mat twice. EXACT does not include any special feature for building tables (benchmark 3 of last year's benchmark set). Table entries can be positioned, like matrix elements, and the user can then manually box them in. Although complete tables can be constructed by combining certain primitives of the ML, this is an extremely tedious process.

In reviewing EXACT, I tried to consider who this product is suited for. I feel the program does an excellent job at handling complex equations. It works nicely with your WP in either full-page or part-page mode. I can recommend it for long reports. My view of the product relative to some of the other technical WPs is as follows. With EXACT, as it stands today (1/87), you give up some of the formatting power of a typesetting system such as TeX. If you cannot live without seeing text in multicolumn form, or are not flexible in working around some of the deficiencies listed above, the product may not be well suited for you. But if you are flexible, in exchange you will get a nice interface, and a small system with modest hardware requirements that is also capable of working with laser printers.

**TechPrint II, Version 2.0**

**Reviewed by Kenneth A. Glidden**

TechPrint II is an ML postprocessor, which allows the inclusion of special characters within wordprocessing documents. Minimal requirements include an IBM PC, 70Kb RAM, 1 floppy drive, and an Epson FX, RX, or MX printer. Currently no other printers are supported. A new version of TechPrint II, with support for additional printers, is promised by the vendor. To view special characters on the screen, Stony Brook MicroSystems offers "TechProm" ($59.00 - $99.00), a
custom display chip. By working with the vendor, you can order this chip with virtually any characters desired. By using Character Builder ($55.00), also available from Stony Brook MicroSystems, one can create the dot patterns which match the characters in the TechProm. These can be downloaded to the printer. When purchasing two or more of the three products, Stony Brook MicroSystems provides a discounted price, even if they are not purchased at the same time.

TechPrint II seems best suited for the user who makes moderate use of equations, and who is satisfied with his/her current wordprocessor in terms of interface, organizational features, and layout features.

TechPrint II is used primarily for printing. The document itself is created with a wordprocessor or text editor. After printing the document to disk, TechPrint II is invoked.

TechPrint II is told how to print the document (e.g., which fonts to use, where to super-/subscript, what special characters to include) by inserting specified control characters within the document. The ease with which this is done and modified depends upon the wordprocessor used. For example, microEMACS, a text editor, allows easy insertion of control characters which can be viewed on the screen. WordPerfect, a “full-featured” wordprocessor, requires the user to access a menu before inserting control characters which are then invisible on the screen unless you temporarily invoke the “reveal functions” option. (See the Addendum to the SWPE review for more on WordPerfect.)

TechPrint II gives the user access to 94 special characters.

In itself, TechPrint II does not provide facilities for data interchange or the inclusion of graphics. Stony Brook MicroSystems does offer 2 add-ons which appear quite useful, though not necessary. These are the TechProm chip and Character Builder program previously mentioned. Each of these may also be used without TechPrint.

Installation is a breeze and the documentation (provided on disk) provides pleasant and informative reading. Not only does the documentation clearly present the installation procedure, tutorial session, and each option provided, but also the author provides interesting subjective tips here and there. For example, suggestions for incorporating keyboard macros using a product such as ProKey are given. Indexes are not provided in the approximately 40 page manual.

They are not really required though since the manual is well-organized and makes liberal use of tables describing features and options.

The tutorial consists of directions in the manual for producing a 2 line document using 3 special features of TechPrint II. Although limited, it gives an adequate understanding of the workings of TechPrint II and makes the rest of the manual easier to understand.

Deadlines allowed the reviewer barely enough time to read the manuals and briefly experiment with the product. Time did not allow reviewing Character Builder and the TechProm was unavailable at the time of this review. In general, TechPrint II is easy to use. To increase the effectiveness and efficiency of one’s use of TechPrint II, one ought to 1. buy Character Builder, 2. use it to create the character set desired, 3. order a custom version of TechProm from Stony Brook MicroSystems to match your character set. It is, however, possible to use TechPrint effectively without either of these products. It seems best suited for individual rather than corporate-wide use because of the Tech-Prom: it might be hard to get a group of people to agree on what modified version of the chip to use as a standard. The standard Prom provides 17 special characters that are not included in the IBM extended character set.

**Proofwriter TURBOFONTS**

*Reviewed by Kenneth Glidden*

TURBOFONTS is a memory resident program intended to allow wordprocessors and other applications programs to display and print technical and/or foreign language characters. In addition, TURBOFONTS provides a method for including graphics from other programs within wordprocessing documents.

The program requires an IBM PC, XT, AT, or any “true” compatible. You will also need DOS 2.0 or higher and 15Kb to 40Kb (depending on your printer) of memory in addition to that required by your wordprocessor. To take full advantage of TURBOFONTS’ display capability, you will need an IBM Enhanced Graphics Adapter (EGA) or equivalent, or a Hercules Graphics Card Plus. Optional character PROMs are available for other graphics boards, but using one limits the number of technical characters you can display. TURBOFONTS supports a number of popular dot matrix and laser printers.

TURBOFONTS is a difficult program to exhaustively review, since it can be used with a variety of programs, printers, and graphics displays. For this review, I used TURBOFONTS on an IBM PC with a Hercules Graphics Card (with the optional PROM which allows display of the “X3” scientific character set), Princeton Max-12 monitor, 2 floppy drives, 1 10Mb hard drive, and an Epson FX-80 printer. WordPerfect was used as the wordprocessing program.

I was able to spend about 30 hours with this package. About 25% of that time was spent reviewing the documentation, which I found to be very good, and another 25% was spent actually using the product to perform this year’s benchmark. The remaining 50% of the time was spent trying to get TURBOFONTS and my printer to get along.

Using TURBOFONTS is quite simple. The initial installation is clearly described in the documentation. The manual first describes how to install the optional PROM chip, if applicable, and then discusses tweaking your applications program, if that is needed. The tweaking usually involves telling your application to allow the use of extended ASCII characters. Next you run the installation batch file supplied.

Once TURBOFONTS has been installed, you simply type FONTS to make it memory resident. This needs to be done before running your wordprocessor.

From then on, your interaction with TURBOFONTS (to display alternate keyboards, choose a different character set, etc.) is accomplished with a pop-up menu as needed.

Entering a special character is a simple 2 key process. First you strike the “dead” key followed by the key corresponding to your desired character. Voila, the special symbol is displayed on your CRT.

Including graphics is rather painless as well. First you call up the applications program which you use to generate your graphics. Then, using the pop-up
menu, you tell TURBOFONTS to capture the graphics to disk as they are being printed by your applications program. Having done so, you then enter a short command in your document where you want the graphics to appear and leave enough blank lines to accommodate it. When you print your document, TURBOFONTS intercepts the command and inserts the graphics.

TURBOFONTS' strong points stem from its ease of use. The documentation is well-written and clearly laid out. The pop-up menu affords easy interaction with the program. Typing special characters and including graphics are relatively simple procedures. You also get instant feedback since the special characters are displayed as you type them.

Caveats: Depending on your particular combination of hardware and software, you may have problems getting acceptable output. In particular, I never could get my EPSON to properly display symbols with long vertical bars (such as large integral signs). The manufacturer provided me with sample files and printouts which indicated that last year's benchmarks could be printed with TURBOFONTS and WordPerfect on an Epson FX-80. But, even after loading a copy of WordPerfect supplied by the manufacturer, I could not satisfactorily reproduce last year's benchmarks or print this year's benchmark. Also, TURBOFONTS seemed to interfere with some WordPerfect features such as page number positioning.

How did WordPerfect and TURBOFONTS handle this year's benchmark? They performed well in some areas and not so well in others.

It was simple enough to enter scientific characters, but the PROM I used did not have all the characters used in the benchmark. If I had used an EGA or Hercules Plus board, presumably this would not have been a problem. Additionally, TURBOFONTS allows the user to build custom character sets and individual characters. Unfortunately, I ran out of time before I could try this feature.

WordPerfect is one of my favorites, but I found while doing this benchmark that it lacks some organizational features. WordPerfect doesn't automatically reference equations, figures, or tables. It doesn't automatically handle bibliography entries and it only allows one index. Fortunately, WordPerfect has some useful macro features. With these and a lot of patience, you could probably develop macros to overcome most of these shortcomings. (See the Addendum to the SWPE review for more on WordPerfect.)

TURBOFONTS is generally easy to use and inexpensive ($149 for the program and $75 for a PROM if purchased with the program). It is well-suited for someone needing to create technical documents, but unwilling to switch to a new wordprocessing program.

Appendices

Future Work

It is impossible to cover all topics as well as to get volunteer review help from all user classes. Although secretarial and publication staff were too busy to try products, they did give us a few additional comments. Specifically they wanted: speedy displays with no lagging cursors, easy pagination and format feedback, I/O aids such as efficient background printing, and methods for organizing offices. If a product could not help them keep track of documents, backups, subdirectories, references, and phone numbers, it should have a DOS hot key and or compatibility with RAM resident programs that would allow quick and easy access to other utility programs.

Typeset quality output, characters with ligatures and spacing that depends on relative goodness/badness criteria, etc., still require heavy CPU, memory, and disk requirements. However, this is becoming less expensive. Because of the steady improvements in computer and printer technology, an additional category of "ability to produce typeset quality output" should be included in a future review.

Apple, Atari, Commodore, Sun, and Apollo

Some of us eagerly await the new open Macs, especially because Apple is going after the Engineering WorkStation Market and including math coprocessor and CAD/CAM interfaces. Although the MAC excels at WYSIWYG, it still can be difficult to redact equations, repaste figures, and renumber sections/equations (for example, see the acknowledgement in the 1986 Springer Verlag book on Constructive Combinatorial Mathematics by Dennis Stanton and Dennis White). However, it is probably only a matter time before Apple, and other vendors, will introduce easy-to-learn software that also has an underlying powerful command/macro language.

The Commodore Amiga line of computers has defined a standard format for saving graphics—allowing different application programs to easily exchange graphic information. In addition, the public domain MIT X-window standard may allow any UNIX based system to run Macintosh/Small-Talk-like software. A group at the University of California at Berkeley, Division of Computer Science, is producing a new version of TEx on Sun Microsystems. This project, VorTeX, allows split-screen editing with immediate feedback in the second window. The user can then go to the output window and edit the output, and have the input be simultaneously updated.

The Review Group

The review group was formed, for this years' review, after the AMS invited us to do an update of last years' project. We wish to thank the AMS for this invitation. The Boston Computer Society's PC User Technical Subgroup sponsored this technical wordprocessing review. The BCS PC User Subgroup has over 12,000 members in all 50 states and around the world. The technical subgroup provides a forum for the exchange of technical information relevant to microcomputers, particularly engineering and scientific applications of the IBM PC and compatibles. The TWP review group consisted of scientific and technical professionals, from industry and academia, all strongly interested in the broader issue of improved technical communication as well as the efficient creation of their own papers for publication. Over half the group were participants in last year's review.

Disclaimer: All information in this document represents the opinions of the authors named above. It does not necessarily represent the views of their employers or of the Boston Computer Society, the PC
User's Group, or the PC Technical Subgroup. This project was performed on personal time and no reviewer received any monetary compensation, not even copies of the programs reviewed. All vendors were provided with draft reviews, a draft of Part II, and draft versions of the tables for their review. All vendors except for LexiSoft responded.

The TWP Review Committee consisted of:

- A.G.W. Cameron, Ph.D., Professor of Astronomy, Harvard University;
- J. Cronin, Senior Nuclear Engineer, Yankee Atomic Electric Co.;
- Z. Deal, Ph.D., Director of User Assistance, Harvard University Computer Center;
- C. Deno, M.D., and Ph.D. candidate at University of California at Berkeley;
- P. Ford, Ph.D., Center for Space Research, Massachusetts Institute of Technology;
- K. Glidden, Computer Systems Manager, Goldberg, Zoino & Assoc., Inc.;
- R. Goldstein, Ph.D., statistician and Vice-President, Qualitas, Inc. (no relation to Goldstein Software, Inc. [Tech/Word]);
- M. Horn, Ph.D. candidate at Harvard University;
- R. LePage, Ph.D., Department of Statistics and Probability, Michigan State University;
- D. Loomis, English major at Michigan State University, and President, db Management;
- J. Loomis, Nuclear Engineer, Yankee Atomic Electric Co.;
- E. Saletan, Ph.D., Department of Physics, Northeastern University;

We also thank the following for helpful comments: Jack and Linda Pearson and Sid Sklar.

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**PARTIALLY ORDERED ABELIAN GROUPS WITH INTERPOLATION**

K. R. Goodearl

(Mathematical Surveys and Monographs. Volume 20)

In the past decade a new branch of ordered algebraic structures has grown, motivated by K-theoretic applications and mainly concerned with partially ordered abelian groups satisfying the Riesz interpolation property. This book is the first source in which the algebraic and analytic aspects of these interpolation groups have been integrated into a coherent framework for general reference. The author provides a solid foundation in the structure theory of interpolation groups and dimension groups (directed unperforated interpolation groups), with applications to ordered K-theory particularly in mind.

High points of the development include the following: characterization of dimension groups as direct limits of finite products of copies of the integers; the double-dual representation of an interpolation group with order-unit via affine continuous real-valued functions on its state space; the structure of dimension groups complete with respect to the order-unit norm, as well as monotone sigma-complete dimension groups and dimension groups with countably infinite interpolation; and an introduction to the problem of classifying extensions of one dimension group by another. The book also includes a development of portions of the theory of compact convex sets and Choquet simplices, and an expository discussion of various applications of interpolation group theory to rings and C*-algebras via ordered K0. A discussion of some open problems in interpolation groups and dimension groups concludes the book.

Of interest, of course, to researchers in ordered algebraic structures, the book will also be a valuable source for researchers seeking a background in interpolation groups and dimension groups for applications to such subjects as rings, operator algebras, topological Markov chains, positive polynomials, compact group actions, or other areas where ordered Grothendieck groups might be useful.

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Passages: Thoughts About Science and the Public

The relationship between science and the public is in a period of rapid change—full of bumps, bruises, misunderstandings, and rigidities; and simultaneously full of signs of growth, health, and renewed mutual commitment. The maze of seemingly contradictory facts, feelings, and perceptions is reminiscent of the changes that accompany one of life’s “passages” or, perhaps more appropriately for this case, the sorting out process which accompanies the mid-course maturation process in a marriage. We in the mathematics community are having to do our share of sorting out in our relations with government and the public and may possibly gain some insight by looking at the issues we face from a phases-of-life perspective.

Few would dispute that the post-World War II relationship between science and the public began as a love affair. Science was awesome, having “won the war”; and pushing forward what Vannevar Bush called its “endless frontier” seemed a fitting national mission—surely science would somehow help protect us from the Soviet Union and keep the economy booming. The public was immensely attractive, in part because it worshipped science, but primarily because the scientific community had developed a profound love of country in the war effort; and because the public cared for science, it poured into that nurturing act both its tax dollars and the very best of its youth.

A traditional marriage began. Vows were sealed with the creation of the Office of Naval Research in 1946 and the National Science Foundation in 1950. There was thoughtful discussion during the engagement, but the ardor was intense enough to gloss over seeds of future trouble which lay in the facts that the public wasn’t really able to understand what science was doing all day long, that there was much guilt in the scientific community over its final and decisive contribution to winning the war, and that science held too many truths about its importance to society to be self-evident, never clearly articulating, for example, how it would keep the economy booming.

The great United States university research-education system was built, further fueled in the late 1950s and early 1960s by the Sputnik-inspired space race, and highly-trained scientists and engineers were returned to the public in droves. Events moved quickly then: Science went to the moon; the Vietnam War came to tear at the fiber of the public, and by the late 1960s to early 1970s, Congress markedly reduced federal fellowships to slow the production of scientists and passed the one year Mansfield Amendment, which seriously questioned what the Department of Defense was doing in the basic research business. These actions, reactions, and overreactions generated turmoil in the science-public relationship, and each of the partners underwent changes. Neither got its newly formed attitudes or its complaints articulated very well—which is another way of saying that there was no effective federal science policy. The underlying sense of mutual commitment remained, but its emotional basis lay largely in wishing that things could be the way they used to be.

For some years now, it has been evident that things cannot be the way they used to be. This has to be faced. Science and the public each need to stand back and take a long, hard look at the person they married, then describe their mutual commitment in terms that make sense today. Judging by this winter’s events in Washington, we have a ways to go, but we’re getting there if we will but see the progress and not lose our nerve.

Two of the current symptoms of trouble on the science side are the intense reactions to emphasis on engineering and interdisciplinary research centers in the FY 1988 budget of the National Science Foundation and expressed fears that the six billion dollar Superconducting Super Collider, to be funded at the Department of Energy, will significantly detract from resources available for the rest of basic science. These amplify serious concerns which have been and will be with us for some time: The issue of “small” versus “big” science; the apparent growth of goal-oriented research; inadequate federal investment in civilian-sector basic research, especially when compared with the huge amounts of money poured into the “D” side of military R&D; and, pervading all of the above, an inadequate flow of brainpower into science and engineering. As happens in rocky relationships, some of the verbalized concern is long on emotion and short on facts and perspective.

The current symptoms of trouble on the public side are best wrapped up in the word “deficit” and in two perceptions prevalent in many parts of Congress: Science has not done an effective job of educating the public (members of Congress) about what it does and how this directly benefits society, i.e., why science should continue to be adored; and science has failed to articulate clearly the plans that go with its unquenchable lust for life and learning, plans against which to assess its dollar needs and its direct contributions to curing society’s major ills.
Into the midst of all this has come Erich Bloch, Director of the National Science Foundation, with a forcefully presented plan. He has persuaded the President and the Office of Management and Budget to recommend a doubling of the NSF budget in the period 1988–1992. He hopes that, with the active support and involvement of the scientific community, he can persuade Congress to go along by authorizing a four-year budget for the years 1989–1992. (They will still need to appropriate funds year-by-year.) The first year of his five-year plan, 1988, has more emphasis on interdisciplinary centers than many people in the science community find palatable, since it temporarily slows the growth of funding in their fields. (Mathematics funding remains a high priority, although its growth from FY 1987 to FY 1988 is targeted at about 13%, somewhat less than we have been experiencing in recent years.) The budget may also have more emphasis on education than some scientists will find comfortable, when they already feel squeezed.

What seems important to realize and react to here is not this or that detail about continued feelings of apprehension—X went up N% and Y only (N - 2)%—but the fact that there is, for the first time in many years, a plan. In the metaphor of this column—may Erich Bloch forgive me—the NSF Director is playing the role of marriage counselor. He is describing to science and the public a basic plan for putting their relationship on a new footing, one appropriate for the stage of life they have reached together. It asks science to bend a little, to drop some of its near-arrogance, to begin to describe what it does in ways which are more understandable to the public, and to encourage the development of NSF programs which show more clearly how science-technology transfer comes about and how scientists are going to work directly on the major educational problems the country faces. The development of these programs is to take place side by side with the growth of fundamental science programs of more traditional sorts, not instead of them. But, of course there will be skewing in the direction of the "new" efforts during the first year. Who would believe the plan was serious otherwise?

The plan also asks the public to bend a little, to recommit itself to science as redescribed, and to support a congressional ramping up of the NSF budget to a level roughly two billion dollars more per year than it is now. In these tight budgetary times, this will test the public's commitment.

The plan is not primarily monetary. It is conceptual, based on identification and description of the two critical long-term problems which science and the public must work on together, and work on with greatly increased commitment: The competitive economic position of the United States internationally; and the scientific literacy of the public, i.e., the development of the human resources necessary not only to maintain the vitality of science and engineering, but to significantly raise the capability of the nation's broader workforce.

In mathematics, we must continue to debate how the evolving details of these and related plans affect the health of our enterprise. We are the quintessential "small" science; we are heavily dependent for research support on the Department of Defense as well as the NSF; we are only 30% of the way toward reaching the goals of the David Report; we still feel the pinch of the small number of researchers supported in our field; we have staggering problems to deal with at the collegiate teaching level; we must help reform the vast enterprise of school mathematics.

But we must not lose our nerve and begin to think narrowly after the progress we have made over the last five years. Assuming the President's budget is approved, we have increased NSF support for mathematics by 95% in those five years and have increased DOD support by the same percentage. We have educated many people about our problems and have made a good start at educating people about our potential and our role in society. We have set up several major new mechanisms to promote understanding of mathematics and to help lead efforts to strengthen research and education nationally: The Joint Policy Board for Mathematics; the Board on Mathematical Sciences; and the Mathematical Sciences Education Board.

We must help push forward the basic plan. Mr. Bloch has devised and then work within its framework to see to it that the persistent and continuing issues which concern us are discussed and dealt with. We are almost perfectly positioned to benefit from the growth which the general plan will bring. More importantly, we are almost perfectly positioned to contribute to its development, implementation, and success:

We have done as good a job as any scientific discipline at articulating our research needs;

We have demonstrated that we can set priorities and stick by them, even when it hurts;

We are the only scientific discipline to formulate and launch a complete review of its collegiate enterprise;

We are the only scientific discipline to mount a full-scale assault on the problems of education at the school level in our broad area.

And if it is true, as Mr. Bloch says, that basic research is the key to economic competitiveness, then it is true that mathematics is the foundation of economic competitiveness.

That's powerful stuff, if we have the sophistication and the stamina to use it well.
News and Announcements

Harold Grad
1923–1986

Harold Grad, applied mathematician and physicist, died on November 17, 1986.

Born in New York City on January 14, 1923, Grad received his bachelor's degree in electrical engineering at Cooper Union in 1943. From New York University, he received a master's degree in 1945 and a Ph.D. in 1948, both in applied mathematics. He founded the Magneto-Fluid Dynamics Division of the Courant Institute in 1956 and was its director for twenty-five years.

Grad was an active member in several professional societies, including the AMS and the Society for Industrial and Applied Mathematics and was a founder of the Society of Engineering Sciences. In 1970, Grad was elected to the National Academy of Sciences. His other honors include the Boris Pregel award from the New York Academy of Sciences in 1970, the Eringen Medal from the Society of Engineering Sciences in 1982, and the James Clerk Maxwell Prize in 1986.

Grad’s work centered on the applications of mathematics to physics, first in the fields of fluid dynamics, statistical mechanics, and kinetic theory, and later in plasma physics. He introduced the concept of hierarchy of models interpolating between kinetic theory and fluid dynamics and later applied this approach to plasma physics.

In statistical mechanics, he clarified the concepts of entropy and molecular chaos and outlined a derivation of the Boltzmann equation as a singular limit, the details of which were filled in by Oscar Lanford. His work on the asymptotic theory of the Boltzmann equation led to many new developments. Recently, he was concentrating on the development of algorithms and codes for the solution of transport problems.

Sloan Research Fellowships Awarded

The Alfred P. Sloan Foundation has announced that 90 young scientists of extraordinary promise have been selected under a program known as Sloan Research Fellowships to receive awards of $25,000 each. The fellows are working at 51 colleges and universities on problems at the frontiers of physics, chemistry, neuroscience, economics, and pure and applied mathematics.

Selection under this program follows a well-developed procedure designed to identify scholars who show the greatest promise of doing original work in their fields. Fellows, once chosen, are free to pursue whatever lines of inquiry are of most interest to them, and they are permitted to employ fellowship funds in a wide variety of ways to further their research aims. This flexibility is often of great value to young scientists who are at a critical stage in establishing their own independent research projects.

The Sloan Research Fellowship program, one of the oldest fellowship programs in the country, began in 1955 as a means of encouraging basic research by young scholars at a time in their careers when teaching duties can be most pressing and when other support is difficult to obtain. According to Albert Rees, President of the Foundation, “Our evaluations of this program indicate that it has a proven capacity to identify young scientists of outstanding promise.” Many fellows have gone on to distinguished careers both in their disciplines and in public life. Thirteen Sloan fellows have won Nobel prizes later in their careers, and hundreds have received other honors. The 90 winners were selected from more than 400 nominations by committees of distinguished scientists and economists.

Twenty awards for mathematicians were made to CHRISTOPHER R. ANDERSON, University of California, Los Angeles; FRANCIS BONAHON, University of Southern California; ISAAC Y. EFROAT, Columbia University; AARON L. FOGELSON, University of Utah; L. ZHIHYONG GAO, rice University; LISA R. GOLDBERG, City University of New York, Brooklyn College; WILLIAM M. GOLDMAN, University of Maryland; THOMAS G. GOODWILLIE, Harvard University; HELMUT HOFER, Rutgers University; MICHAEL J. HOPKINS, Princeton University; J. F. JARDINE, University of Western Ontario; PARIS C. KANELLAKIS, Brown University; ADRIAN OCNEANU, Pennsylvania State University; ZIV RAN, University of California, Riverside; THOMAS M. SELLKE, Purdue University; STEPHEN W. SEMMES, Rice University; JALAL M. I. SHATAH, New York University; JOSEPH H. SILVERMAN, Boston University; SHMUEL WEINBERGER, University of Chicago; and MACIEJ P. WOTTKOWSKI, University of Arizona.

–Alfred P. Sloan Foundation News

Michael Atiyah Awarded 1987

King Faisal International Prize

The King Faisal Foundation has announced that it has awarded the 1987 King Faisal International Prize in the area of science to Sir Michael Francis Atiyah, University of Oxford. The prizes, which include a monetary grant of $95,000 and a commemorative gold medal, are presented for outstanding achievements in five subject fields. The Science Prize rotates among the disciplines of biology, physics, chemistry, and—this year’s topic—mathematics.

Sir Michael Atiyah received the Prize for his latest work in algebraic geometry and theoretical
News from the Institute for Mathematics and its Applications

University of Minnesota

The 1987–1988 IMA program on Applied Combinatorics will begin with a workshop on Polyhedral Combinatorics and Geometric Complexity on September 14–18. This workshop is being organized by David Dobkin and Martin Grötschel. It will focus on problems involving computation on geometric objects such as convex polytopes. Such problems in high-dimensional spaces arise in Operations Research, while similar problems in lower-dimensional spaces arise in Computer Science. The purpose of the workshop is to facilitate an exchange of ideas between experts from these two areas and mathematicians with related interests.

This workshop will introduce simultaneous periods of concentration on Discrete and Computational Geometry and on Combinatorial Optimization during the fall. These periods are being coordinated by Victor Klee and by Eugene Lawler.

The Applied Combinatorics program will follow a six-week long period of concentration on Atomic and Molecular Structures and Dynamics from June 15–July 24 and a program on Mathematical Aspects of Robotics from August 3–28. Both of these programs are intended to introduce mathematicians to some interesting applications of mathematics and are described more fully in the News and Announcements section of the February issue of the Notices. Some funds are available for expenses of participants.

物理学。自1973年以来，他一直在牛津大学数学系担任教授。他还担任过普林斯顿大学的高级研究教授和访问教授或讲师，以及在哈佛大学，加州大学，伯克利，芝加哥大学，耶鲁大学，哥伦比亚大学，其他许多大学以及全世界的其他大学工作。

Aliyah was awarded the prestigious Fields Medal in 1966. He was a member-at-large of the AMS Council from 1970 to 1972 and was the Colloquium Lecturer of the Society in January 1973. He served as President of the London Mathematical Society in 1976 and, in 1978, was elected to the U.S. National Academy of Sciences, Section of Mathematics.

Manuscripts in \textsc{ams-}\textsc{t}\textsc{ex} Will Speed Up Publication Process

In the March 1986 Notices (pages 299–302), the AMS announced the establishment of an Electronic Manuscript Program. The article outlined the procedures for submitting manuscripts to AMS journals and book series in electronic form using \textsc{t}\textsc{ex} and the \textsc{ams-}\textsc{t}\textsc{ex} macro package. It also listed some of the advantages of this program for both the Society and authors.

One advantage to the author of a paper is the reduction in the waiting time required between the acceptance of a manuscript and its publication. The Executive Committee of the Council has quantified this time period by adopting a policy that allows for accelerating the publication date by as much as twenty weeks, which is approximately equal to the time normally needed by the Society for copyediting, typesetting, and proofreading an average manuscript.

With the rapid expansion of computer networks and the development of sophisticated text processing software, like \textsc{t}\textsc{ex}, the electronic form will soon become the standard process by which an author creates and submits papers for publication. The AMS is currently receiving some manuscripts prepared with \textsc{ams-}\textsc{t}\textsc{ex} and submitted in electronic form and invites other authors to explore the possibility of using this method to submit papers to the Society. We hope that, by reducing the time between writing a paper and having it appear in print, authors will be encouraged to participate in the AMS Electronic Manuscript Program.

For further information about the Program, see the March 1986 article in Notices or write to AMS Electronic Manuscript Program, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

Fulbright Teacher Exchange Program

The United States Information Agency has announced details of the 1988–1989 Fulbright Teacher Exchange Program.

The Teacher Exchange Program involves a one-on-one exchange for teachers at the elementary, secondary, and postsecondary levels with suitable teachers overseas. The 1988–1989 overseas exchange programs will involve Argentina, Australia, Belgium/Luxembourg, Brazil, Canada, Colombia, Denmark, the Federal Republic of Germany, France, Iceland, the Netherlands, Norway, Panama, South Africa, Switzerland, and the United Kingdom. The number of exchanges available and the eligibility requirements vary by country.

The program also provides opportunities for teachers to participate in summer seminars from three to eight weeks in length. During the summer of 1988, seminars will be held in Italy and the Netherlands.

Applications will be available in the summer. The deadline for receipt of completed applications is October 15, 1987. For further information,

**Competition Opens for Fulbright Collaborative Research Grants**

The United States Information Agency (USIA) and Institute of International Education (IIE) announce the May 1, 1987, opening of the competition for collaborative research grants abroad for teams of 2 or 3 U.S. graduate students or recent postdoctoral researchers under the Fulbright Program.

The Fulbright Collaborative Research Grants will be available to all countries in the world, (except most East European countries, the U.S.S.R., and Indochina), for the academic year 1988-1989. There are no restrictions on fields of study. Prospective applicants should check with IIE regarding country availability prior to applying.

Applicants must be U.S. citizens at the time of application and must hold a B.A. degree or equivalent before the beginning date of the grant. Applicants with a Ph.D. at the time of application may have obtained the degree no earlier than June 1986. All applicants must have sufficient proficiency in both the written and spoken language of the host country to carry out the research.

The statement of proposed research submitted by team members may be identical, complementary to, or present a different dimension of the team's research. It is preferable that applications be submitted through a U.S. academic institution or professional entity. In addition, evidence of affiliation abroad with a host country institution or ongoing project that will oversee the research must be presented with the application.

Grants will normally be for 6-10 months and will provide monthly fixed sum awards to each member of the team. Grantees also receive basic health and accident insurance coverage as part of the award. It is expected that each member of the team will carry out their research in one country abroad for a minimum of 6 months during the same academic year, although all members of the team do not necessarily have to be in the host country concurrently conducting research.

Additional information and application forms may be obtained from U.S. Student Programs Division at IIE's New York headquarters or from one of its regional offices. Completed applications from all team members must be submitted to IIE's New York headquarters by January 16, 1988. For further information, contact Theresa Granza, IIE, 809 United Nations Plaza, New York, New York 10017. Telephone: 212-984-5329.

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**Euromath: First Phase Funded**

The Commission of the European Communities convened a one-day meeting on December 3, 1986, in Brussels, Belgium to discuss Euromath, a proposed integrated database and communications system for European mathematicians. The meeting was called in response to an application submitted by the European Mathematical Council (EMC), for funding Euromath. As a result of the meeting, a decision was made, based on the recommendation of CODEST (Committee for the European Development of Science and Technology), to begin a first phase of the Euromath

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**Competition Opens for Fulbright and Other Grants for Graduate Study Abroad**

The United States Information Agency (USIA) and the Institute of International Education (IIE) announced that the official opening of the 1988-1989 competition for grants for graduate study or research abroad in academic fields is scheduled for May 1, 1987. It is expected that approximately 690 awards to over 70 countries will be available for the 1988-1989 academic year.

The purpose of these grants is to increase mutual understanding between the people of the United States and other countries through the exchange of persons, knowledge, and skills. They are provided under the terms of the Mutual Educational and Cultural Exchange Act of 1961 (Fulbright-Hays Act) and by foreign governments, universities, corporations, and private donors.

Applicants must be U.S. citizens at the time of application, who will generally hold a bachelor’s degree or its equivalent before the beginning date of the grant and, in most cases, will be proficient in the language of the host country. Except for certain specific awards, candidates may not hold a Ph.D. at the time of application.

Grants include maintenance for the tenure of the award, round-trip international travel, health and accident insurance, and tuition waivers, if applicable. Selection is based on the academic and professional excellence of the applicant, the validity and feasibility of the proposed study plan, the applicant's language preparation, and personal qualifications. Preference is given to candidates who have not had prior opportunity for extended study or residence abroad.

Application forms and further information may be obtained from IIE's New York headquarters or from one of its regional offices. The deadline date for receipt of completed applications is October 31, 1987. Requests for application materials postmarked after October 15, 1987, will not be honored. For further information, contact Walter Jackson, IIE, 809 United Nations Plaza, New York, New York 10017. Telephone: 212-984-5327. -IIE News Release
project with funds from the Stimulation Action (Plan to Stimulate European Cooperation and Scientific and Technical Interchange, also referred to as Researchers Europe). The first phase of the project will probably include specifications of the Euromath system, guidelines to institutes for their eventual participation, and the development of a limited part of the software.

Euromath facilities will fall into three categories: (1) information retrieval, (2) interpersonal communication, and (3) document preparation and delivery.

Information retrieval includes access to various directories, reviews of published literature, other databases, and drafts and notes of individual mathematicians. While some of this information is available in other forms, Euromath will provide multiuser updating and storage capabilities. In addition, mathematical periodicals may be available in the form of electronic newsletters.

Euromath will extend the idea of electronic mail as a form of interpersonal electronic communication to include the idea of electronic conferences, in which individual participants log on occasionally to enter their contributions and see what others have contributed. A user could call a list to be reminded of which electronic conferences he or she is participating in, or which conferences are available. Euromath will also provide for synchronous conferences, in which two users can view the same part of a document and discuss and perform changes which they both will be able to see simultaneously.

Document preparation and delivery—which includes entering, editing, transmitting, receiving, and printing mathematical documents—presents special problems due to the sophisticated structure of mathematical documents. An explicit goal of Euromath is to develop a European Standard for Mathematical Communication (ESMC).

Special Program/Workshop for Department Chairs

The Joint Policy Board for the Mathematics Committee for Department Chairs will sponsor a one day Special Program/Workshop for Chairs in the Mathematical Sciences. The Program will be held on Tuesday, August 4, 1987, in Salt Lake City, Utah, the day before the start of the AMS–MAA Joint Mathematics Meetings.

The program will be presented by Dr. John Bennett of the American Council on Education for Leadership Development. Dr. Bennett has given numerous workshops of this nature for many universities and is considered to be the best in the field. The agenda planned for the day includes an overview of chairs' responsibility, case studies, and faculty development and evaluation. There will also be opportunities for small group discussions. The sessions are designed to help new department chairs, who may have received little or no training and direction, to better fulfill the administrative aspects of the position, as well as more experienced department chairs who want a thoughtful review of their leadership opportunities.

Support for this meeting is provided by the registration fee only, and unless sufficient confirmed registrations are received by June 15, the program will be cancelled. Full refunds will be made if the program is cancelled.

For program details, including registration information, contact David Lutzer, Mathematics and Statistics Department, Miami University, Oxford, OH 45056.

Electronic Addresses in the CML

In the March 1986 issue of Notices, it was announced that members of AMS, MAA, and SIAM would have the opportunity to add computer network addresses to their Combined Membership List (CML) listings. At that time, members were invited to include, within a 100 character limit, one telephone number and as many electronic addresses as would fit in that space. Effective with the 1987-1988 CML, the restriction to one telephone number will be removed. The telephone/electronic address portion of the listing can now include as many telephone numbers and/or electronic addresses as will fit within the 100 character limit. It would be helpful if telephone numbers were identified as home and/or office, again within the 100 character limitation.

In mid to late April, AMS members will receive a request to update the information for their CML listing. They are urged to take advantage of that opportunity to include any network addresses.

The AMS is now in the process of arranging to connect to one of the major computer networks. It is anticipated that people will be able to communicate with the AMS over a network by this summer. When arrangements have been completed, the AMS's network address will be announced in this section of Notices.
NSF-CBMS Regional Conferences in the Mathematical Sciences

Arrangements for the ninth regional conference in this series have now been finalized. This conference will be held September 14-18, 1987, at the University of Cincinnati, on the subject of Fractal Geometry. The lecturer will be Benoit Mandelbrot.

Information on the regional conference project and the other conferences in this series can be found in the February 1987 Notices, page 296.

Research Opportunities for Minority Scientists and Engineers

The mandate of the NSF to ensure the vitality of the nation's scientific enterprise includes concern for the quality, distribution, and effectiveness of the human resource base in science and engineering. The Foundation seeks to encourage the entry and full utilization in research careers of all highly qualified scientists and engineers. Because members of certain minority groups are underrepresented in all disciplines, several activities are directed toward increasing their numbers as full participants in the mainstream of research. The activities described below include grants for individual research and training efforts and for institutional development.

- **Standard Research Awards.** Minority scientists and engineers are eligible to apply for grants in all of the Foundation's programs, and are encouraged to do so.

- **Minority Research Initiation (MRI) Awards** are for research conducted by minority investigators who have not previously received federal research support. Proposals for these one-time awards are given special attention by NSF programs.

- **Minority Research Initiation Planning Grants** are limited in amount and duration and are designed to help minority investigators develop competitive research proposals.

- **Research Improvement in Minority Institutions (RIMI) Awards** are intended to strengthen the research environment of participating institutions by supporting faculty research and the acquisition of equipment.

- **Minority Graduate Fellowships** provide support to outstanding minority graduate students in all fields of science and engineering that are supported by the Foundation.

- **Supplemental Funding for Research Assistants.** Principal investigators who already have NSF awards or plan to apply for NSF grants may receive supplemental support to involve minority high school students as research assistants in their research activities.

Inquiries related to the area of proposed research should be directed to the NSF program officer in the applicant's field of interest. General inquiries about these programs may be made to the Coordinator for Minority Programs, Room 1225, National Science Foundation, Washington, D.C. 20550. Telephone: 202-357-7350.

Other programs of interest to minority investigators are: **Support for Predominantly Undergraduate Institutions [Research in Undergraduate Institutions (RUI)]; Research Opportunity Awards (ROA)]; Facilitation Awards for Handicapped Scientists and Engineers (FAH); NSF Visiting Professorships for Women (VPW); and Research Experiences for Undergraduates (REU).**

For further information on these programs, contact the NSF program officer in the relevant discipline, or the RUI Coordinator, Room 1225, National Science Foundation, Washington, D.C. 20550. Telephone: 202-357-7456.

NSF Program Announcement

**Proposals for The NSF Division of Mathematical Sciences**

Last year, the Division of Mathematical Sciences (DMS) eliminated formal deadlines for submission of proposals for research project support. Individuals seeking Foundation support should keep in mind that about a six-month processing time is needed for most proposals and that proposals should be submitted to the DMS at least that far in advance of the requested starting date. The DMS also pointed out that, even if the proposal is asking primarily for summer support, the starting date requested need not be the date on which the researcher begins to receive summer salary.

The DMS is still receiving many of its proposals during the fall, with the beginning of summer as the requested starting date. They realize that it is difficult to break a tradition developed over many years, but it would be of great help to the DMS if proposals were submitted more evenly during the year.

The Program Directors at the DMS are: **Algebra and Number Theory:** William Adams or Ann Boyle, 202-357-3696; **Applied Mathematics:** Andrzej Manitius or Frederic Wan, 202-357-3686; **Classical Analysis:** John Ryff, 202-357-3455; **Computational Mathematics:** Paul Swarztrauber, 202-357-3691; **Geometric Analysis:** Paul Goodey, 202-357-3451; **Modern Analysis:** Kenneth Gross, 202-357-3697; **Special Projects:** Bernard McDonald, 202-357-3453; **Statistics and Probability:** Nancy Flournoy or Yashaswini Mittal, 202-357-3693; and **Topology and Foundations:** Ralph Krause, 202-357-3457.

NSF Bulletin
Mathematical Sciences in the FY 1988 Budget

Frank Gilfeather

Board on Mathematical Sciences, National Research Council

The following report was prepared by Frank Gilfeather, Staff Director of the Board on Mathematical Sciences. The report is a chapter in AAAS XII: Research and Development, FY 1988.

Overview and Trends

The trend, begun in 1984, of significantly increased federal support for the mathematical sciences seems to have continued into 1987 and slowed in 1988. Moreover, there appears to be a shift in emphasis between programs, support levels, and support elements. Significant changes involve the DOD University Research Initiative (URI), increased emphasis on undergraduate education programs at NSF, Strategic Defense Initiative (SDI) funding, the continuing computational science thrust at NSF, the (1985) Defense Advanced Research Projects Agency (DARPA) program in mathematics, and special mandated projects, to name a few.

The major impact on basic research budgets in the mathematical sciences will be the dynamics of the effort to double the NSF budget in the next few years. How this is done will significantly affect mathematics because of NSF's dominance in federal mathematics funding.

The general trend towards enhancement of mathematics budgets attests to the great impact of the 1984 National Research Council (NRC) report, Renewing U.S. Mathematics: Critical Resource for the Future. The National Science Board passed a resolution in 1984 "that a concerted effort should be made by all funding agencies to increase support for the mathematical sciences for several years until a proper level of sustaining support has been achieved." Subsequent acknowledgment of this report includes reports to the DOD University Forum and language in the URI legislation urging redressing of the funding issue raised in the NRC report.

A key recommendation of this seminal report was an increase in graduate student and postdoctoral support levels to bring mathematics in line with other fields. Considerable increases in these areas are now seen in the agency programs. Another effect of the changes in current and future budgets is a trend towards an increasing emphasis on applied research, larger projects, and center activities. It is uncertain to what extent the 1987 URI programs impact on the existing programs at the DOD agencies.

Distribution of Federal Support

Although the National Science Foundation (NSF) is the only federal agency responsible for support across the entire spectrum of the mathematical sciences, other federal agencies play a significant role in support of basic research in the mathematical sciences. Research is also funded by the Department of Defense (DOD), the Department of Energy (DOE), the National Security Agency (NSA), and the National Aeronautics and Space Administration (NASA). Some agencies have no extramural programs of support for mathematical sciences. Details of support by these agencies are difficult to obtain and must be estimated.

The role of NSF in support of academic basic research for the mathematical sciences is important. NSF continues to provide about 80 percent of the support in core mathematics and an overall total of over 50 percent. The mission agencies, e.g., DOD, DOE, and NASA, have focused their support primarily on applied mathematics, statistics, and computer science. Table 1 shows the breakdown of agency support for mathematics.

The evolution of the mathematical sciences budgets by major organizations is given in Table 1. It is important to note that in those agencies where mathematics and computer sciences are jointly funded, an estimate was made as to the split between university-based mathematics and computer science budgets.

Within agencies, certain dynamics are observed. The 1988 figures show the DOD agencies, except DARPA, losing ground to their 1986 budget level. We note that factors such as URI and SDI make accurate assessment of program levels impossible to determine. For example, some agencies used 1987 URI money to fund multiyear programs entirely, and others funded one-year increments of multiyear programs. Moreover, the nature of some supported projects are considerably different from core programs, thus resulting in the displacement of investigators and projects.

The portion of DOD's research and development funding for research efforts that most
directly advance science or strengthen the technology base is divided into 2 categories; basic research (6.1 funding) and exploratory development (6.2 funding). DOD support of R&D in the mathematical sciences is accomplished primarily through the following arms of the various departments:

- The Army Research Office (ARO);
- The Office of Naval Research (ONR);
- The Air Force Office of Scientific Research (AFOSR);
- The Defense Advanced Research Projects Agency (DARPA).

In addition, DOD supports a substantial amount of 6.1 and 6.2 research intramurally at various DOD laboratories. Some of these laboratories provide funding support for applied mathematics, statistics, and computer science. This work is highly mission-oriented, with only a small percent of the funding going to university-based research. The first agencies (ARO, ONR, AFOSR) are much alike in their basic method of operation. However, DARPA differs in that it is not attached to any one department and does little of its own contract administration.

### Agency Programs

Each agency provides support for a variety of programs including institutes, individual and group awards, equipment awards, and special programs. In addition, all agencies participate in a variety of select programs often administered at a cross-discipline level, for example, equipment awards, special fellowship awards including women and minority fellowships, and small institution awards. Agency programs are also involved in cooperative funding arrangements with other disciplines and other agency programs. These include industrial, university, and laboratory cooperative programs.

1. **National Science Foundation (NSF).** Within the NSF Division of Mathematical Sciences, the FY 1988 budget request will permit continued increases in the support for research assistants, postdoctoral associates, and young investigators. In addition, increased funds are provided for participation by mathematical scientists in the Foundation’s thrust in undergraduate education. A major portion is designated to mathematics curriculum reform centers on efforts to renew and enhance calculus curriculum and instruction.

In 1987, a new program in computational mathematics was begun. It is proving popular and will continue to be an integral part of the NSF program in mathematical science. The level of support for the Mathematical Sciences Research Institutes at Berkeley and Minnesota will be essentially level. About 60 percent of the researchers supported at these institutes are postdoctoral and young researchers. There will be continued emphasis placed on the support for young investigators.

2. **Air Force Office of Scientific Research (AFOSR).** The AFOSR mathematical science programs will continue basically the same for 1988 with a small additional increase planned in nonlinear mathematics. Major AFOSR mathematics programs include: control theory, mathematics of

### Table 1: Federal Academic Mathematics Funding FY 1988

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1. These figures are subject to change and include amounts for URI and SDI.
2. The DOD figures include estimates for URI and SDI budgets.
3. In addition, DMS/NSF budgets include 0.38 in FY 1987 and 4.08 in FY 1988 in undergraduate education.
computation, probability and statistics, applied analysis, and mathematical physics and optimization.

3. Army Research Office (ARO). The Army Research Office outlook is clouded by uncertainty over continued URI commitments and possible set-asides for predetermined projects. In 1988, ARO will handle the bulk of SDI mathematics funding, which in 1987 amounted to just under $2 million. In 1986, ARO began funding for a Mathematical Sciences Institute at Cornell at an approximate level of $2.5 million per year. ARO programs include areas of applied mathematics, statistics, and computer science.

4. Office of Naval Research (ONR). The Navy’s mathematical sciences program also faces uncertainty over eventual levels of funding. The Mathematical Sciences Division at ONR is currently organized into the following 8 program areas: applied analysis, numerical analysis, mathematical statistics and probability, statistical signal analysis, discrete mathematics, operations research, and decision sciences. The decision sciences program is currently under review. In addition, ONR handles R&D work at the Naval Research Laboratory, Naval Air Systems Command, Naval Sea Systems Command, and the Naval Electronic Systems Command. In the past, the order of magnitude of funds for each of these was about $1 million, except for NRL funds which have been somewhat larger.

5. Department of Energy (DOE). Activities supporting R&D in the mathematical sciences at the Department of Energy are lodged primarily in the Energy Sciences Computational Research Program. This program consists of 2 activities: applied mathematical sciences supercomputing research and energy science advanced computation. The applied mathematical sciences supercomputing research program funds basic research at national laboratories, universities, and private research institutions in 3 major categories: analytic and numerical methods, information analysis, techniques, and advanced computing concepts.

6. Defense Advanced Research Project Agency (DARPA). A substantial new mathematics program has emerged at DARPA. The thrust of this new program is in the areas of dynamical systems, harmonic analysis, data compression, neural connections, and computational algorithms. There continue to be changes of organization within DARPA affecting the administration and budget of this program.

7. National Security Agency (NSA). The NSA currently has a modest program ($1.2 million) for support in basic, unclassified external mathematical sciences. They have announced plans to enhance this effort significantly, increasing it to $5.0 million by 1990. Of considerable concern to NSA and others is the continuing decline of U.S. Ph.D. graduates in mathematical sciences.

8. Other agencies. Several collateral agencies such as the National Aeronautics and Space Administration (NASA) and the National Institutes of Health (NIH) have modest mathematics science programs. The National Bureau of Standards (NBS), as well as the numerous national laboratories attached to other agencies, provide considerable in-house mathematics, statistics, and computer research programs.

APPREXIMATION THEORY

Carl de Boor, Editor

The papers in this book, first presented at a 1986 AMS Short Course, give a brief introduction to approximation theory and some of its current areas of active research, both theoretical and applied. The first lecture describes and illustrates the basic concerns of the field. Topics highlighted in the other lectures include the following: approximation in the complex domain, N-width, optimal recovery, interpolation, algorithms for approximation, and splines, with a strong emphasis on a multivariate setting for the last three topics.

The book is aimed at mathematicians interested in exploring the field for possible applications to their own fields. The book is best understood by those with a standard first graduate course in real and complex analysis, but some of the presentations are accessible with the minimal requirements of advanced calculus and linear algebra.

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Goals of Defense Funding

This letter is about the second of two motions introduced at the recent AMS meeting in San Antonio (Notices January 1987, p. 76). It concerns U.S. Federal Government funding for mathematics research through Department of Defense agencies generally, rather than funds from special sources such as SDI. The motion deplores trends perceived in research funding and requests that those representing the AMS "direct their efforts towards increasing the fraction of non-military funding for mathematics research, as well as increasing total research support."

There is a long history of DOD support for basic research in the mathematical sciences. This support has come for the most part through ongoing programs rather than special initiatives. Although the mechanisms for evaluating research proposals vary from agency to agency, the scientific standard for DOD funding has tended to focus on more applied areas of the mathematical sciences. The long-term DOD support, along with NSF and more recently the Department of Energy, has been an important factor in the development of applied mathematics in the U.S. since World War II. In particular, DOD support for graduate students and postdocs has provided real encouragement to several generations of younger researchers. During recent years, well over half the U.S. Government funding for research in applied mathematics, probability, and statistics has come from DOD agencies.

There is a continuing shortage of research support for highly qualified mathematicians, in "core" areas for which the only source of U.S. government funding has been NSF. It is my view that in addressing this problem one must continue to build the case for supporting mathematics as broadly as possible, emphasizing the unity of the mathematical sciences and pointing to the many ways (often unexpected) in which mathematics is applied. The case for U.S. government support of pure scientific research is made in the context of pressures to fund science directed toward such national goals as maintaining leadership in high technology and improving the competitive position of U.S. industry. In making the case for mathematics research funding one needs to continue to show how the national effort in the mathematical sciences ties in with these goals. During the early 1970s support for a number of mathematicians by DOD agencies was discontinued. It was expected that NSF support for mathematics would increase accordingly. In fact, most of the increases in NSF budgets during the period 1970-75 went to fields identified with industrial development rather than mathematics. (See the David Committee report "Renewing U.S. Mathematics: Critical Resource for the Future," National Academy Press, 1984, p. 112.)

Continuing discussions within the mathematical community and dialogues with the funding agencies are needed concerning policies and problems connected with research funding. The motion in question does not seem to me helpful in this regard. If passed at the next AMS business meeting, it is in fact likely to be counterproductive. I oppose it.

Wendell H. Fleming
Brown University
(Received February 24, 1987)

A Request for Reconsideration of the Motions

The business meeting of the society at San Antonio on January 22 referred to the coming meeting at Salt Lake City two motions on SDI and on military research. The motion recommending that the coming meeting adopt these two motions was passed, but by a narrow majority. Thus it is clear that a number of our members are passionately in favor of the motions as stated; there are others who strongly oppose them in their present form. Some of the questions at issue could be formulated in ways that would command much wider agreement from the members of the Society; such wide agreement would be welcome, especially at this time when Mathematics is in dire need of better funding.
The first sentence of Motion 1 reads, "Many scientists consider SDI ... incapable of achieving its stated goals and dangerously destabilizing." Now SDI may (or may not) be destabilizing, but this is a judgement about international politics in which scientists (and in particular mathematicians) have no special expertise. As a citizen, I share this negative judgement but I do not think it is the business of our Society nor do I think that political leaders will pay the slightest attention to the views of the AMS on this question.

While many scientists do consider "SDI ... incapable ... of reaching its stated goals" (Motion 1) it is not clear which goals are meant: They have been stated quite differently by different authorities at different times. For some of the goals, there may be "proof" that they are unattainable; however, experts with classified knowledge may have classified experimental evidence that other goals can perhaps be attained. Among those many scientists who voted in various opinion polls on this issue, we do not know how many had real (or even classified) knowledge. I suggest that what we need is not such a sweeping statement about the goals, but perhaps a call for a careful, objective, and informal study, by scientists and others, of the merits and demerits of SDI.

Such a study is what has been tragically lacking and is still lacking. Pending such a study, the last sentences of Motion 1 (non-participation of the AMS in SDI) is an appropriate position for our Society.

To give a specific reference as to different goals: The Jan. 6, 1987 issue of Science (vol. 235) carries an article (p. 277) "Debate over SDI enters new phase" which begins "A clash over goals ..." Thus the motion presented to the business meeting did not take account of the actual political debate about the goals—and the Society is hardly in a position to take note of these rapidly changing arguments.

Motion 2 speaks of the "increasing militarization of mathematical research," although the statistical evidence (% of such funding by military agencies) does not strongly bear this out. There is perhaps more evidence for the growth of "narrowly funded (mission-oriented) programs." This issue has several subtle aspects. We are not experts on some of these missions; whatever we say, the government is likely to have mission-oriented agencies, some of which may need highly specialized mathematical help and may pay well for this help. We are (or can be) experts on the distortion of mathematics, but the motion does not say why this should matter to the country. A strong and balanced mathematical activity is important to the prosperity and especially to the long run security of the United States. A suitable motion should say so.

The long continued government support of mathematical research, complete with summer salaries, came about in large part because mathe-
I. I agree. The Federal government supports mathematics above and beyond its support for the arts largely because of its usefulness to society. Washington responded positively to the David Report because it is beginning to understand the importance of mathematics.

II (1). The argument that federal support of basic research would bring with it unwanted restrictions and corrupting influences is an old one. Many of us taught summer school when we were young. We were pleased that our older colleagues, who believed government support would be beneficial, prevailed. I think there is common agreement that government support has greatly enhanced mathematics in the United States with much benefit to society.

But those who warned of government interference had a point. For example, Government auditors and university administrators hit upon time and effort reporting as a method of accountability for grants. Led by Serge Lang, we have been trying to eliminate that method of accountability so inimicable to university life. For the moment, it appears we have won.

See the Corson report ("Scientific Communication and National Security," National Academy of Sciences, 1982) for another example. It attempts to resolve the apparent conflict between free flow of scientific information and national security needs.

It seems to me that we have benefited by seeking and accepting Federal support for basic research while at the same time fighting explicitly against specific restrictions destructive to our discipline.

Those who commissioned Bill Thurston's article probably feel that while my argument may be valid for support from civilian agencies, it is not valid for DOD. I believe differently.

Many in the Defense Department recognize how important basic research is to the welfare of the nation and to the broad aims of their agency. They therefore feel basic research is worth supporting on a broad front. DOD has a tradition of supporting research in mathematics without strings attached, a tradition which we should encourage.

I would suggest then we follow an established and successful precedent: seek and accept DOD support but be on the alert and argue against specific restrictions detrimental to us.

II (2). The large resources made available to the scientific community by the Federal government has already created a considerable imbalance in universities. Check your local English department. Better still, contrast the resources for research mathematicians, with say, those for composers. By and large the humanities are poorly supported compared to the sciences. On the other side of the coin, graduate student support in mathematics is much smaller than other sciences (see the David Report). So where Thurston states he is concerned about imbalance, I would say he is concerned about change—the present imbalances are manifest.

I too am concerned about change, but in a different way. I think that greater support for mathematical research would benefit the country enormously. And it would allow us to capitalize on the exciting developments happening this very moment in mathematics.

I don't think the percentage of support from DOD will increase much, if at all. Moreover, I don't see it affecting our way of working, if we are careful about guarding against harmful restrictions.

II (3). When I was chairman of the Committee of Science and Public Policy (National Academy of Sciences) I oversaw two studies of Peer Review (see Peer Review in the National Science Foundation, Phases I, II, National Academy of Sciences, 1978 and 1981). Peer Review (which needs to be defined; it means different things at NSF than at NIH, for example) is the best system I know for determining which proposals to support. But I learned that it is very conservative. Very few gambles can be taken and it is almost impossible to begin new activities. Therefore, I believe it is unwise to rely on peer review as the only way to determine which areas of science to support and which scientists to support.

My experiences in Washington suggest a different and perhaps more constructive approach. The mathematical community should attempt to be more involved in the recruitment of mathematics program officers and their superiors in all agencies that support basic research. We should continue to strengthen our contacts with all agencies and be ready to offer our advice about research opportunities in mathematics, when it is sought.

II (4). Yes it does. The added statement that that's bad is a political or moral judgment. One that I don't agree with. And I don't particularly care to have someone else's political position dictate where I and other scientists should seek support.

I. M. Singer
Massachusetts Institute of Technology
(Received March 3, 1987)

In Support of the Motion Against SDI

I have been encouraged to reiterate in print, presumably for a wider audience, the comments that I made in San Antonio at the business meeting of the society.

There are clear and persuasive reasons for strong opposition to the so-called Strategic Defense Initiative (SDI). First, it amounts to a major escalation of the arms race. The word "defense" and the rhetoric of "umbrellas" are transparent fig leaves. Even a superficial reading of the proposals associated with SDI makes clear
that the envisioned systems could either directly and immediately be used offensively or could be used in that way with very minor modifications. Already the initiation of this idea has aggravated world tensions. Each step of building, testing, and putting in place will be that much more dangerous.

Second, the idea of SDI makes the current president and possibly his successor(s) intransigent in negotiating for arms reductions. This is no idle or marginal concern. Many observers feel that a perhaps unprecedented opportunity for arms reduction was missed in Iceland due to President Reagan's fixation on SDI.

Third, SDI is unrealistic. The fantasy is lifted whole from the "Death Star" of the Star Wars movies; such movies are not a plausible source for developing United States policy. That the envisioned systems are unrealistic has been the judgement of the overwhelming majority in every poll I've seen of people with relevant expertise. One might indulge oneself in what is unrealistic but harmless for the sake of the inevitable spin-off gains in knowledge. SDI is not, however, harmless. In addition to the above grave dangers, commitment of societal resources to SDI must inevitably drain those resources away from pressing needs, which will be reflected not only in the dollar figures of the U.S. budget but also in the allocation of intellectual and institutional resources. Also, one can realistically expect of SDI research an increased variety of weapons, which will hardly be harmless.

If it be given that SDI is a grave mistake, and therefore something which reasonable citizens should oppose, one should ask: what action should the membership of the AMS take qua members of the society, as distinct from actions we may choose to take as individuals or as members of other groups, e.g., political parties or religious organizations or whatever.

In response to that it should be first made clear that the current proposal, Motion 1, as it appears on page 76 of the January 1987 issue of Notices, is only a neutral stand. It says that the AMS "will lend no support," NOT "will oppose." Further, the representatives of the AMS, when acting qua representatives of the AMS will not seek funding for SDI related research, NOT that they shall attempt to hinder or interfere with such.

Even if Motion 1 be interpreted as in effect putting the AMS on record as opposed to SDI, that would not be improper per se. If the majority of the members of the AMS are persuaded by arguments similar to the above to oppose SDI, then it is fully appropriate for us to say so as mathematicians, expressing ourselves through a mathematical body. Our fellow citizens and elected officials correctly recognize that mathematicians have training that in fact helps us judge the reasonableness of SDI. Let us not underestimate the significance of our own training and perspective.

Healthy and wise action on the part of a free, open, and democratic society depends on citizens who publicly debate and publicly speak their minds. Within reasonable limits professional organizations such as the AMS provide an appropriate avenue for such speech, exactly when the expertise we share has relevance to the issue at hand. (Some may mutter: "Exactly! In this case we have no relevant expertise!" But if that were so, then why would we be potentially involved in the research? We have expertise; the mathematical community is and will be involved, acting as mathematicians.)

No one will deny the importance of the issues at hand. That which may increase the likelihood of nuclear war between the major powers literally threatens the survival of humankind, perhaps of all life, on the planet. In such a case being overly circumspect about the forum in which one speaks is neither wise nor responsible. I urge the membership of the AMS to support Motion 1, which would put the AMS in a neutral position with regard to SDI. I urge them further to oppose SDI in those contexts where expressing such opposition is appropriate.

Samuel B. Johnson
Guilford College
(Received March 9, 1987)

The Quest for National Security
Sponsored by hundreds of AMS members, two motions on military funding were put on the agenda for the next Business Meeting. The paper by Hyman Bass for the AMS panel at San Antonio takes up the questions raised by these two motions. His mention of SDI is brief and appears to support the group's Motion 1 completely. The bulk of his article is a treatment of exactly the question raised by Motion 2 of the group on military funding: the consequences for mathematics, in the present context, of military funding in general. He comes to a conclusion much more welcoming of military support than the group does.

Professor Bass speaks from years of awareness and a store of detailed knowledge. His remarks deserve to be taken seriously. Exactly for this reason it is important to be alert to a danger of confusion in his assumptions.

His premise 1 reads, "National security, like economic strength and social well-being, is a legitimate national goal, to which scientists can significantly contribute. As such, it deserves appropriate public and scientific support." Now who could possibly object to that? All the same, it opens the door to a possible confusion which (as I trust Professor Bass would agree) must be avoided. Namely, it leaves unexamined the question of what agencies support national security.
But this question is not self-answering. One surely ought not to take for granted that the goal of national security can be identified with the goals of government agencies that purport to defend it—like the National Security Agency and the Department of Defense. They have those good words in their names, but we must look at their actual policies. One of the reasons there is concern about DARPA money, CIA money, and SDIO money is precisely that it does not increase security, but in many people’s view decreases it; that U.S. weapons, while they threaten the whole world (including ourselves), and have been used against countries powerless to attack us, can not be seen in many people’s view to be defending us from anything.

The copiously flowing money is directed to designing and building more numerous and more destructive weapons which can be fired more quickly in response to alarms. But the greatest problem we face, the greatest problem the world has ever faced, is exactly that the weapons are now too numerous, too destructive, and too quick on the trigger. The main objectives of the Department of Defense, therefore, work to destroy security, what little of it we have left. This is true not only of their weapons production, but also of their research.

I am not saying that research per se undermines security, even mission-oriented research—not at all. Let us have mission-oriented research in the interest of national security, if we can get it. Research on satellites which would detect and publish to all parties evidence of warlike moves by anyone. Research on how to dismantle nuclear weapons and nuclear installations safely. Research on converting military industry to useful production without causing economic dislocation. Let us (individually and through AMS and JPBM) encourage mathematicians to do such research. But it is silly to expect support for it from organizations going in the opposite direction—such as the so-called Department of Defense. Military funding is anti-security.

Chandler Davis
University of Toronto
(Received February 27, 1987)

Urging Rejection of the SDI Motion
In the Notices, January 1987 on page 76, there appear two motions seeking to bind the AMS in opposition to mathematical projects funded by the U.S. Department of Defense, particularly by military sources such as SDI. I urge the members of the AMS to reject these motions, which I consider to be outside the authority and interest of the AMS.

The DOD, with various programs such as SDI, has a legitimate and important role in the American republic. The SDI represents an established policy of the U.S. government and has been formally endorsed by Congress. It is not a frivolous or foolish concept, as attested by the many serious supporting discussions and writings by authorities on international relations and military strategy—for example, by the current Democratic Senate Majority Leader, R. Byrd, as well as by experts in prior administrations such as H. Kissinger and Z. Brzezinski.

Honest opinions may differ on the long-term value of SDI to the people of the U.S.; therefore the AMS membership should not be casually assigned to any particular position. It is not appropriate for the Society to make an official statement on any such political policy except, perhaps, after a special vote of the entire membership.

Recent polls show that a substantial majority of the American people support SDI and I believe that similar support would occur among the membership of the AMS. Moreover, my experience indicates that most of these mathematicians would support SDI, and other policies of DOD, not because they anticipate personal gains through military funding, nor because they are intrigued by scientific curiosity and excitement, but because they sincerely believe that these policies constitute a valid program contributing to the defense of the security and freedom of the American people—as well as of other peoples of the world.

It would be undemocratic, even dictatorial, for a few dozen partisan advocates at a Business Meeting to pretend to commit the entire membership of the AMS on these matters.

Lawrence Markus
University of Minnesota,
Minneapolis
(Received January 14, 1987)

Research Funding
Last June, I learned that Sheldon Kamienny’s NSF grant was not renewed. I wish to take this occasion to make some general comments on current NSF funding in light of this special case.

1. Financial support by the NSF today is insufficient to insure proper funding at the level of activity which both scientists and many people in the government seem to find appropriate. One result is that the cut off point for NSF grants is so high that reviewers for the NSF are placed in a position where they cannot function intelligently, and are playing dice. The lack of funds thus induces a malfunctioning of the peer review system. Who am I to be playing God and determine who is to get one month, or two months summer salary support, with many candidates equally worthy?

A few years ago, the NSF was cutting back on the support of a mathematician, basing its judgement in part on comments like: “This is a carefully written proposal. It would have been quite fashionable ten years ago.” Some people contacted the NSF to complain about any
students told that when they attend graduate school? To some extent there is a certain amount of super people and their graduate students at those places if most of these students are going to be dumped a few years after their Ph.D.? Are those students warned of the way they are going to be treated? People like me would be irresponsible to advise students to go into mathematics—pure mathematics at least—knowing what can happen to them. Is it the Government’s intention to drive people like Kamienny out of mathematics?

In fact this may very well happen. Kamienny has written me that lack of financial support means that he had to cut short his visit to MSRI during the special year on arithmetic; also that the absence of travel money makes it difficult for him to consult with colleagues in order to continue doing research.

3. Even more importantly, NSF decisions affect tenure positions. Kamienny wrote me that rejection of his grant by the NSF affects his prospects for tenure at Ohio State. Joseph Ferrar, Chairman of his Department, told me (authorized quote): “It is clear in our department that in recent years the existence or non-existence of an NSF grant has played an important role in tenure deliberations.” Speaking for himself personally, Joseph Ferrar also told me: “If there is to be less money available for support of mathematics research than is necessary to support qualified applicants, then I feel that it would be wise to cut across the board on summer salary support and devote the money available to other categories such as travel, consulting, equipment, and so on, so that more people are supported.”

4. Of course, the distinction between “pure” and “applied” mathematics is not absolute, but in “applied” directions, money seems to be much more easily available. Historically, some pure mathematicians have gone from one to the other, and it is never possible to tell when such transfers of persons or subjects will happen (vide the Goppa codes in connection with Shimura curves, for instance).

5. The shortage of funds available to the NSF is parallel to the expansion of funds available for support via the Defense Department or things like SDI (Star Wars). As a result, some scientists—mathematicians—who find insufficient money to do research in the universities via NSF are now directing their fund raising efforts toward the Defense Department. We have seen during the Vietnam war where this leads.

I oppose this trend for at least two reasons:

one, it transforms research whose origins lie with the researcher and the universities into directed research, with specific goals set a priori, and even military goals at that;

two, the universities get hooked on military funding, with all the political implications that go along with this, and the substantial erosion of whatever independence the universities have.

Serge Lang
Yale University
(Received October 4, 1986)
Electronic Addresses in the CML

I was pleased when I learned that the current edition of the CML would have space for computer network addresses. At last, it seemed that the pure mathematicians had caught on to what the computer scientists (and a good many others) had known for years: that the networks provide a convenient, and nearly cost-free method of communicating, generally in hours (at worst), with colleagues at thousands of universities and other establishments throughout North America, Europe, Japan, Israel, Australia, and other places.

The results were unspectacular. A random sample of 10 pages from CML yielded exactly 12 members with network addresses, a rate of 3/4 of 1%. Perhaps some mathematicians chose not to publish network addresses, but it seems far more likely that most are simply not taking advantage of this form of technology for communication and collaboration.

It also seems passing strange that there is no obvious network address for the main offices of the AMS. The establishment of such would be a valuable gesture to encourage the use of the networks among mathematicians. This technology continues to have a vast, but largely unrealized, potential for tying mathematicians, especially those at small institutions, together in active collaborative efforts without the annoying delays of what our colleagues in computer science often contemptuously call "snail mail."

Douglass L. Grant
University College of Cape Breton
(Received February 19, 1987)

EDITOR'S NOTE: See the News and Announcements section of this issue of Notices.

Open Letter to the President of the Soviet Academy

I would like to have the following open letter to the President of the Soviet Academy of Sciences published in the Notices. This letter was written at a meeting in Oberwolfach which was organized by Martin Kruskal, Mark Ablowitz, and Benno Fuchsteiner. The letter was signed by 30 mathematicians.

Dear Professor Alexandrov,

We are participating in an international meeting at the Mathematical Institute in Oberwolfach on "Nonlinear Evolution Equations, Solitons and the Inverse Scattering Transform." Regrettably no Soviet participant is taking part in our meeting. This is particularly unfortunate since Soviet scientists have played and are playing a fundamental role in this field of research. One purpose of this letter is to express our hope that the obstacles that sometimes impede the fruitful collaboration among scientists, by preventing their participation in international meetings, may eventually be overcome. This hope is encouraged by several recent pronouncements by Soviet leaders emphasizing the political, economic, and cultural advantages that everybody would reap from more extensive international collaboration, corresponding to the growing interdependence in the contemporary world between all countries and nations.

In this context, we would also like to call to your attention—and through you, the attention of the Soviet authorities—the plight of a colleague of ours, whose research interests and activities fall precisely within the field of study that we are pursuing and are discussing here. This is the second purpose of this letter, which we have written in a positive spirit and in the hope to contribute thereby to the solution of an unfortunate situation.

Our colleague is Professor Solomon Al'ber, a mathematical physicist attached to the Institute of Chemical Physics of the Soviet Academy of Sciences in Chernogolovka, Moscow Region. Eleven years ago he submitted to the Soviet authorities his first application to get permission to leave the Soviet Union with his family. Several years ago he was informed that such permission would be granted in 1981; but he is still waiting. In the meantime he is having great difficulties in pursuing his scientific activities, and his family is also suffering (including a son of his who has received a mathematical education, largely from his father, and who is also active, although with great difficulty, in our research field).

We are purely expressing the feelings of all our colleagues working worldwide on Nonlinear Evolution Equations, Solitons and the Inverse Scattering Transform, and more generally of the entire community of mathematicians and mathematical physicists, in expressing our hope that Professor Solomon Al'ber be allowed to leave the Soviet Union together with his family, so that he may resume under more normal conditions his research activity. And we also hope that you will take in positive consideration this open letter, that we address to you in your capacity as President of the Soviet Academy of Sciences.

Francesco Calogero
University of Rome I
(Received September 11, 1986)

Call for Support of a Soviet Mathematician

We (Mark Pinsky, Joel L. Lebowitz, George C. Papanicolaou, Henry P. McKean, Eugene B. Dynkin, S. R. S. Varadhan, Lawrence C. Evans, Joseph L. Doob, and Walter Phillip) would like to share with the American Mathematical Community the current status and future prospects of the eminent Soviet mathematician M. I. Freidlin who, together with his wife, applied for emigration in 1979. They were summarily fired from their jobs at Moscow State University, denied any possibility of publishing in Soviet scientific journals, and until recently have not been able to attend meetings or otherwise participate in scientific life.
This spring Freidlin was invited to participate in the First World Congress of the Bernoulli Society, held in Tashkent, U.S.S.R. September 8-14, 1986. Friedlin gave a fifteen minute talk on his recent work (on the probabilistic treatment of semi-linear parabolic equations). Prior to the technical portion of his talk, he made the following remarks.

"First of all, I would like to thank those of my colleagues who helped me to be invited to this Congress. I should say that this is the first time in more than seven years that I have had the opportunity to take part in a scientific meeting. I would also like to thank all of the many colleagues in the Congress who expressed personally to me their support and concern about my situation. I do hope that my problem will be solved in the only proper way—that I shall be permitted to leave this country. Then perhaps I will have a normal life and normal conditions for mathematical research."

Freidlin added in a personal conversation after the Congress the following additional remarks: "For more than seven years my family and I have been refused permission to emigrate to Israel. The only official explanation given to us is that we were told that our relatives in Israel were not close enough. According to Soviet law, one can hardly consider that such an explanation is legal. No legal grounds for refusal were given to me and such reasons do not exist. Alleged "explanations" of our multi-year refusal which sometimes are given by allegedly friendly colleagues in fact are deliberate lies. All of these years since June 1979 neither I nor my wife (also a Ph.D.—in Applied Mathematics) have permanent jobs."

We call upon the American Mathematical Community to continue the supportive efforts for Freidlin and other "refusenik" scientists. Earlier this year two physicists (Khachatourian and Ozerny) and the biologist Goldfarb have been allowed to emigrate and more recently Orlov was "exchanged". This was due, according to these individuals, in great part to the continued pressure, from Western colleagues. This pressure can and should take many forms: i) participation in organizations which work directly for human rights of scientists, ii) contact with refusenik mathematicians by sending them papers and looking them up when visiting the Soviet Union, iii) protests to the Soviet government and iv) urging our own scientific organizations, Congressmen and Senators to work on behalf of the refuseniks. We appeal to our colleagues for such support.

Mark Pinsky
Northwestern University
(Received November 6, 1986)

Seeking Tenure-Track Faculty Appointments
As one who has applied for tenure-track positions, I would like to address this as an open letter to all those who find themselves members of search committees and thus responsible for dealing with applications such as mine.

In addition to those jobs which I apply for because I have actually seen an advertisement, I also routinely send letters of inquiry to those universities which I am most interested in. I am always careful to indicate that I am only interested in tenure-track positions, and I always enclose a copy of my CV.

Nevertheless, the number of replies "thanking me for my application for a postdoc" (or other temporary position) has finally induced me to complain. One institution even went so far as to acknowledge my application for a tenure-track position, and the next thing I knew was that I had been turned down for a postdoc! (Subsequent inquiry finally revealed that my file had been transferred when it was decided that I was not suitable for the tenure-track position. It seems nobody thought to inform me of this.) Equally frustrating was the university whose advertisement (in the AMS Notices) clearly stated that references should not be sent. The acknowledgement I received by return mail informed me that my application was incomplete and would I please arrange to have letters sent!

It is quite common for a positive reply to a letter of inquiry not to mention whether the "available position" is in fact tenure-track and/or whether letters of reference need to be sent. Only slightly better are the letters which thank me for my application and request that I arrange for letters of reference, but neglect to mention what position, if any, I have in fact applied for! It would be much appreciated if departments would clearly distinguish between replies to genuine applications and replies to letters of inquiry. Is it really too much to ask that such replies clearly state what is available and what needs to be done in order to apply?

Finally, a minor point. I am quite happy in principle to provide the information which universities are required to ask for under affirmative action. But I see absolutely no reason why this information, which is only for statistical purposes anyway, needs to have my name on it! To date, I have received precisely one such form which did not have a space for my name, in most cases already filled in. Some departments actually expect the form to be returned to them, not to a central office at the university! I, for one, simply throw these forms away; how much longer do we still have to wait before the meaning of data protection is understood?

Tevian Dray
University of York, United Kingdom
(Received February 16, 1987)
1987 AMS Elections

Nominations by Petition

Vice-President or Member-at-Large

Two positions of vice-president and member of the Council ex officio for a term of two years are to be filled in the election of 1987. The Council intends to nominate four candidates, whose names may be expected to appear in the June issue of Notices, which is scheduled to be mailed by the printer on May 22. Nominations by petition as described in the box are acceptable.

Five positions of member-at-large of the Council for a term of three years are to be filled in the same election. The Council intends to nominate seven candidates, whose names may be expected to appear in the June Notices. Nominations by petition in the manner described in the box are acceptable. The Council has stated its intent to have at least ten candidates and will bring the number up to ten if the nominations by petition do not do so.

Petitions are presented to the Council, which, according to Section 2 of Article VII of the bylaws, makes the nominations. The Council of 23 January 1979 stated the intent of the Council of nominating all persons on whose behalf there were valid petitions. The Council of 20 January 1987 established a policy that, beginning with the interval 1987–1996, the Council intends to approve no more than two nominations by petition of the same individual in any ten year period.

Prior to presentation to the Council, petitions in aid of a candidate for the position of vice-president or of member-at-large of the Council must have at least 50 valid signatures and must conform to several rules and operational considerations, which are described in the box.

The Nominating Committee for 1988

Four places on the Nominating Committee will be filled by election. There will be four continuing members of the Nominating Committee, namely

- M. Salah Baouendi
- Paul C. Fife
- Carl Pomerance
- William P. Ziemer

The new members will be elected in a preferential ballot. The President will name six candidates for these four places. The names may be expected to appear in the June issue of Notices. Nominations by petition, in the manner described in the box, will be accepted. Should the final number of candidates be less than eight, the President will bring it up to eight.

Rules and Procedures

Use separate copies of the form for each candidate for vice-president, member-at-large, or member of the Nominating Committee.

1. To be considered, petitions must be addressed to Everett Pitcher, Secretary, P.O. Box 6248, Providence, Rhode Island 02940, and must arrive by July 6, 1987.

2. The name of the candidate must be given as it appears in the Combined Membership List. If the name does not appear in the list, as in the case of a new member or by error, it must be as it appears in the mailing lists, for example on the mailing label of the Notices. If the name does not identify the candidate uniquely, append the member code, which may be obtained from the candidate’s mailing label or the Providence office.

3. The petition for a single candidate may consist of several sheets each bearing the statement of the petition, including the name of the position, and signatures. The name of the candidate must be exactly the same on all sheets.

4. On the facing page is a sample form for petitions. Copies may be obtained from the Secretary; however, petitioners may make and use photocopies or reasonable facsimiles.

5. A signature is valid when it is clearly that of the member whose name and address is given in the left-hand column.

6. The signature may be in the style chosen by the signer. However, the printed name and address will be checked against the Combined Membership List and the mailing lists. No attempt will be made to match variants or names with the form of name on the CML. A name in CML is that of a member. The name Everett Pitcher appears not to be. Note that the mailing label of the Notices can be peeled off and affixed to the petition as a convenient way of presenting the printed name correctly.

7. When a petition meeting these various requirements appears, the Secretary will ask the candidate whether he is willing to have his name on the ballot. Petitioners can facilitate the procedure by accompanying the petitions with a signed statement from the candidate giving his consent.

The name of a candidate for member of the Nominating Committee may be placed on the ballot by petition. The candidate’s assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and operational considerations which are described in the box should be followed.
NOMINATION PETITION FOR 1987 ELECTION

The undersigned members of the American Mathematical Society propose the name of

______________________________

as a candidate for the position of (check one):

☐ Vice-President
☐ Member-at-Large of the Council
☐ Member of the Nominating Committee


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<tr>
<th>Name and Address (printed or typed, or Notices mailing label)</th>
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The eighteenth AMS-SIAM Summer Seminar in Applied Mathematics will be held April 30–May 7, 1987, please note the new dates, at the Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. The seminar will be sponsored jointly by the American Mathematical Society, the Society for Industrial and Applied Mathematics, and the Institute for Mathematics and its Applications. It is anticipated that it will be supported by grants from federal agencies. The topic, Computational aspects of VLSI design with an emphasis on semiconductor device simulation, was selected by an AMS-SIAM Committee on Applied Mathematics whose members at the time were C. K. Chu, Constantine M. Dafermos, James M. Hyman, Alan G. Konheim, George C. Papanicolaou (chairman), and Robert F. Warming. The proceedings of the seminar will be published by the Society in the Lectures in Applied Mathematics series.

The seminar will form a part of the 1986–1987 Institute for Mathematics and its Applications program on Scientific Computation. The design of very large scale integrated (VLSI) semiconductor devices is an important problem in a variety of technological applications. The goal of simulation is to remove the need of actually fabricating prototype chips in order to study their behavior and optimize their design. Even the simplest system of partial differential equations which can be used to model semiconductor devices poses severe computational challenges. This is true partly because of the strong nonlinearity of the system and partly because of the large and rapid variations in the solution.

The first three days of the seminar will feature a series of three lectures each on process modeling by R. W. Dutton of Stanford University, on device modeling by W. Fichtner of the ETH, Zurich, and on circuit modeling by A. Sangiovanni-Vincentelli of the University of California, Berkeley. These lectures will be expository in nature and will introduce the subject to the participants. The following week will feature lectures of a more technical nature by a set of speakers including R. Bank of University of California, San Diego; J. Blue of National Bureau of Standards; F. Brezzi of the Universita di Pavia; W. Coughran of AT&T Bell Labs; P. Degond of Ecole Polytechnique; J. Jerome of Northwestern University; T. Kerkhoven of Yale University; P. Markowich of Technical University of Vienna; H. Mittelman of Arizona State University; L. Petzold of Lawrence Livermore National Laboratories; C. Rafferty of Stanford University; C. Ringhofer of Arizona State University; and D. Rose of Duke University. These speakers have been invited by the Organizing Committee which consists of Randolph Bank (chairman), William Coughran, Eric Grosse, R. Kent Smith, and Mitchell Luskin. In order to allow ample time for informal discussion among participants, only three lectures per day will be presented.

A brochure is available from the AMS office which includes a description of the scientific program, information on accommodations, and local information. Each participant will pay a $10 registration fee.

Those interested in attending the seminar should send the following information to Betty A. Verducci, Conference Coordinator, American Mathematical Society, P. O. Box 6248, Providence, RI 02940. Requests for support to attend the seminar should have been sent to the AMS before February 13, 1987.

Please type or print the following:
1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home;
4. Anticipated arrival and departure dates;
5. Your scientific background relevant to the topic of the seminar.

Graduate students who have completed at least one year of graduate school are encouraged to participate.
With the anticipated support of the National Science Foundation, a symposium on *The Mathematical Heritage of Hermann Weyl* will take place Tuesday through Saturday, May 12–16, 1987, in the Bryan Center at Duke University, Durham, North Carolina. This topic was selected by the 1985 Committee on Summer Institutes and Special Symposia, whose members at the time were Albert Baernstein II, Eric Friedlander, Hui-Hsiung Kuo (chairman), H. Blaine Lawson, Jr., Judith D. Sally, and John Wermer.

The Organizing Committee for the symposium includes Michael F. Atiyah, Lipman Bers, Felix E. Browder, S. S. Chern, George D. Mostow, R. O. Wells, Jr. (chairman), and C. N. Yang.

The symposium is to honor Hermann Weyl for his great accomplishments in mathematics. In addition, it is intended to provide a stimulus to the younger generation of mathematicians by indicating the cohesive nature of modern mathematical ideas as looked at from the vantage point of Weyl's ideas. Although Weyl did not cover all of mathematics, the breadth of his contributions is nevertheless astonishing and formed the basis for some of the best of modern mathematics. A complete program of the lectures, all of which will be presented in the Film Theater on the intermediate level of the Bryan Center, follows.

Registrations

A registration desk will be located in the Video Screening Room on the intermediate level of the Bryan Center. The desk will be staffed from 8:00 a.m. until 4:00 p.m. on Tuesday, and from 8:30 a.m. until 4:00 p.m. Wednesday through Friday. Please note that the desk will not be open on Saturday, as was previously announced. The registration fee for the entire symposium is $10 per person.

Proceedings of the symposium will be published in the AMS series *Proceedings of Symposia in Pure Mathematics*. Registered participants will be able to purchase the volume when available at a discount which is greater than the usual 40 percent individual member discount.

Book Exhibit and Sale

There will be an exhibit of assorted mathematics books offered by various publishers, and a sale at substantial discounts of recent books published by the American Mathematical Society. The book exhibit and sale will be open during the same hours and in the same location as the registration desk Tuesday through Friday.

Accommodations

Blocks of rooms have been held for participants at the following hotels which are within walking distance of the campus. Individuals should make their own reservations directly with the hotel of their choice and be sure to identify themselves as participants in the American Mathematical Society's symposium at Duke University, in order to obtain these special rates. The deadline for reservations was April 10, 1987, after which reservations will be accepted on a space available basis. Please note that rates do not include the applicable state sales tax, which was recently increased to 8 percent.

**Brownstone Inn (.6 mile) (formerly Hilton Inn)**

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<th>Reservations Manager</th>
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<tr>
<td>2424 Erwin Road, Durham 27705</td>
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<tr>
<td>Telephone: 919-286-7761</td>
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<th>Outside North Carolina:</th>
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<td>1-800-367-0293</td>
<td>1-800-872-9009</td>
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<th>Single or Double $52</th>
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<td>Rate includes continental breakfast.</td>
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**Sheraton University Center Inn (1.4 miles)**

2800 Middleton Avenue at Morreene Road (Rte. 15-501), Durham 27705

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<td>1-800-367-0293</td>
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<td>Telephone: 919-383-8575</td>
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<th>Single or Double $52</th>
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<tr>
<td>Complimentary airport transportation is provided by the Brownstone Inn and Sheraton University Center Inn for registered guests. Participants are strongly advised to provide flight number and arrival time when making their room reservations, because the number of vehicles is limited.</td>
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<tr>
<td>A list of additional motels was published in the February issue of <em>Notices</em>.</td>
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Food Service

The University Room on the main level in the West Campus Union is scheduled to be open from 7:30 a.m. until 2:00 p.m. for breakfast and lunch service. Lunch service starts at 11:00 a.m. and by noon it is usually crowded. In addition, either the Rathskellar or the Boyd-Pishko Cafe in the Bryan Center will be open (9:00 a.m.–9:00 p.m.) for the convenience of participants.

A list of local restaurants will be available for pick-up at the registration desk in the Video Screening Room.

Social Event

A no-host cocktail reception will take place at the Sheraton University Center Inn from 6:00 p.m. to 10:00 p.m. on Thursday and is open to all participants.
Travel

The Raleigh-Durham Airport is served by most major airlines, including American, Continental, Delta, Eastern, New York Air, Pan American, Piedmont, TWA, United, and US Air. Car rental agencies at the airport include Avis, Budget, Dollar, Hertz, National, and Triangle. Shannon Limousine offers shuttle service from the airport every hour on the half-hour between 7:30 a.m. and 11:30 p.m. daily. Reservations are not required. The current one-way fare to Duke University and most hotels or motels in Durham is $8.50 per person.

AMTRAK provides train service to Raleigh, which is approximately 20 miles from Durham. Both Greyhound and Trailways offer bus service to Durham, where the terminals are located approximately three miles from the main campus. Taxicabs are available from all of the foregoing locations.

Those driving to Duke University should take either of the following routes to Durham. From the South: Drive north on I-85 to Exit #170, then travel 1.5 miles east on Route 70 until reaching Route 751 South. Proceed south on Route 751, take a left turn onto Science Drive, and continue through the first traffic light. A short distance beyond the light is the Biological Sciences Building and parking lot, on the left side of Science Drive. Cars with a permit may park in that lot, and the Bryan Center is across the road. From the North (and Richmond, Virginia): Drive south on I-85 to Exit #170 and follow the above directions to Science Drive. From the West: Drive east on I-40 to connect with I-85; stay on I-85 until reaching Exit #170, then follow above directions to Science Drive. From the Raleigh/Durham Airport: When leaving the airport follow signs to Route I-40 West, staying on I-40 until reaching Exit 279B (Freeway North). Remain on the Freeway until it ends and intersects with Erwin Road. Turn left and proceed 1.5 miles to the fifth traffic light and then turn left onto Research Drive (across from the Brownstone Inn). At the first traffic light on Research Drive take a right turn onto Science Drive. When coming from this direction the Bryan Center is on the left and the Biological Sciences Building and parking lot is on the right.

Parking

Although metered parking is available in the lot at the Bryan Center, the space is limited. Parking permits are required for any of the (also limited) free parking spaces that are available, including the lot at the Biological Sciences Building. Parking permits will be available at the registration desk in the Video Screening Room at no charge. Please note that parking is not allowed in Zone A (on Chapel Drive), Zone R (Card Gymnasium, Cameron Indoor Stadium), the main quadrangle in front of the Chapel, or in fire lanes, emergency zones, red or yellow curb areas, handicapped spaces, loading zones, or service areas.

Weather

The normal temperatures in mid-May range from a low of 55 degrees F to a high of 80 degrees F, and short afternoon or evening thunderstorms are a possibility.

RESIDUES AND TRACES
OF DIFFERENTIAL
FORMS VIA
HOCHEISCHLD
HOMOLOGY

Joseph Lipman

Requiring only some understanding of homological algebra and commutative ring theory, this book gives those who have encountered Grothendieck residues in geometry or complex analysis a better understanding of residues, as well as an appreciation of Hochschild homology. While numerous papers have treated the topic of residues from a variety of viewpoints, no books have addressed this topic. The author fills this gap by using Hochschild homology to provide a natural, general, and easily accessible approach to residues, and by identifying connections with other treatments of residues. Developing a theory of the Grothendieck symbol by means of elementary homological and commutative algebra, the author derives residues from a simple pairing between Hochschild homology and cohomology groups, and defines all concepts along the way. The author also establishes some functorial properties and introduces certain trace and cotrace maps with potential use in other contexts.

Shipping/Handling: 1st book $2, each add'l $1, $25 max. By air, 1st book $5, each add'l $3, $100 max. Prepayment required. Order from AMS, P.O. Box 1571, Annex Station, Providence, RI 02901-9930, or call 800-556-7774 to use VISA or MasterCard.
Program for the Symposium on The Mathematical Heritage of Hermann Weyl

All sessions will be held in the Film Theater, Bryan Center

Tuesday, May 12

9:00 - 10:00  Induced representations.  RAOUl BOTT, Harvard University
10:30 - 11:30  Hermann Weyl as a philosopher, and the difference it made to his mathematics and physics.  FELIX E. BROWDER, Rutgers University
1:30 - 2:30  Riemann surfaces applied to one-dimensional dynamical systems.  DENNIS P. SULLIVAN, CUNY Graduate School and University Center, and IHES, France
2:45 - 3:45  Representation theory and arithmetic.  ROBERT P. LANGLANDS, Princeton University
4:15 - 5:15  Non-commutative algebras and unitary representations.  DAVID A. VOGAN, JR., Massachusetts Institute of Technology

Wednesday, May 13

9:00 - 10:00  The oscillator semigroup.  ROGER E. HOWE, Yale University
10:30 - 11:30  Harmonic analysis and the trace formula.  JAMES G. ARTHUR, University of Toronto
1:30 - 2:30  Vertex operators and the monster.  JAMES I. LEPOWSKY, Rutgers University
2:45 - 3:45  Equidistribution and ergodic theory.  HARRY FURSTENBERG, Hebrew University, Israel
4:15 - 5:15  Some mathematical aspects of string theory.  I. M. SINGER, Massachusetts Institute of Technology

Thursday, May 14

9:00 - 10:00  Nonlinear elliptic equations.  LOUIS NIRENBERG, NYU, Courant Institute of Mathematical Sciences
10:30 - 11:30  Value distribution theory.  PHILLIP A. GRIFFITHS, Duke University
2:45 - 3:45  Surfaces in conformal geometry.  ROBERT L. BRYANT, Rice University
4:15 - 5:15  Algebraic cycles and homotopy.  H. BLAINE LAWSON, Jr., SUNY, Center at Stony Brook

Friday, May 15

9:00 - 10:00  Yang-Mills theory over Kähler manifolds.  S.-T. YAU, University of California, San Diego
10:30 - 11:30  Invariants for elliptic operators.  RONALD G. DOUGLAS, SUNY, Center at Stony Brook
1:30 - 2:30  New invariants for manifolds of dimensions 3 and 4.  MICHAEL F. ATIYAH, University of Oxford, England
2:45 - 3:45  The stable topology of self-moduli spaces: A nonlinear Hodge theory.  CLIFFORD TAUBES, Harvard University
4:15 - 5:15  Fundamental asymmetry in physical laws.  ROGER PENROSE, University of Oxford, England

Saturday, May 16

9:00 - 10:00  Hermann Weyl, wave mechanics and gauge fields.  C. N. YANG, SUNY, Center at Stony Brook
10:30 - 11:30  Some mathematical applications of quantum field theory.  EDWARD WITTEN, Princeton University
Tacoma, June 19–20, Pacific Lutheran University

Second Announcement of the 835th Meeting

The eight hundred and thirty-fifth meeting of the American Mathematical Society will be held at Pacific Lutheran University in Tacoma, Washington, on Friday and Saturday, June 19–20, 1987. This meeting will be held in conjunction with the Pacific Northwest section of the Mathematical Association of America.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there will be two invited one-hour addresses. The speakers are as follows:

BRANKO GRUNBAUM, University of Washington, The geometry of polyhedra.
HENRYK HECHT, University of Utah, title to be announced.

Special Sessions

By invitation of the same committee, there will be two special sessions of selected twenty-minute papers. The topics of these sessions and the names and affiliations of the organizers are as follows:

Geometric methods in representation theory, HENRYK HECHT.
Polyhedral and planar graphs, MOSHE ROSENFELD, Pacific Lutheran University.

Contributed Papers

There will also be sessions for contributed ten-minute papers.

MAA Program

The MAA program will take place on Saturday and will include a luncheon. Additional information will be included in the program announcement in the June issue of Notices.

Registration

The meeting registration desk will be located in the foyer of the Rieke Science Center. The desk will be open from 1:00 p.m. to 5:00 p.m. on Friday and from 8:30 a.m. to 12:30 p.m. on Saturday. The registration fees are $10 for members of the AMS or MAA, $16 for nonmembers, and $5 for students or unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information can be found in a box on page 62 in the San Antonio meeting announcement in the January issue of Notices.

Accommodations

A block of dormitory rooms will be reserved on campus for participants. Prices and reservation procedures will be announced in the program announcement in the June issue of Notices.

Participants who prefer off-campus accommodations should make their own reservations directly with the hotel/motel of their choice. A listing of area motels, the distance from the University, and current rates are as follows. Rates do not include local taxes and are subject to change.

Apple Inn (6 blocks)
1811 S. 76th Street, Tacoma, WA 98499
Telephone: 206-473-7100
Single: $29 Double: $34

Best Western Lakewood Motor Inn (6 blocks)
6125 Motor S. W., Tacoma, WA 98499
Telephone: 206-584-2212
Single: $38 Double: $40

Butler's Heritage Inn (6 blocks)
6802 S. Sprague, Tacoma, WA 98499
Telephone: 206-475-5900
Single: $29 Double: $34

Nendel's Motel (5 blocks)
8702 S. Hosmer, Tacoma, WA 98499
Telephone: 206-535-3100
Single: $39 Double: $45

Quality Inn (4 blocks)
9920 South Tacoma Way, Tacoma, WA 98499
Telephone: 206-588-5241
Single: $28 Double: $31

Tacoma South Travelodge (4 blocks)
9915 So. Tacoma Way, Tacoma, WA 98499
Telephone: 206-588-6615
Single: $28 Double: $32

Food Service

The cafeteria in the University Center will be open during both days of the meeting as well as Snack Bars in the University Center and Columbia Center. In addition, a listing of local restaurants will be available at the registration desk.

Travel and Local Information

Tacoma is served by all major airlines. The Sea-Tac airport is situated approximately 30 miles north of Tacoma. The Capital Aeroporter provides round trip shuttle service to Tacoma. Reservations are required and may be obtained by calling 206-572-9544. The one-way fare is $14 per person, or $25 round trip.

Passengers traveling by train will arrive at the AMTRAK station at 1001 Puyallup Avenue, where Pierce Transit buses are available for travel to downtown. From there, transfer to bus #45 which stops at Pacific Lutheran University.
arriving by bus, the terminal is in downtown Tacoma; take bus #45 to the University.

Persons driving to the meeting should take Interstate route I-5 to Tacoma, take exit 127 and travel east on Highway 512 to Pacific Avenue (Parkland/Mount Rainier exit), turn south and continue approximately 12 blocks to 121st Street or Garfield Street. The campus is two blocks west of Pacific Avenue.

Parking
There are regular visitor parking lots on campus, close to the Rieke Science Center. Reserved lots may be used by visitors 5:00 p.m. to 7:00 a.m. and on weekends.

Weather
The weather in the Puget Sound area should be mild, sunny, and dry in June, affording spectacular views of Mount Rainier.

Hugo Rossi
Associate Secretary
Salt Lake City, Utah

FUNCTION ESTIMATES
J. S. Marron, Editor

This volume collects together papers presented at the 1985 Conference in Function Estimation held at Humboldt State University. The papers focus especially on various types of spline estimations and convolution problems. The use of estimation and approximation methods as applied to geophysics, numerical analysis, and nonparametric statistics was a special feature of this conference.

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ISBN 0-8218-5062-8, LC 86-14203
ISSN 0271-4132
188 pages (softcover), August 1986
List price $22, Institutional member $18,
Individual member $13
To order, please specify CONM/59NA

Shipping/Handling: 1st book $2, each add’l $1, $25 max. By air, 1st book $5, each add’l $3, $100 max.
Prepayment required. Order from AMS,
P.O. Box 1571, Annex Station, Providence,
RI 02901-9930, or call 800-556-7774 to use VISA or MasterCard.
The August 1987 Joint Mathematics Meetings, including the 90th Summer Meeting of the AMS, the 66th Summer Meeting of the Mathematical Association of America, the 1987 Annual Meeting of Pi Mu Epsilon, and the 1987 Summer Meeting of the Association for Women in Mathematics, will be held August 5–8, 1987 (Wednesday–Saturday), at the University of Utah, Salt Lake City. Sessions will take place on the campus of the university. Please note that no AMS Short Course is planned for Salt Lake City.

The members of the Local Arrangements Committee are C. Edmund Burgess (chairman), E. Allan Davis, William J. LeVeque (ex-officio), Deanne Randall, Kenneth A. Ross (ex-officio), Hugo Rossi (ex-officio), Peter C. Trombi, and Carolyn Tucker.

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90th Summer Meeting of the AMS  August 5–8, 1987
Colloquium Lectures
There will be a series of four Colloquium Lectures presented by EDWARD WITTEN of the Joseph Henry Laboratory, Princeton University. The tentative title of his lecture series is Mathematical applications of quantum field theory. The lectures will be given at 1:15 p.m. daily, Wednesday–Saturday, August 5–8.

Prize Session
The 1987 Leroy P. Steele Prizes will be awarded at 4:05 p.m. on Friday, August 7.

Invited Addresses
By invitation of the Program Committee, there will be eight fifty-minute invited addresses. The names of the speakers, their affiliations, the titles, and the times and days of their talks follow:

DONALD G. ARONSON, University of Minnesota, Minneapolis, title to be announced, 10:10 a.m. Wednesday;

EDWARD W. FORMANEK, Pennsylvania State University, The invariants and polynomial identities of nxn matrices, 8:00 a.m. Friday;

DAVID JERISON, Massachusetts Institute of Technology, title to be announced, 3:35 p.m. Saturday;

STEPHEN KERCOFF, Stanford University, title to be announced, 8:00 a.m. Wednesday;

PAUL C. ROBERTS, University of Utah, title to be announced, 9:05 a.m. Wednesday;

KAREN VOIGTMANN, Cornell University, title to be announced, 9:05 a.m. Friday;

BRIAN C. WHITE, Stanford University, title to be announced, 1:15 p.m. Saturday;

ROBERT LEE WILSON, Rutgers University, Classification of restricted simple Lie algebras, 2:30 p.m. Saturday.

Special Sessions
By invitation of the same committee, there will be six special sessions of selected twenty-minute papers. The topics of these special sessions, the names and affiliations of the mathematicians arranging them, and the days and times they will meet are as follows:

Nonlinear evolution equations, DONALD G. ARONSON and HANS OTHMER, University of Utah. 2:30 p.m. Wednesday and 8:00 a.m. Thursday.

Geometric methods in group theory, KENNETH S. BROWN, Cornell University. 1:00 p.m. Friday and 8:00 a.m. Saturday.
Preregistration and Housing

**Preregistration.** Preregistration for these meetings must be completed by June 1, 1987. All those wishing to preregister must complete the form which appears at the back of this issue and submit it along with the appropriate preregistration payments to the Mathematics Meetings Housing Bureau in Providence by June 1.

Please provide your nickname if you wish this information to be printed on your badge.

Preregistration for the meeting and full payment of room charges is a requirement in order to obtain confirmed residence hall accommodations at the University of Utah through the Mathematics Meetings Housing Bureau.

Checks for preregistration fee, housing payments, and fees for social events should be made payable to the AMS. Canadian checks must be marked for "in U.S. funds." The registration fees at the meeting will be 30 percent higher than the preregistration fees listed below:

<table>
<thead>
<tr>
<th>Joint Mathematics Meetings</th>
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<tbody>
<tr>
<td>Member of AMS, MAA, IIME</td>
<td>$59</td>
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<tr>
<td>Emeritus Member of AMS, MAA</td>
<td>$16</td>
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<tr>
<td>Nonmember</td>
<td>$90</td>
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<tr>
<td>Student/Unemployed</td>
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A $5 charge will be imposed for all invoices prepared when preregistration forms are submitted without accompanying check(s) for the preregistration fee or are accompanied by an amount insufficient to cover the total payments due. Preregistration forms received well before the deadline of June 1 which are not accompanied by correct payment will be returned to the participant with a request for resubmission with full payment.

A 50 percent refund of the preregistration fee will be made for all cancellations received in Providence no later than August 4, 1987. **No refunds will be granted for cancellations received after that date,** or to persons who do not attend the meetings.

The only exception to this rule is someone who preregisters for the Joint Mathematics Meetings only in order to attend an MAA Minicourse, and is too late to obtain a slot in the MAA Minicourse. In this case, full refund will be made of the Joint Mathematics Meetings preregistration fee, provided the preregistrant has checked the box on the MAA Minicourse Preregistration Form that this was his or her intent. Individuals who preregister for both the Joint Meetings and an MAA Minicourse and who intend to attend the Joint Meetings, even if the MAA Minicourse is not available, should, of course, not check the box on the MAA Minicourse Preregistration Form. In this case, the Joint Meetings preregistration will be processed and will be subject to the 50 percent refund rule.

**Housing.** The use of the services offered by the Mathematics Meetings Housing Bureau requires preregistration for the meetings. Persons desiring confirmed residence hall accommodations should complete the Preregistration/Housing Form, or a reasonable facsimile, and send it with payment in full to the Mathematics Meetings Housing Bureau, Post Office Box 6887, Providence, Rhode Island 02940-6887, Telex 797192, so that it will arrive no later than June 1, 1987. (See Housing section of Preregistration/Housing Form.)

Please read carefully the section on University Housing before completing the form. Forms sent to the wrong address and thus incurring delay in delivery to the Housing Bureau until after the deadline cannot be accepted. All residence halls reservations with full prepayment for room will be confirmed by the Housing Bureau. All reservation requests must be received in writing and be processed through the Housing Bureau in Providence. Please do not contact the university directly. **Telephone requests will not be accepted.**

Housing assignments are made on a first-come, first-served basis, so participants desiring specific types of accommodations are urged to get their housing requests in as early as possible. **Housing requests received after the deadline of June 1 must surely cannot be honored.**

Participants who are able to do so are urged to share a room whenever possible. This procedure can be economically beneficial. The housing form should be fully completed to ensure proper assignment of rooms. Participants planning to share accommodations should provide the name of the person with whom they plan to occupy a room. Each participant should, however, complete a separate Preregistration/Housing Form. Parties planning to share rooms should send their forms together in the same envelope, if possible.

**Changes/Cancellations**

Please make all changes to or cancellations of residence hall reservations with the Housing Bureau in Providence before August 4, 1987, in order to receive a 90% refund of housing payment. After that date, refunds for cancellations or no-shows will equal 90% of the amount paid minus one night's room charge. No cancellations can be made between 5:00 p.m. on Tuesday, August 4, and 4:00 p.m. on Thursday, August 6, after which changes or cancellations may be called in to Penny Pina at the Telephone Message Center number in Salt Lake City. Changes in reservations may be made at any time by notifying the Housing Bureau in Providence.
Ring theory and invariant theory, EDWARD W. FORMANEK. 1:00 p.m. Friday and 8:00 a.m. Saturday.

Discrete geometry and convexity, JACOB GOODMAN, City College, CUNY, and ERWIN LUTWAK, Polytechnic University of New York. 2:30 p.m. Wednesday and 8:00 a.m. Thursday.

Geometry and analysis on CR manifolds, JOHN M. LEE, Harvard University. 1:00 p.m. Friday and 8:00 a.m. Saturday.

Commutative algebra and algebraic geometry, PAUL C. ROBERTS. 2:30 p.m. Wednesday and 8:00 a.m. Thursday.

Most of the papers to be presented at these special sessions will be by invitation; however, anyone contributing an abstract for the meeting who feels that his or her paper would be particularly appropriate for one of these sessions should indicate this clearly on the abstract, and should submit it by April 21, three weeks earlier than anyone contributing an abstract for the meeting. Larly appropriate for one of these sessions should order that it may be considered for inclusion.

Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in departments of mathematics, and should be sent to Abstracts, Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940. A charge of $16 is imposed for retyping abstracts that are not in camera-ready form.

Committee on the Agenda for Business Meetings
The Society has a Committee on the Agenda for Business Meetings. The purpose is to make Business Meetings orderly and effective. The committee does not have legal or administrative power. It is intended that the committee consider what may be called "quasi-political" motions. The committee has several possible courses of action on a proposed motion, including but not restricted to

(a) doing nothing;
(b) conferring with supporters and opponents to arrive at a mutually accepted amended version to be circulated in advance of the meeting;
(c) recommending and planning a format for debate to suggest to a Business Meeting;
(d) recommending referral to a committee;
(e) recommending debate followed by referral to a committee.

There is no mechanism that requires automatic submission of a motion to the committee. However, if a motion has not been submitted through the committee, it may be thought reasonable by a Business Meeting to refer it rather than to act on it without benefit of the advice of the committee.

The committee consists of M. Salah Baouendi, Everett Pitcher (chairman), and Carol L. Walker.

In order that a motion for the Business Meeting of August 7, 1987, receive the service offered by the committee in the most effective manner, it should be in the hands of the secretary by July 7, 1987.

Everett Pitcher, Secretary

Contributed Papers
There will be sessions for contributed papers on Wednesday afternoon, Thursday morning, Friday afternoon, and Saturday morning. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in departments of mathematics, and should be sent to Abstracts, Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, so as to arrive by the abstract deadline of May 12. A charge of $16 is imposed for retyping abstracts that are not in camera-ready form.

Late papers will not be accepted.

Other AMS Sessions

Committee on Science Policy Discussion
The AMS Committee on Science Policy will sponsor a discussion on Wednesday, August 5, from 5:30 p.m. to 7:30 p.m.

Council Meeting
The Council of the Society will meet at 5:00 p.m. on Tuesday, August 4.

Business Meeting
The Business Meeting of the Society will take place immediately following the Steele Prize Session at 4:05 p.m. on Friday, August 7. The secretary notes the following resolution of the Council: Each person who attends a Business Meeting of the Society shall be willing and able to identify himself as a member of the Society. In further explanation, it is noted that each person who is to vote at a meeting is thereby identifying himself as and claiming to be a member of the American Mathematical Society. For additional information on the Business Meeting, please refer to the box titled Committee on the Agenda for Business Meetings.

66th Summer Meeting of the MAA
August 5 – 8, 1987

Hedrick Lectures
The 35th Earle Raymond Hedrick Lectures will be given by WILLIAM P. THURSTON of Princeton University. The title of this series will be announced later. These lectures will be given at 11:15 a.m. on Thursday, Friday, and Saturday, August 6 – 8.

Invited Addresses
There will be at least seven invited fifty-minute addresses. The names of the speakers, their affiliations, times and days of their talks, and some of the titles follow:

EDWARD G. EFFROS, University of California, Los Angeles, title to be announced, 9:05 a.m. Thursday.
Minicourses

Seven Minicourses are being offered by MAA. The names and affiliations of the organizers, the topics, the dates and times of their meetings, and the enrollment limitations of each are as follows:

Minicourse #1: Applied mathematics via classroom experiments is being organized by HERBERT R. BAILEY, Rose-Hulman Institute of Technology. Part A is scheduled from 9:00 a.m. to 11:00 a.m. on Wednesday, August 5, and Part B from 7:00 p.m. to 9:00 p.m. on Wednesday, August 5. Total enrollment for this MAA Minicourse is limited to 80 persons.

This Minicourse is based on a junior level applied mathematics course which has been developed to encourage students to combine their knowledge of physics, calculus, and differential equations. Students are asked to derive and solve the equations that model simple classroom experiments. For example, the first experiment is to let a ball bounce until it stops. The problem is to relate “percent rebound” and “time to stop bouncing”. The student must combine the concepts of time of fall and summation of geometric series. The full course includes five units: I - The Chain, II - Rotation, III - Fluid Flow, IV - Heat Flow, and V - Calculus of Variations. The Minicourse will begin with a brief description of each unit including demonstrations of most of the experiments. Participants will then be asked to work through some of the units either individually or in small groups. Each participant will be given a writeup and a solution manual for each of the units. The writeups include review sections covering the necessary mathematics and physics.

Minicourse #2: Using computer spreadsheet programs in calculus, differential equations, and combinatorics is being organized by DONALD R. SNOW, Brigham Young University. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Tuesday, August 4, and Part B from 7:00 p.m. to 9:00 p.m. on Wednesday, August 5. Total enrollment for this MAA Minicourse is limited to 30 persons.

Computer spreadsheet programs such as Lotus 1-2-3 can be used in many places in mathematics where a table or matrix format occurs. Examples in Calculus include the evaluation and graphing of functions illustrating parameter changes, illustrations of limits of sequences or functions, approximate integration, summation of series, and for iteration processes such as Newton’s method for root finding. In differential equations the applications include computation of approximate solutions from the corresponding difference equations and graphing allowing comparison with exact solutions. In combinatorics the uses include computation of tables such as Pascal’s triangle and generalizations, r-permutations, Stirling number tables, and other recurrence relation problems, difference tables, and determining and expanding generating functions for various sequences such as the Fibonacci and Lucas numbers.

This Minicourse will begin with an introduction to Lotus 1-2-3 on the IBM PC. Student copies of Lotus which will handle all of the above problems can now be purchased very inexpensively. Participants will have hands-on experience using Lotus with some of the above examples and will receive a disk containing the worksheets (but not Lotus itself) which they can use in their own classes or research.

Minicourse #3: A microcomputer linear algebra course using Linear-Kit is being organized by HOWARD ANTON, Drexel University. Part A is scheduled from 9:00 a.m. to 11:00 a.m. on Wednesday, August 5, and Part B from 3:30 p.m. to 5:30 p.m. on Wednesday, August 5. Total enrollment for this MAA Minicourse is limited to 30 persons.

Linear-Kit is a powerful microcomputer package which can do linear algebra operations in either exact rational arithmetic (without the distraction of round-off error) or floating point arithmetic (facilitating study of computational aspects). Its data storage and retrieval capabilities lend themselves to self-paced courses.

The Minicourse will consist of (1) a “hands-on” session on the use of Linear-Kit, (2) a problem-solving session, making application of Linear-Kit, (3) a session on design of courses to meet various needs, and (4) a summary session devoted to discussion and perhaps design of a new computer-based linear algebra course. Microcomputers will be used extensively by participants, but prior experience is not required.

Minicourse #4: A survey of educational software is being organized by DAVID P. KRAINES, Duke University, and VIVIAN KRAINES, Meredith College. Part A is scheduled from 8:00 a.m. to 9:55 a.m. on Thursday, August 6, and Part B from 8:00 a.m. to 9:55 a.m. on Friday, August 7. Total enrollment for this MAA Minicourse is limited to 30 persons.

The variety and the quality of software for IBM compatible computers has been increasing...
steadily. The objective of this Minicourse is to allow the participants to experiment with a representative collection of the better programs in calculus, linear algebra, differential equations, and other mathematical subjects. A variety of classroom applications will be demonstrated from a number of different computer packages. At the end of each two hour session, the participants will have the opportunity for "hands-on" use of some of these programs. Handouts will provide information on other educational software on the market or under development. No computer experience is required.

Minicourse #5: Introduction to computer graphics is being organized by JOAN P. WYZKOSKI, Fairfield University. Part A is scheduled from 1:30 p.m. to 3:30 p.m. on Friday, August 7, and Part B from 8:00 a.m. to 9:55 a.m. on Saturday, August 8. Total enrollment for this MAA Minicourse is limited to 30 persons.

Graphs and illustrations of geometrical objects are useful tools in the teaching of mathematics. Computer graphics simplifies the production of these teaching aids. This Minicourse will present some of the mathematical techniques used to produce realistic pictures on graphics display devices. Some of the topics to be discussed are curve and surface sketching, 2D and 3D transformations, perspective drawing, and hidden line removal. Suggestions will be given for the use of these techniques to complement mathematics instruction. Since personal computers will be available for demonstrations and in-class implementations, programming experience is necessary.

Minicourse #6: A calculus lab course using MicroCalc is being organized by HARLEY FLANDERS, University of Michigan, Ann Arbor. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, August 7, and Part B from 2:30 p.m. to 4:30 p.m. on Saturday, August 8. Total enrollment for this MAA Minicourse is limited to 30 persons.

This will be a hands-on introduction to MicroCalc, a commercially available interactive package of about 30 programs designed to stimulate mathematical experimentation, minimize the drudgery of calculation, and test results of hand calculation. The programs include extensive graphing capability, symbolic differentiation, and function editing, including composition. Part of each session will be devoted to working out projects and experiments. Take-home demo disks of MicroCalc will be given to the students.

Minicourse #7: For all practical purposes is being organized by SOLOMON A. GARFUNKEL, COMAP, Inc. Part A is scheduled from 1:30 p.m. to 3:30 p.m. on Friday, August 7, and Part B from 1:30 p.m. to 3:30 p.m. on Saturday, August 8. Total enrollment for this MAA Minicourse is limited to 40 persons.

This course deals with introducing contemporary applications throughout the undergraduate curriculum. Materials presented will include tapes from the soon-to-be-released PBS telecourse For all practical purposes as well as print modules from the UMAP series. Applications will cover a wide variety of fields with special emphasis on discrete mathematics and applications to management science and decision making.

Please note the new procedure for registering for MAA Minicourses. Participants interested in attending any of the MAA Minicourses should complete the MAA Minicourse Preregistration Form. Send the form along with payment directly to the MAA Office at the address given on the form so as arrive prior to the June 1 deadline. DO NOT SEND THIS FORM TO PROVIDENCE.

Please note that prepayment is now required. Payment can be made by check payable to MAA (Canadian checks must be marked "in U.S. funds") or VISA or MASTERCARD credit cards.

The MAA Minicourses are open only to persons who have registered for the Joint Mathematics Meetings and paid the Joint Meetings registration fee.

If the only reason for registering for the Joint Mathematics Meetings is to gain admission to a MAA Minicourse, this should be indicated by checking the appropriate box on the MAA Minicourse Preregistration Form. Then, if the MAA Minicourse is fully subscribed, full refund can be made of the Joint Mathematics Meetings preregistration fee(s). Otherwise, the Joint Meetings preregistration will be processed, and then be subject to the 50 percent refund rule. PREREGERISTRATION FORMS FOR THE JOINT MATHEMATICS MEETINGS SHOULD BE MAILED TO PROVIDENCE PRIOR TO THE DEADLINE OF JUNE 1.

The registration fee for MAA Minicourses #2–#6 is $40 each. The registration fee for MAA Minicourses #1 and #7 is $30 each. This fee entitles the registrant to attend all sessions of the MAA Minicourse for which he/she has registered. Participants are limited to two MAA Minicourses each. It is advised that alternate choices be given in the event the first and/or second choice MAA Minicourse(s) are full.

Contributed Papers

Contributed papers are being accepted on five topics in collegiate mathematics for presentation in contributed paper sessions at the MAA Summer Meeting in Salt Lake City. The topics, organizers, their affiliations, and days they will meet are:

- Teaching strategies involving computers (CHRIS AVERY, DeAnza College), Friday morning, August 7.

Papers should focus on new and innovative ways microcomputers can be used in the teaching of mathematics. Possible topics may include but are not limited to: innovative classroom presentation of concepts, new content made accessible
to students by computers, change in emphasis for traditional curriculum, or actual classroom experience with a CAI model. Particular software description is relevant to the degree that it applies to the above pedagogical concerns.

- **In search of the lean and lively calculus**, KATHERINE A. FRANKLIN, Los Angeles Pierce College, Wednesday morning, August 5.

  Papers which describe attempts to implement some of the recommendations of the Tulane workshop on the calculus, or which consider the merits of those recommendations, or which present specific alternative plans for reviving the calculus are solicited.

- **The teaching of mathematics and computer science in one department**, ZAVEN KARIAN, Denison University, Wednesday morning, August 5.


- **Using computer algebra in the classroom**, WARREN PAGE visiting Ohio State University, Saturday afternoon, August 8.

  All papers related to the use of computer algebra systems in the classroom will be considered.

  Presentations are normally limited to ten minutes, although selected contributors may be given up to twenty minutes. Individuals wishing to submit papers for any of these sessions should send the following information to the MAA Washington office (1529 Eighteenth Street, NW, Washington, DC 20036) by May 27.

  1. Title
  2. Intended session
  3. A one-paragraph abstract (for distribution at the meeting)
  4. A one-page outline of the presentation

  This information will be sent to session leaders who will arrange for refereeing. Selection of papers will be announced by June 15.

**Undergraduate Student Paper Session**

On an experimental basis, there will be an Undergraduate Student Paper Session sponsored by the MAA in conjunction with Pi Mu Epsilon, the undergraduate mathematics honorary society. The session will be held on Friday, August 7. Nominations for papers from sections of the MAA, mathematics departments, and other interested parties, with a brief abstract, should be sent to Ron Barnes, Department of Applied Mathematics, University of Houston-Downtown, 1 Main Street, Houston, TX 77002. **Deadline for nominations is May 15, 1987.**

**Other MAA Sessions**

The Committee on the Mathematical Education of Teachers (COMET) is sponsoring a panel discussion on *New directions in teacher education – pros and cons*. The session is scheduled from 8:30 a.m. to 9:55 a.m. on Friday, August 7. The participants are HENRY L. ALDER, University of California, Davis (moderator), ALPHONSE BUCINO, University of Georgia, SHIRLEY A. HILL, University of Missouri, Kansas City, KATHERINE P. LAYTON, Beverly Hills High School, and BILLY E. RHODES, Indiana University.

The Committee on Placement Examinations (COPE) is sponsoring a panel discussion on *Using placement examinations to create order in freshman placement*. The moderator is JOHN W. KENELLY, Clemson University. The session will take place at 2:30 p.m. on Saturday, August 8.

The Mathematical Sciences Education Board and the Board on Mathematical Sciences of the National Research Council are sponsoring a panel discussion on *The mathematical sciences in the year 2000: Assessment for renewal in U.S. colleges and universities*. The moderator is BERNARD L. MADISON, University of Arkansas. The panel is scheduled for 9:30 a.m. to 11:00 a.m. on Wednesday, August 5.

The Committee on the Participation of Women is sponsoring a panel discussion on Friday, August 7, from 8:30 a.m. to 9:55 a.m. on *What are the problems? What are the solutions?*

**Audio-Visual Equipment**

Rooms where MAA sessions will be held are equipped with one overhead projector and screen. (Invited 50-minute speakers are automatically provided with two overhead projectors.) Blackboards are also available in most of these rooms, but speakers are urged to use the overhead projector for maximum visibility by the audience. These rooms, but speakers are urged to use the overhead projector for maximum visibility by the audience.

Upon written request, the following projection equipment will be made available: one additional overhead projector/screen, 35 mm carousel slide projector, 16 mm film projector, or VHS video cassette recorder with one color monitor. Speakers requiring any of the equipment listed in this paragraph are required to submit their needs **in writing prior to June 30** to John Balletto, Meetings Department, AMS, P.O. Box 6248, Providence, RI 02940. Please be certain to include your name, affiliation, telephone number, name of session or session organizer, and explicit equipment needs.

No other equipment can be made available for these sessions without approval of the MAA Secretary. Requests for equipment not listed above should also be addressed to John Balletto (again, prior to June 30), who will forward them to the Secretary for possible approval.

**Films**

The MAA Film Program will take place on Friday, August 7, at 7:00 p.m. The program includes *Hypothesis testing, inferential statistics, Part II;*
Regular homotopies in the plane, Part II; Symmetries of the cube. The program will also include some COMAP films.

Business Meeting
The Business Meeting of the MAA will take place at 2:30 p.m. on Thursday, August 6. The 1987 Carl B. Allendoerfer, Lester R. Ford, and George Polya Awards for expository writing will be presented. Six Certificates of Meritorious Service will also be presented. This meeting is open to all members of the Association.

Board of Governors
The MAA Board of Governors will meet at 9:00 a.m. on Tuesday, August 4. This meeting is open to all members of the Association.

Section Officers
There will be a Section Officers’ Meeting at 4:30 p.m. on Wednesday, August 5.

Banquet for 25-year Members
The MAA is planning its twelfth annual banquet for individuals who have been members of the Association for twenty-five years or more. The banquet will be preceded by a reception from 6:15 p.m. to 6:45 p.m. on Wednesday evening, August 5 in the Tanner Dining Room of the Alumni House. Dinner will be served at 7:00 p.m. The menu includes fresh strawberries, hearts of palm salad with vinaigrette dressing, beef Wellington, parsley potatoes, broccoli spears with hollandaise sauce, rolls, muffins, butter, chocolate mousse cake, and beverages. State law prohibits the serving of alcoholic beverages; therefore, no alcoholic beverages will be served at this function.

Please note that all tickets for this banquet must be purchased through preregistration, since a guarantee must be given to the caterer. Tickets are $17 each; the price includes the gratuity. Interested participants should complete the appropriate section of the preregistration form. In the event of cancellations, a 50% refund of the amount paid for the ticket will be made if notification is received in Providence prior to July 31. After that date, no refund can be given.

Joint AMS-MAA Sessions
By invitation of the AMS-MAA Joint Program Committee (Judith V. Grabiner, Reuben Hersh, Paul H. Rabinowitz (chairman), and John M. Smith), the following speakers will address the joint meeting of the AMS and MAA on the history and development of mathematics. The names of the speakers, their affiliations, and one of their titles are:

ROBERT FINN, Stanford University and Max-Planck Institut, title to be announced, 10:10 a.m. Thursday.

MICHAEL STARBIRD, University of Texas, Austin, R.H. Bing’s mathematical vitality, 10:10 Friday.

Activities Of Other Organizations
The Association for Women in Mathematics (AWM) will sponsor a panel discussion at 8:30 a.m. on Thursday, August 6, on Gender and science. The AWM Membership Meeting will follow at 9:30 a.m. The AWM Party will be held on Thursday evening, August 6.

The Interagency Commission for Extramural Mathematics Programs (ICEMAP) will present a session at 8:00 p.m. on Wednesday, August 5.

The Joint Policy Board for Mathematics (JPBM) Committee for Mathematics Department Heads has organized a National Meeting of Department Heads at 7:45 p.m. on Wednesday, August 5. This session will feature a presentation organized by BERNARD MADISON, University of Arkansas, on Faculty renewal and talent flow: Linked, critical, and at risk. This will be followed by Birds-of-a-Feather sessions on The Ph.D. college teacher: An endangered species? organized by JOHN FULTON, Clemson University, including a large department session presented by FRANK GILFEATHER, University of Nebraska; and a small department session presented by LYNN A. STEEN, St. Olaf College. COLIN BENNETT, University of South Carolina, will organize a second Birds-of-a-Feather session Does calculus belong in a university wide core curriculum?

The Committee for Department Chairs of the JPBM will also cosponsor a workshop for department chairs with the American Council on Education (ACE) on Tuesday, August 4, from 9:00 a.m. to 5:00 p.m. Participants who are interested in this workshop should see News and Announcements in this issue of Notices.

Pi Mu Epsilon (IIME) will hold its annual meeting on Wednesday, Thursday, and Friday, August 5 – 7. The J. Sutherland Frame Lecture will be given at 8:30 p.m., on Friday, August 7. The name of the speaker and the title of the lecture will be announced later. There will also be sessions for contributed papers on Thursday morning and Friday morning and afternoon.

The National Science Foundation (NSF) will sponsor a presentation at 4:25 p.m. on Wednesday, August 5.

Other Events or Items Of Interest
Book Sales
Books published by the AMS and MAA will be sold at discounted prices somewhat below the cost for the same books purchased by mail. These discounts will be available only to registered participants wearing the official meeting badge. VISA and MASTERCARD credit cards will be accepted for book sale purchases at the meeting. The book sales will be open the same days and hours as the exhibits and are located in the Center Ballroom in the A. Ray Olpin University Union Building.
Exhibits

The book and educational media exhibits will be open from 1:00 to 5:00 p.m. on Wednesday, August 5, 9:00 a.m. to 3:00 p.m. on Thursday, August 6, 9:00 a.m. to 5:00 p.m. on Friday, August 7, and from 9:00 a.m. to noon on Saturday, January 8. All participants are encouraged to visit the exhibits during the meeting.

Summer List of Applicants

At the direction of the AMS-MAA-SIAM Committee on Employment Opportunities, which is charged with operation of the Employment Register and with the publication of Employment Information in the Mathematical Sciences, the Society will publish a Summer List of mathematical scientists seeking employment for distribution at the Salt Lake City meeting.

Copies of the 1987 summer list of applicants will be available at the Transparencies section of the registration desk for $4. Following the meeting, they may be purchased from the AMS office in Providence for $6. This list should prove useful to employers who have last-minute openings in the latter part of the summer or in the fall.

The deadline for receipt of applicant forms to appear in this summer list is June 1.

The applicant preregistration résumé and instructions on its completion can be found in this issue.

Instead of an Employment Register at the Summer Meeting in Salt Lake City, there will be an opportunity for posting of both applicant résumé forms and employers' announcements of open positions in or near the main meeting registration area. There will be no special room set aside for interviews. No provisions will be made by the Society for interviews: arrangements will be the responsibility of each employer and applicant. Messages may be left in the message box located in the registration area.

Special applicant and employer forms will be available at the Transparencies section of the registration desk both for applicants to post résumés and for employers to post forms announcing positions.

Applicants who submit an applicant form, but do not plan to attend the meeting, will appear on the printed list only. There is no provision made for posting résumés for participants who do not attend the meeting. No printed lists of employers or applicants who register at the meeting will be available after the meeting.

Accommodations

University Housing

Participants desiring confirmed reservations for on-campus housing must preregister and send payment in full for housing to the Mathematics Meetings Housing Bureau prior to the June 1, 1987 deadline. Participants in the Joint Mathematics Meetings may occupy residence hall rooms at the University of Utah during the period August 4 to August 9 only. All must check out by August 9. A limited number of rooms on campus will be available for those participants who do not preregister but plan on attending the Salt Lake City meetings and registering on site. Rooms will be assigned at the Meetings Registration Desk during registration hours and at the check-in desks of designated residence halls (see below) after meeting registration hours. Onsite payments for residence hall rooms can be made with cash, personal checks, travelers' checks, and credit cards (VISA and MasterCard only).

Participants requesting housing on the University of Utah campus will be assigned to one of three residence halls: Austin Hall, Ballif Hall, or Van Cott Hall. (Please refer to the section below titled Room Rates.)

Families with children will be allowed to stay in the dormitories; however, there is a maximum of one child per room. Sleeping bags for children five years and younger staying with both parents will be permitted at a child rate. Any child occupying a bed in a room with a parent must pay the adult rate. (See section on Hotel Accommodations below for alternate housing for families.)

Residence halls at the University of Utah have three floors; however, there are no elevators. It is expected that helpers will be available at the check-in desks to assist with luggage. Of the three residence halls assigned to the meetings, Austin Hall is the only air-conditioned
building. Handicapped persons will be assigned to Austin and Van Cott Halls. Sleeping rooms are good size, very well maintained, and contain two single beds, desks, chairs, and closets. Some rooms have reading lamps; others have overhead lamps. Rooms will be prepared for occupancy in advance. In addition to bed linen, pillow, and blanket, participants will receive a towel, soap, and glass (exchangeable upon request at the check-in desk). Participants are advised to bring their own washcloths and hangers. There is no daily maid service in the sleeping rooms.

There are two bathrooms with showers on each floor; one for each gender. Walls separate shower stalls and curtains screen the interiors. Hooks are placed on the outside of stall dividers where robes can be hung. Each hall is equipped with washers ($0.50) and dryers ($0.25); however there is no provision for purchasing detergents. Vending machines are available for soft drinks, candy, and ice cream in each residence hall.

No pets are allowed in the residence halls. Alcoholic beverages are not permitted. Smoking is permitted in participants' rooms only. The hallways as well as the rooms are equipped with heat sensors.

Check-In Locations and Times
A check-in desk will be maintained in the lobby of each residence hall. These desks will be staffed from 7:00 a.m. to midnight seven days per week. Telephone numbers for assistance will be posted on the door of each hall for those participants arriving after midnight. Phones are located outside of each main entrance. Parking stickers for nearby university lots may be purchased at the residence hall check-in desks for a daily rate of $1.50. (Parking is free on Saturday.)

Directions to the residence halls are as follows:

**BALLIF HALL** - Take 400 South (South Campus Drive) to traffic light on 1900 East (Wasatch Drive), turn left onto Wasatch Drive, proceed 3/10 mile and turn left on Ballif Road (130 South) and take immediate left.

**VAN COTT HALL** - Same directions as above, except go straight on Ballif Road instead of taking an immediate left.

**AUSTIN HALL** - Same directions as above, except go 4/10 mile and turn left on Austin Road (100 South).

At the time of check-in, participants assigned rooms through the Mathematics Meetings Housing Bureau will present their receipt which will enable them to receive two keys: one for the outside door and one for the room. Those participants being assigned a room directly by the check-in desk (only after meeting registration hours) will be required to fill out a housing form, thus enabling them to receive keys. Spouses desiring a room key must follow this procedure also. Please note that, although there is no deposit required for keys, a penalty of $25 will be imposed for each key lost or not returned. It is the responsibility of the Mathematics Meetings Housing Bureau to collect this penalty. Therefore, it is requested that proper caution be exercised to avoid this charge. At checkout, all keys must be returned to the main desk in the lobby. Should the clerk not be present, please ensure that your name is left at the check-in desk with the key.

**Room Rates**
The following rates apply for residence hall accommodations at the University of Utah. Please note that there is no room tax applicable to these rates.

There is a $5 daily rate for a child five years of age and younger in the same room with parents, provided a sleeping bag is used. Children six years of age and older must occupy a bed and are subject to the adult rate. The university allows a maximum of three occupants only in each room. Should a family with two children request accommodations, two rooms would be required and the double rate applies in each case. A family of three (with a child six years of age and older) would require one double room at the double rate plus a second room for the third occupant at the single rate. Adult rates are as follows:

<table>
<thead>
<tr>
<th>Residence Type</th>
<th>Singles</th>
<th>Doubles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hall</td>
<td>(1 person)</td>
<td>(2 persons)</td>
</tr>
<tr>
<td>Austin a/c</td>
<td>$13</td>
<td>$19 (or $9.50 p/p)</td>
</tr>
<tr>
<td>Ballif no a/c</td>
<td>$12</td>
<td>$17 (or $8.50 p/p)</td>
</tr>
<tr>
<td>Van Cott no a/c</td>
<td>$12</td>
<td>$17 (or $8.50 p/p)</td>
</tr>
</tbody>
</table>

Note: Van Cott Hall has three double-bedded rooms per apartment with six apartments per floor; one bath per apartment.

**Changes/Cancellations**
Please make all changes to or cancellations of residence hall reservations with the Housing Bureau in Providence before August 4, 1987, in order to receive a 90% refund of housing payment. After that date, refunds for cancellations or no shows will equal 90% of the amount paid minus one night's room charge. No cancellations can be made between 5:00 p.m. on Tuesday, August 4, and 4:00 p.m. on Thursday, August 6, after which changes or cancellations may be called in to Penny Pina at the Telephone Message Center number in Salt Lake City. Changes in reservations may be made at any time by notifying the Housing Bureau in Providence.

**Food Services**
The A. Ray Olpin University Union Building offers a variety of food services from fast foods to full dinners on a cash basis in the Union Terrace (see below). The average prices for meals would be: $3.50 for breakfast, $4.50 for lunch, and $5.50 for dinner. Serving hours and locations are as follows:
DOWNTOWN SALT LAKE

Scale: about 7 city blocks to the mile

DOWNTOWN SUNNYSIDE AVE (840 S.)

Foothill Dr.

Zoo

NORTH UNIVERSITY CAMPUS

HOW TO GET TO UNIVERSITY OF UTAH CAMPUS

TO: BRIGHTON

7200 S.O. 7000 S.O. 9000 S.O.

TO: PARK CITY

DENVER 3.5 MILES

CHEYENNE

I-80

3 MILES

Go to the South End of I-215 and then continue on Wasatch Dr.

9400 S.O. Elv. 5100 ft.

ENTRY 2

SNOWBIRD 6.5 MILES

ALTA

ELEV. 8100 ft.
Breakfast Cafe  6:30 a.m.-10:30 a.m.
Lunch  Deli  11:00 a.m.-2:00 p.m.
   Cafe  10:30 a.m.-2:00 p.m.
   Foreign
   Exchange  11:00 a.m.-2:00 p.m.
   Panorama Rm.  11:30 a.m.-2:00 p.m.
Dinner  Int'l Side of
   Foreign
   Exchange  5:00 p.m.-7:00 p.m.
   Cafe  6:00 p.m.-8:00 p.m.
Servings are generous, well prepared, and reasonably priced. Choices for breakfast would include eggs to order any style, cold or hot cereals, biscuit sandwiches, and assorted beverages. Lunch and dinner include Italian pasta, stuffed baked potatoes, grilled and fried sandwiches, Mexican cuisine and other ethnic specialties (alternating daily), fresh baked pizza, salads, fresh vegetables, fresh fruit, pies, and cakes.

For those participants who wish to go off campus to get their meals, please be advised that there are only a few restaurants within walking distance. Among these are a pizza parlor and a seafood restaurant.

**Hotel Accommodations**

Since most of the hotels in Salt Lake City are not within easy walking distance of the campus, it is recommended that participants planning to stay in a hotel be prepared to provide their own transportation to the university campus. The hotels listed below are approximately 2–3 miles from the extreme western end of campus. Buses frequently connect the University with downtown. Wait at any of the well marked bustops along Main or State Streets between 400 South and South Temple and inquire of the driver. Buses stop on campus on the “U” in front of the Park building (about 1450 East 200 South), and on the “Business” loop just South of the Business Lecture Hall. Currently, the average taxi fare for a distance of approximately three miles is $5.15 regardless of the number of passengers. The following is a partial list of hotels and their approximate distance from the University of Utah campus. Rates are subject to a 9-3/4% state room tax. Rates quoted are firm.

**Little America—2 1/2 miles to extreme west of campus**

500 South Main
Salt Lake City, UT 84101
801-363-6781
800-453-9450

<table>
<thead>
<tr>
<th></th>
<th>Single occupancy</th>
<th>Double occupancy</th>
<th>Triple occupancy</th>
<th>Quadruple occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little America</td>
<td>$59</td>
<td>$59</td>
<td>$59</td>
<td>$59</td>
</tr>
</tbody>
</table>

Full service hotel. Swimming pool, health spa, shopping mall, restaurant, lounge, free parking. Rooms have queen and king-size beds. All major credit cards accepted.

**Salt Lake City Marriott (Headquarters)—2 1/4 miles to extreme west of campus**

75 South West Temple
Salt Lake City, UT 84101
801-531-0800

<table>
<thead>
<tr>
<th></th>
<th>Single occupancy</th>
<th>Double occupancy</th>
<th>Triple occupancy</th>
<th>Quadruple occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marriott</td>
<td>$52</td>
<td>$52</td>
<td>$62</td>
<td>$62</td>
</tr>
</tbody>
</table>

Full service hotel. Swimming pool, free parking, restaurant, lounge. All major credit cards accepted.

**Peery Hotel—2 1/2 miles to extreme west of campus**

110 West 300 South
Salt Lake City, UT 84101
801-521-4300
1-800-331-0073 (toll free for room reservations only)

<table>
<thead>
<tr>
<th></th>
<th>Single occupancy</th>
<th>Double occupancy</th>
<th>N/C for child in same room with parents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peery Hotel</td>
<td>$45</td>
<td>$55</td>
<td></td>
</tr>
</tbody>
</table>

Full service hotel. Continental breakfast included in rates, jacuzzi, fitness room, restaurant, lounge, free parking. Rooms have queen-size beds only. All major credit cards accepted.

**Shilo Inn—2 1/4 miles to extreme west of campus**

206 South West Temple
Salt Lake City, UT 84101
801-521-9500
1-800-222-2244 (toll free for room reservations only)

<table>
<thead>
<tr>
<th></th>
<th>Single occupancy</th>
<th>Double occupancy</th>
<th>Triple occupancy</th>
<th>Quadruple occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shilo Inn</td>
<td>$41</td>
<td>$41</td>
<td>$45</td>
<td>$49</td>
</tr>
</tbody>
</table>

Children 12 years and younger are free in same room with parents. Rollaways—$6 additional.

Full service hotel. Free parking, continental breakfast included in rates, swimming pool, public laundry, restaurant, lounge. Rooms have double or queen-size beds. All major credit cards accepted.

**Howard Johnson’s at Temple Square—2 miles to extreme west of campus**

122 West South Temple
Salt Lake City, UT 84101
801-521-0130

<table>
<thead>
<tr>
<th></th>
<th>Single occupancy</th>
<th>Double occupancy</th>
<th>Triple occupancy</th>
<th>Quadruple occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Howard Johnson</td>
<td>$34</td>
<td>$39</td>
<td>$44</td>
<td>$49</td>
</tr>
</tbody>
</table>

Children 14 years and younger are free in same room with parents.

Full service hotel. Free parking, jacuzzi, exercise room, 24-hour restaurant. All major credit cards accepted.
TIMETABLE

The purpose of this timetable is to provide assistance to preregistrants in the selection of arrival and departure dates. The program, as outlined below, is based on information available at press time.

<table>
<thead>
<tr>
<th>JOINT MATHEMATICS MEETINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tuesday, August 4</strong></td>
</tr>
<tr>
<td>9:00 a.m. - 4:00 p.m.</td>
</tr>
<tr>
<td>4:00 p.m. - 8:00 p.m.</td>
</tr>
<tr>
<td>5:00 p.m. - 10:00 p.m.</td>
</tr>
<tr>
<td>7:00 p.m. - 9:00 p.m.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Wednesday, August 5</strong></th>
<th><strong>AMS</strong></th>
<th><strong>MAA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>morning</td>
<td></td>
<td>MAA - CONTRIBUTED PAPER SESSION</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In search of the lean and lively calculus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Katherine A. Franklin</td>
</tr>
<tr>
<td>morning</td>
<td></td>
<td>MAA - CONTRIBUTED PAPER SESSION</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The teaching of mathematics and computer science in one department</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zaven Karian</td>
</tr>
<tr>
<td>7:30 a.m. - 4:00 p.m.</td>
<td></td>
<td>REGISTRATION</td>
</tr>
<tr>
<td>8:00 a.m. - 8:50 a.m.</td>
<td>INVITED ADDRESS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Title to be announced</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stephen Kerchoff</td>
<td></td>
</tr>
<tr>
<td>9:00 a.m. - 11:00 a.m.</td>
<td></td>
<td>MAA - MINICOURSE #1 (Part A)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Applied mathematics via classroom experiments</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Herbert R. Bailey</td>
</tr>
<tr>
<td>9:00 a.m. - 11:00 a.m.</td>
<td></td>
<td>MAA – MINICOURSE #3 (Part A)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A microcomputer linear algebra course using Linear-Kit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Howard Anton</td>
</tr>
<tr>
<td>9:05 a.m. - 9:55 a.m.</td>
<td>INVITED ADDRESS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Title to be announced</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paul C. Roberts</td>
<td></td>
</tr>
<tr>
<td>9:30 a.m. - 11:00 a.m.</td>
<td></td>
<td>MAA - PANEL DISCUSSION</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The mathematical sciences in the year 2000: Assessment for renewal in U.S. colleges and universities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bernard L. Madison (moderator)</td>
</tr>
<tr>
<td>10:10 a.m. - 11:00 a.m.</td>
<td>INVITED ADDRESS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Title to be announced</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Donald G. Aronson</td>
<td></td>
</tr>
</tbody>
</table>

531
Registration At The Meetings

Meeting preregistration and registration fees only partially cover expenses of holding meetings. All mathematicians who wish to attend sessions are expected to register, and should be prepared to show their meeting badge, if so requested. Badges are required to obtain discounts at the AMS and MAA Book Sales, to cash a check with the meeting cashier, and to attend sessions scheduled in the Fine Arts Auditorium. (If a preregistrant should arrive too late in the day to pick up his/her badge, he/she may show the acknowledgment received from the Mathematics Meetings Housing Bureau as proof of registration.) The fees for Joint Meetings registration at the meetings (listed below) are 30 percent higher than the preregistration fees.

Joint Mathematics Meetings

<table>
<thead>
<tr>
<th>Membership Category</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member of AMS, MAA, IIME</td>
<td>$ 77</td>
</tr>
<tr>
<td>Emeritus Member of AMS, MAA</td>
<td>$ 21</td>
</tr>
<tr>
<td>Nonmember</td>
<td>$117</td>
</tr>
<tr>
<td>Student/Unemployed</td>
<td>$ 21</td>
</tr>
</tbody>
</table>

MAA Minicourses

(if openings available)

<table>
<thead>
<tr>
<th>Minicourse #</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>#2 - #6</td>
<td>$40 each</td>
</tr>
<tr>
<td>#1 &amp; #7</td>
<td>$30 each</td>
</tr>
</tbody>
</table>

Registration fees may be paid at the meetings in cash, by personal or traveler's checks, or by VISA or MASTERCARD credit card. Canadian checks must be marked for payment in U.S. funds.

There is no extra charge for members of the families of registered participants, except that all professional mathematicians who wish to attend sessions must register independently.

All full-time students currently working toward a degree or diploma qualify for the student registration fees, regardless of income.

The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is not intended to include any person who has voluntarily resigned or retired from his or her latest position.

Persons who qualify for emeritus membership in either the Society or the Association may register at the emeritus member rate. The emeritus status refers to any person who has been a member of the AMS or MAA for twenty years or more, and is retired on account of age from his or her latest position.

Nonmembers who preregister or register at the meeting and pay the nonmember fee will receive mailings from AMS and MAA, after the meeting is over, containing information about a special membership offer.

Registration Dates, Times, and Locations

Joint Mathematics Meetings

Center Ballroom, A. Ray Olpin University Union Building

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday, Aug 4</td>
<td>4:00 p.m. to 8:00 p.m.</td>
</tr>
<tr>
<td>Wednesday, Aug 5</td>
<td>7:30 a.m. to 4:00 p.m.</td>
</tr>
<tr>
<td>Thursday, Aug 6</td>
<td>7:30 a.m. to 2:00 p.m.</td>
</tr>
<tr>
<td>Friday, Aug 7</td>
<td>7:30 a.m. to 4:00 p.m.</td>
</tr>
<tr>
<td>Saturday, Aug 8</td>
<td>7:30 a.m. to 3:00 p.m.</td>
</tr>
</tbody>
</table>

Registration Desk Services

Assistance, Comments and Complaints

A log for registering participants' comments or complaints about the meeting is kept at the Transparencies section of the registration desk. All participants are encouraged to use this method of helping to improve future meetings. Comments on all phases of the meeting are welcome. If a written reply is desired, participants should furnish their name and address.

Participants with problems of an immediate nature requiring action at the meeting should see the Director of Meetings, who will try to assist them.

Audio-Visual Equipment and Assistance

A member of the AMS/MAA staff will be available to advise or consult with speakers on audio-visual usage.

Most rooms where sessions will be held are equipped with an overhead projector, screen, and blackboard. Speakers are strongly urged to use the overhead projector rather than the blackboard for their presentation in order to obtain maximum visibility by all members of the audience of the material being presented.

Baggage and Coat Check

Provision will be made for participants checking out of the residence halls or motels early to leave baggage in the meeting registration area while it is open.

Check Cashing

The meeting cashier will cash personal or travelers' checks up to $50, upon presentation of the official meeting registration badge, provided there is enough cash on hand. Canadian checks must be marked for payment in U.S. funds. It is advisable that participants bring travelers' checks with them. When funds are low the meetings cashier will not be able to cash checks, and travelers' checks can be easily cashed at local banks, restaurants, or hotels.

Local Information

This section of the desk will be staffed by members of the Local Arrangements Committee and other volunteers from the Salt Lake City mathematical community.

Lost and Found

See the meeting cashier during the meeting. After the meeting, all lost articles not claimed will be turned over to the Department of Mathematics.
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00 p.m. - 5:00 p.m.</td>
<td>AMS EXHIBIT AND BOOK SALE</td>
</tr>
</tbody>
</table>
| 1:15 p.m. - 2:15 p.m. | COLLOQUIUM LECTURE I  
* Mathematical applications of quantum field theory (tentative)  
* Edward Witten                                                                                                                                                                           |
| 2:15 p.m. - 3:05 p.m. | MAA - INVITED ADDRESS  
* Introduction to quas crystals: A new form of matter  
* Paul J. Steinhardt                                                                                                                                                                       |
| 2:30 p.m. - 6:00 p.m. | SPECIAL SESSIONS  
* Commutative algebra and algebraic geometry I  
* Discrete geometry and convexity I  
* Nonlinear evolution equations I                                                                                                                                                        |
| 2:30 p.m. - 6:00 p.m. | SESSIONS FOR CONTRIBUTED PAPERS                                                                                                                                                             |
| 3:20 p.m. - 4:10 p.m. | MAA - INVITED ADDRESS  
* Title to be announced  
* John P. Hempel                                                                                                                                                                           |
| 3:30 p.m. - 5:30 p.m. | MAA - MINICOURSE #3 (Part B)  
* A microcomputer linear algebra course using Linear Kit  
* Howard Anton                                                                                                                                                                             |
| 4:25 p.m. - 5:25 p.m. | NATIONAL SCIENCE FOUNDATION                                                                                                                                                                |
| 4:30 p.m. - 6:30 p.m. | MAA - SECTION OFFICERS' MEETING                                                                                                                                                             |
| 5:30 p.m. - 7:30 p.m. | COMMITTEE ON SCIENCE POLICY                                                                                                                                                                 |
| 6:15 p.m. - 10:00 p.m. | MAA - BANQUET FOR 25-YEAR MEMBERS                                                                                                                                                            |
| 7:00 p.m. - 9:00 p.m. | MAA - MINICOURSE #1 (Part B)  
* Applied mathematics via classroom experiments  
* Herbert R. Bailey                                                                                                                                                                         |
| 7:00 p.m. - 9:00 p.m. | MAA - MINICOURSE #2 (Part B)  
* Using computer spreadsheet programs in calculus, differential equations, and combinatorics  
* Donald R. Snow                                                                                                                                                                          |
| 7:00 p.m. - 9:00 p.m. | PI MU EPSILON - RECEPTION                                                                                                                                                                    |
| 7:45 p.m. - 9:45 p.m. | NATIONAL MEETING OF DEPARTMENT HEADS  
* PRESENTATION: Faculty renewal and talent flow: Linked, critical, and at risk  
* Bernard Madison  
* SESSION I: Birds-of-a-Feather  
* The Ph.D. college teacher: An endangered species?  
* John Fulton (organizer)  
* Frank Gilfeather  
* Lynn A. Steen  
* SESSION II: Does calculus belong in a university wide core curriculum?  
* Colin Bennett  
* INTERAGENCY COMMISSION FOR EXTRAMURAL MATHEMATICS PROGRAMS (ICEMAP)                                                                                                                      |
Information Table

The information table at Joint Meetings of the AMS and MAA is set up in the registration area for the dissemination of information of a nonmathematical nature of possible interest to the members. The administration of the information table is in the hands of the AMS-MAA Joint Meetings Committee, as are all arrangements for such joint meetings. The following rules and procedures apply.

1. Announcements submitted by participants should ordinarily be limited to a single sheet no more than $8 \frac{1}{2}'' \times 14''$.

2. A copy of any announcement proposed for the table is to be sent to: H. Hope Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940 to arrive at least one week before the first day of the scientific sessions.

3. The judgment on the suitability of an announcement for display rests with the Joint Meetings Committee. It will make its judgments on a case by case basis to establish precedents.

4. Announcements of events competing in time or place with the scheduled scientific program will not be accepted.

5. Copies of an accepted announcement for the table are to be provided by the proponent. Announcements are not to be distributed in any other way at the meeting (for example, not by posting or personal distribution of handbills).

6. It may be necessary to limit the number of events or the quantity of announcements distributed at a meeting.

7. At the close of registration, the table will be swept clean. A proponent who wishes the return of extra copies should remove them.

Mail

All mail and telegrams for persons attending the meetings should be addressed as follows: Name of Participant, c/o Joint Mathematics Meetings, Department of Mathematics, University of Utah, Salt Lake City, Utah 84112. Mail and telegrams so addressed may be picked up at the mailbox in the registration area during the hours the registration desk is open. U.S. mail not picked up will be forwarded after the meeting to the mailing address given on the participant’s registration record.

Personal Messages

Participants wishing to exchange messages during the meeting should use the mailbox mentioned above. Message pads and pencils are provided. It is regretted that such messages left in the box cannot be forwarded to participants after the meeting is over.

Telephone Messages

A telephone message center will be located in the registration area to receive incoming calls for participants. The center will be open from August 4 through 8, during the hours that the Joint Mathematics Meetings registration desk is open. Messages will be taken and the name of any individual for whom a message has been received will be posted until the message has been picked up at the message center. The telephone number of the message center will be provided later.

Transparencies

Speakers wishing to prepare transparencies in advance of their talk will find the necessary materials and copying machines at this section of the registration desk. A member of the staff will assist and advise speakers on the best procedures and methods for preparation of their material. There is a modest charge for these materials.

Visual Index

An alphabetical list of registered participants, including local addresses and arrival and departure dates, is maintained in the registration area.

Miscellaneous Information

Athletic Facilities

The university has two large sport complexes: HPER and the E. Nielsen Fieldhouse. The HPER Complex has several basketball, badminton, volleyball, racquetball, and handball courts. There are weightlifting rooms and an olympic size swimming pool. The Fieldhouse has seven indoor tennis courts, racquetball and squash courts, an indoor track, and weightlifting facilities. These facilities will be made available to registered participants who pay a $3 fee. The fee entitles the participant to a temporary pass, good for one week. The pass can be purchased at HPER East 214 during business hours. Participants should bring their meeting badges when purchasing the pass. The hours that the various facilities will be available to participants is determined quarterly and a schedule will be given to those who purchase a pass. In addition to these facilities, the university also has a golf course and many outdoor tennis courts which are open to the general public.

Book Stores

The University of Utah Bookstore on campus is open from 8:00 a.m. to 5:00 p.m., Monday through Friday. The bookstore will be closed Saturday. The Sam Weller Book Store is located at 254 South Main (downtown).
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:30 a.m. - 2:00 p.m.</td>
<td>REGISTRATION &lt;br&gt;Center Ballroom, Olpin Union</td>
</tr>
<tr>
<td>8:00 a.m. - 8:50 a.m.</td>
<td>MAA - INVITED ADDRESS &lt;br&gt;Title to be announced &lt;br&gt;Walter Tape</td>
</tr>
<tr>
<td>8:00 a.m. - 9:55 a.m.</td>
<td>IIIE - CONTRIBUTED PAPER SESSIONS</td>
</tr>
<tr>
<td>8:00 a.m. - 9:55 a.m.</td>
<td>MAA - MINICOURSE #4 (Part A) &lt;br&gt;A survey of educational software &lt;br&gt;David P. Kraines &lt;br&gt;Vivian Kraines</td>
</tr>
<tr>
<td>8:00 a.m. - 9:55 a.m.</td>
<td>SPECIAL SESSIONS &lt;br&gt;Categorical algebra and algebraic geometry II &lt;br&gt;Discrete geometry and convexity II &lt;br&gt;Nonlinear evolution equations II</td>
</tr>
<tr>
<td>8:00 a.m. - 9:55 a.m.</td>
<td>SESSIONS FOR CONTRIBUTED PAPERS</td>
</tr>
<tr>
<td>8:30 a.m. - 9:30 a.m.</td>
<td>ASSOCIATION FOR WOMEN IN MATHEMATICS PANEL DISCUSSION &lt;br&gt;Gender and science</td>
</tr>
<tr>
<td>9:00 a.m. - 3:00 p.m.</td>
<td>AMS EXHIBIT AND BOOK SALE</td>
</tr>
<tr>
<td>9:05 a.m. - 9:55 a.m.</td>
<td>MAA - INVITED ADDRESS &lt;br&gt;Title to be announced &lt;br&gt;Edward G. Effros</td>
</tr>
<tr>
<td>9:30 a.m. - 10:00 a.m.</td>
<td>AWM - MEMBERSHIP MEETING</td>
</tr>
<tr>
<td>10:10 a.m. - 11:00 a.m.</td>
<td>AMS-MAA INVITED ADDRESS &lt;br&gt;Title to be announced &lt;br&gt;Robert Finn</td>
</tr>
<tr>
<td>11:15 a.m. - 12:15 a.m.</td>
<td>MAA - THE EARLE RAYMOND HEDRICK LECTURES: LECTURE I &lt;br&gt;Title to be announced &lt;br&gt;William P. Thurston</td>
</tr>
<tr>
<td>noon - 1:00 p.m.</td>
<td>IIIE - COUNCIL</td>
</tr>
<tr>
<td>1:15 p.m. - 2:15 p.m.</td>
<td>COLLOQUIUM LECTURE II &lt;br&gt;Mathematical applications of quantum field theory (tentative) &lt;br&gt;Edward Witten</td>
</tr>
<tr>
<td>2:30 p.m. - 3:20 p.m.</td>
<td>MAA - BUSINESS MEETING</td>
</tr>
<tr>
<td>3:30 p.m. - 9:30 p.m.</td>
<td>SNOWBIRD OUTING</td>
</tr>
<tr>
<td>8:00 p.m. - 10:00 p.m.</td>
<td>AWM - PARTY</td>
</tr>
</tbody>
</table>
Camping and RV Facilities

The closest commercial campgrounds, about five miles west of the campus by bus or automobile, are KOA Salt Lake City Campground, 1400 West North Temple, Salt Lake City, UT 84116 (801-355-1192) and Campground VIP, 1350 West North Temple, Salt Lake City, UT 84116 (801-328-0224). It is suggested that people interested in these campgrounds contact them several weeks in advance for information and reservations.

For those who desire locations that are more isolated and primitive, there are four campgrounds (Spruces, Redman, Tanner's Flat, Albion) under the supervision of the National Forest Service in the nearby Wasatch Mountains, all within about 25 miles of the campus, at altitudes of 7,000 – 10,000 feet. These do not accept reservations, but spaces are usually available for people arriving on weekdays from Monday through Thursday. The procedure is to select a vacant camp site and then pay a fee at a registration box at the entrance. These campgrounds are in the watershed for the Salt Lake City water supply and no pets are permitted. People interested in these four campgrounds should write for a map and further information from the Department of Mathematics, University of Utah, Salt Lake City, UT 84112.

Child Care

There are several state licensed childcare facilities in the vicinity of the University of Utah. A list of some recommended centers follows. Reservations should be made directly with the center of your choice at least two weeks in advance.

**Taylor-Wright Childcare Center**

801-363-4332
1063 East 200 South
Salt Lake City, UT 84102
Director: Anne Taylor
Ages: 2 – 13. Hours: 6:30 a.m. – 6:00 p.m.
Rates: Daily – $11; half-day, up to 5 hours – $7.50, hourly – $1.90

**Tutor Time Child Care/Learning Centers (2 locations)**

801-363-5437
560 East 200 South
Salt Lake City, UT 84102
Assistant Director: Verlene Beck

801-363-5437
505 Wakara (in Research Park, just south of the university)
Salt Lake City, UT 84113
801-582-3423
Director: Helen Villamor
Ages: 6 weeks to age 12
Hours: 6:30 a.m. – 6:30 p.m. (evening hours possible if there is sufficient demand)
Rates: up to age 2, $2 per hour; age 3 and up $1.50 per hour

**For Children Only (2 locations)**

560 East 200 South
Salt Lake City, UT 84102
801-355-5437
Director: Bianca Candelaria

and

1400 South 1100 East
Salt Lake City, UT 84105
801-467-5730
Director: Bianca Candelaria

Ages and rates: 0 – 24 months – $3.50 per hour, $14 per day; 2 year olds – $2 per hour, $10 per day; age 3 to 8 – $1.75 per hour, $9 per day.

If you wish to have an individual babysitter (high school or college age student), call the Arts and Sciences office at Westminster College 801-488-4166, 9:00 a.m. – 4:00 p.m., no later than July 28.

**Crib Rental**

Portacribs and metal cribs (standard size) can be rented from **Progressive Rental** (about four miles south of campus), 2253 East 3300 South, 801-487-4601. Portacribs cost $17.50 per week. Metal cribs cost $20 per week. Tax is 5.75%. They will deliver for a charge of $13 each way. Cribs can be reserved from July 1 on.

**Handicapped**

Most (not all) university facilities are accessible to the handicapped. People with special requirements for campus housing should have made these clear when submitting preregistration forms. People with special questions regarding handicapped access should contact Deanne Randall, Department of Mathematics, University of Utah, Salt Lake City, UT 84112 (801-581-6851).

**Libraries**

The Marriott Library is the main library on campus. The Mathematics Research Library is located in Room 121 of the John Widstoe Building. Summer hours for these libraries will be announced later.

The main branch of the Salt Lake City Public Library is located at 200 East 500 South, downtown.

The new Genealogical Library of the Latter Day Saints (LDS Mormon) Church is located at 35 North West Temple. The library is open to the public and there is no fee for using the research facilities for genealogical purposes. The library houses the world's largest collection of genealogical records. The hours are Monday 7:30 a.m. to 6:00 p.m., Tuesday through Friday 7:30 a.m. to 10:00 p.m., and Saturday 7:30 a.m. to 5:00 p.m.

**Local Information**

Salt Lake City is the main city in a valley populated by nearly a million people. The city is laid out like the (xy)-plane, with the LDS Temple at the origin. Locations are identified
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
</table>
| 7:30 a.m. -  4:00 p.m. | REGISTRATION
Center Ballroom, Olpin Union                                  |
| 8:00 a.m. -  8:50 a.m. | INVITED ADDRESS
The invariants and polynomial identities
of $n \times n$ matrices
Edward W. Formanek       |
| 8:00 a.m. -  9:00 a.m. | IIME - DUTCH TREAT BREAKFAST                                        |
| 8:00 a.m. -  9:55 a.m. | MAA - MINICOURSE #4 (Part B)
A survey of educational software
David P. Kraines
Vivian Kraines |
| 8:00 a.m. -  9:55 a.m. | MAA - UNDERGRADUATE STUDENT PAPER SESSION                          |
| 8:00 a.m. -  9:55 a.m. | IIME - CONTRIBUTED PAPER SESSIONS                                    |
| 8:30 a.m. -  9:55 a.m. | MAA - COMMITTEE ON THE MATHEMATICAL EDUCATION OF TEACHERS (COMET) PANEL DISCUSSION
New directions in teacher education - pros and cons
Henry L. Alder (moderator)
Alphonse Buccino
Shirley A. Hill
Katherine P. Layton
Billy E. Rhoades |
| 9:00 a.m. -  5:00 p.m. | IIME - CONTRIBUTED PAPER SESSIONS                                    |
| 9:05 a.m. -  9:55 a.m. | MAA - THE EARLE RAYMOND HEDRICK LECTURES: LECTURE II
Title to be announced
William P. Thurston       |
| 11:15 a.m. - 12:15 a.m. | SPECIAL SESSIONS
Geometry and analysis on CR manifolds I
Geometric methods in group theory I
Ring theory and invariant theory I |
| 1:00 p.m. -  3:50 p.m. | SESSIONS FOR CONTRIBUTED PAPERS                                     |
| 1:00 p.m. -  4:00 p.m. | IIME - CONTRIBUTED PAPER SESSIONS                                    |

MAA - CONTRIBUTED PAPER SESSION
Teaching strategies involving computers
Chris Avery
with reference to this coordinatization like this: “351 South 700 East” means a building which is between three and four blocks south of the x-axis (South Temple Street), and on the street which is seven blocks east of the negative y-axis (Main Street). While walking around the city, keep in mind that seven blocks make a mile (more or less). There is a free trolley (called the Brigham Street Trolley) which regularly wends its way around the main locations in downtown: this is an easy (but not speedy) way to get around. Bus service between downtown and the university is very good during the daylight hours. There are many routes which originate along Main or State Streets and pass by the university.

The novice homemaker visiting Italy will eat insipid food until he discovers that salt is sold in the tobacco stores. Similarly, in Utah, the visitor goes dry until he becomes familiar with the local customs. First of all, beer is sold in all supermarkets and most drugstores. Wine and liquor are to be found in outlets of the state monopoly called “Utah State Stores.” These stores are open from 11:00 a.m. until 7:00 p.m. except on Sundays, and any other day that passes for a holiday. Now, to find the locations of these establishments is easy: just look in the blue pages of your copy of the White Pages under “ALCOHOLIC BEVERAGE CONTROL DEPARTMENT – Liquor Stores.” You will discover that none of these addresses has anything to do with the nice coordinate system described above; why one of these stores is on something called “Kentucky Avenue!” The stores closest to the university are these: 1615 Foothill Boulevard is really “1615 South 2300 East,” and 416 6 Avenue is at “416 East 300 North.” The university is at 200 South 1500 East, so both of these are more than a mile away. Salt Lake City does have two outlets which have a remarkably good selection of wines, champagnes, and liqueurs; the one closest to the university (and downtown) is at 250 South 300 East.

One of the advantages of our quaint method of liquor distribution is that all restaurants and hotels are required to accept the contents of brown bags (of course they’ll get you on the cost of the glass to put it in – but don’t fret, the total is still more reasonable than in most cities). Now, if you’ve forgotten your brown bag, don’t worry; there is almost always a liquor store on the premises which can provide you with minibottles and splits of wine after 4:00 p.m. So you see, once you learn the language, it’s just like back home. More about restaurants will appear in the Program.

As a city of moderate size, Salt Lake City has a moderate amount of things going on. Brochures on events taking place during the month of August will be available at the Local Information Section of the Meeting Registration Desk. But the most interesting thing about Salt Lake City is its environment. There are very many good hikes (or climbs) for all abilities within minutes of the campus. In fact, one can walk just to the east of the campus into foothills reaching an elevation of about 7500 feet. Here again, more information will be available at the meeting.

The most famous landmark, the Great Salt Lake, will be a disappointment to all. At its best it is foul and brackish water which allows its occupants to bob around like corks. Also, this summer it is at flood stage and at its worst: it is not even particularly buoyant.

Following closely behind in national—that is not local—interest is the headquarters of the LDS faith. This is located at the center of coordinates—about two miles west of the university. The Visitor’s Center is open for almost all the daylight hours (save Sunday). The Mormon Tabernacle is on the grounds, and features an organ, and the Tabernacle choir. There are organ recitals on Monday through Friday at noon, and Saturday and Sunday at 4:00 p.m. The choir has a public rehearsal on Thursday at 8:00 p.m., and a public radio broadcast on Sunday at 9:30 a.m.

There are several attractions which may be of interest to families. There are the Utah Museums of Fine Arts and Natural History on campus. Hogle Zoo is on the very eastern end of the city on Sunnyside Avenue (900 South). North of Hogle Zoo is Pioneer State Park, commemorating the Mormon migration to Utah. Liberty Park, between 500 and 700 East, and 900 and 1300 South, is a pleasant place to walk around or picnic. It contains the Tracy Aviary, as well as a small pond with pedal boats. On State Street just north of 100 South is the Hansen Planetarium.

Salt Lake City lies within one day’s drive (an average of 300 miles) of ten national parks (Arches, Bryce Canyon, Canyonlands, Capitol Reef, Grand Canyon, Grand Teton, Great Basin, Mesa Verde, Yellowstone, and Zion’s). For further information, write to the National Park Service, 125 South State, Salt Lake City, UT 84111.

For scenic air tours, contact Interwest Scenic Tours, P. O. Box 22063, Salt Lake City, UT 84122.

Medical Services
The following medical care facilities are located close to the university.

Instacare
Provides quick service walk in care, emergency or otherwise
1355 Foothill Drive
Hours 7 days per week Monday through Sunday
9:00 a.m. to 9:00 p.m.
Telephone: 321-2495

University Medical Center (East of Dormitories)
50 North 18th East
24 Hour a day service
Telephone Emergency: 581-2291

Holy Cross Hospital
24 Hour a day service
<table>
<thead>
<tr>
<th>Time</th>
<th>American Mathematical Society</th>
<th>Mathematical Association of America and Other Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00 p.m. - 4:00 p.m.</td>
<td></td>
<td>MAA - UNDERGRADUATE STUDENT PAPER SESSION</td>
</tr>
<tr>
<td>1:15 p.m. - 2:05 p.m.</td>
<td></td>
<td>MAA - INVITED ADDRESS</td>
</tr>
<tr>
<td>1:15 p.m. - 2:15 p.m.</td>
<td><strong>COLLOQUIUM LECTURE III</strong>&lt;br&gt;Mathematical applications of quantum field theory (tentative)&lt;br&gt;Edward Witten</td>
<td></td>
</tr>
<tr>
<td>1:30 p.m. - 3:30 p.m.</td>
<td></td>
<td>MAA - MINICOURSE #5 (Part A)&lt;br&gt;Introduction to computer graphics&lt;br&gt;Joan P. Wyzkoski</td>
</tr>
<tr>
<td>1:30 p.m. - 3:30 p.m.</td>
<td></td>
<td>MAA - MINICOURSE #7 (Part A)&lt;br&gt;For all practical purposes&lt;br&gt;Solomon A. Garfunkel</td>
</tr>
<tr>
<td>2:30 p.m. - 3:20 p.m.</td>
<td></td>
<td>MAA - INVITED ADDRESS&lt;br&gt;Larger bodies with smaller cross-sectional areas&lt;br&gt;Erwin Lutwak</td>
</tr>
<tr>
<td>4:05 p.m. - 6:05 p.m.</td>
<td><strong>STEELE PRIZE SESSION</strong>&lt;br&gt;AND BUSINESS MEETING</td>
<td>IIME - BANQUET</td>
</tr>
<tr>
<td>6:15 p.m. - 8:15 p.m.</td>
<td></td>
<td>MAA - FILM PROGRAM&lt;br&gt;Hypothesis testing, inferential statistics, Part II&lt;br&gt;Regular homotopies in the plane, Part II&lt;br&gt;Symmetries of the cube&lt;br&gt;COMAP films</td>
</tr>
<tr>
<td>7:00 p.m. - 9:00 p.m.</td>
<td></td>
<td>MAA - MINICOURSE #6 (Part A)&lt;br&gt;A calculus lab course using MicroCalc&lt;br&gt;Harley Flanders</td>
</tr>
<tr>
<td>7:00 p.m. - 9:00 p.m.</td>
<td></td>
<td>IIME - J. SUTHERLAND FRAME LECTURE</td>
</tr>
</tbody>
</table>

**Saturday, August 8**

<table>
<thead>
<tr>
<th>Time</th>
<th>AMS</th>
<th>MAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:30 a.m. - 3:00 p.m.</td>
<td>REGISTRATION&lt;br&gt;Center Ballroom, Olpin Union</td>
<td>MAA - MINICOURSE #5 (Part B)&lt;br&gt;Introduction to computer graphics&lt;br&gt;Joan P. Wyzkoski</td>
</tr>
<tr>
<td>8:00 a.m. - 9:55 a.m.</td>
<td>SPECIAL SESSIONS&lt;br&gt;Geometry and analysis on CR manifolds II&lt;br&gt;Geometric methods in group theory II&lt;br&gt;Ring theory and invariant theory II</td>
<td>MAA BOOK SALE&lt;br&gt;MAA - INVITED ADDRESS&lt;br&gt;Modern research trends in matrix analysis&lt;br&gt;Charles R. Johnson</td>
</tr>
<tr>
<td>8:00 a.m. - 9:55 a.m.</td>
<td><strong>SESSIONS FOR CONTRIBUTED PAPERS</strong></td>
<td>MAA - THE EARLE RAYMOND HEDRICK LECTURES: LECTURE III&lt;br&gt;Title to be announced&lt;br&gt;William P. Thurston</td>
</tr>
<tr>
<td>9:00 a.m. - noon</td>
<td>AMS EXHIBIT AND BOOK SALE</td>
<td></td>
</tr>
<tr>
<td>9:05 a.m. - 9:55 a.m.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:15 a.m. - 12:15 a.m.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1045 East 100 South
Telephone Emergency: 350-4630
Paramedics
Emergency: 911
LDS Hospital
8th Avenue and C Street
24 Hour a day service
Telephone Emergency: 321-1180

Parking
Parking stickers for those participants not residing on campus will be available for purchase at the Meetings Registration Desk for $1.50 per day or $4.50 for August 5–8. These stickers will allow parking in all campus lots.

Smoking
Please note that smoking is not allowed in any of the buildings or public areas on the University of Utah campus, except for specially designated areas; for example, certain areas of the cafeterias in the Union building.

Social Event
On Thursday afternoon and evening there will be an outing including buffet dinner and sightseeing at Snowbird Ski and Summer Resort, at an altitude of 8,100 feet in the Wasatch Mountains about 25 miles from the university campus. This activity is highly recommended for everyone who attends the meeting. Buses, arranged by courtesy of the Department of Mathematics, will leave from Olpin Union Building at 3:30 p.m. – 4:00 p.m. and reach the resort in about 45 minutes. (People with automobiles may wish to drive instead. Please check at the Local Information section of the registration desk for driving instructions.) The schedule will enable people to have some time for sight-seeing before the Western Barbecue Buffet is served on the Plaza between 6:00 p.m. – 7:00 p.m. (There is a sheltered area in case of rain.) Those who desire may buy tickets on the Plaza to ride the tram to the top of Hidden Peak, at an elevation of 11,000 feet. This is truly a spectacular vantage point from which, on a clear day, forest and mountains can be seen in all directions at distances of at least 50 miles. With time for sight-seeing at the top, about an hour should be planned for this. People who eat early should have time for the tram ride after dinner. Wildflowers should be in abundance in early August, and there will likely be some lingering snowdrifts. People who do not wish to ride the tram may enjoy the scenery from the Plaza or walk among the nearby mountain streams, trees, and wildflowers. Suitable warm clothing is recommended for this occasion. The first bus will leave the resort at about 7:30 p.m. and the last one at 8:30 p.m. for the return trip to the campus.
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
</table>
| 1:15 p.m. – 2:05 p.m. | INVITED ADDRESS  
*Title to be announced*  
*Brian C. White*  
**American Mathematical Society** |
| 1:15 p.m. – 2:15 p.m. | COLLOQUIUM LECTURE IV  
*Mathematical applications of quantum field theory (tentative)*  
*Edward Witten*  
**American Mathematical Society** |
| 1:30 p.m. – 2:30 p.m. | MAA – CONTRIBUTED PAPER  
*Classification of restricted simple Lie algebras*  
*Robert Lee Wilson*  
**Mathematical Association of America** |
| 2:30 p.m. – 4:00 p.m. | MAA – COMMITTEE ON PLACEMENT EXAMINATIONS PANEL  
*Using placement examinations to create order in freshman placement*  
*John W. Kenelly (moderator)*  
**Mathematical Association of America** |
| 2:30 p.m. – 4:30 p.m. | MAA – MINICOURSE #6 (Part B)  
*A calculus lab course using MicroCalc*  
*Harley Flanders*  
**Mathematical Association of America** |
| 3:35 p.m. – 4:25 p.m. | INVITED ADDRESS  
*Title to be announced*  
*David Jerison*  
**American Mathematical Society** |
SPECIAL AIRFARES
1-800-826-6011

MICA, the official travel management firm for the Joint Mathematics Meeting to be held in Salt Lake City, August 5-8, 1987, has arranged for special discounts aboard American Airlines.

Save 5% off all published promotional fares, meeting all restrictions, or 35-40% off regular roundtrip coach fares, with a 7-day advance purchase.

It is possible to receive an even lower airfare depending on your individual circumstances.

Sample Airfares to Salt Lake City
(Quoted 2/11/87 and subject to change)

<table>
<thead>
<tr>
<th>Originating City</th>
<th>Coach Fares</th>
<th>Discounted Coach Fares</th>
<th>Discounted Promotional Fares</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York</td>
<td>$900.00</td>
<td>$585.00</td>
<td>$245.00</td>
</tr>
<tr>
<td>Chicago</td>
<td>$740.00</td>
<td>$444.00</td>
<td>$207.00</td>
</tr>
<tr>
<td>San Francisco</td>
<td>$518.00</td>
<td>$310.00</td>
<td>$188.00</td>
</tr>
</tbody>
</table>

Please Note: The lowest published promotional fares require a Saturday night stay, are subject to an airline change/cancellation penalty, and must be purchased at least 30 days prior to departure.

Make your reservations today! MICA reservationists can obtain the lowest available airfare on any airline, and help you with car rental arrangements.

You may pay by credit card or ask to be invoiced. We urge you to purchase your airline tickets without delay using your credit card. This will confirm your reservation, the current airfare and protect you against later fare increases.

Remember, these special discounts are available only through MICA's toll-free-number.

Call 1-800-826-6011 And Save!
In Connecticut call (203) 678-1040
Monday - Friday, 9:00 am - 5:30 pm E.S.T.

Meetings, Incentives, Conventions of America, Inc./MICA, Inc.
Suite 303, 195 Farmington Avenue
Farmington, CT 06032

American Airlines
The buffet menu includes barbecued chicken and spareribs, five different salads, a relish tray, corn on the cob, baked beans, baked potatoes, chef's selection of vegetables, rolls, butter, two desserts, and soft beverages (Beer can be purchased at the Birdfeeder on the Plaza.) There is no special menu for vegetarians since the above selections suffice; however, one should indicate if a vegetarian meal is wanted to insure that a substantial amount of vegetables will be available. Tickets are $15 per person for adults and $9 per person for children (12 years old and younger).

Those planning to attend the outing should purchase their tickets through preregistration, since a guarantee must be given. Interested participants should complete the appropriate section of the preregistration form. In the event of cancellations, a 50% refund of the amount paid for the ticket will be made if notification is received in Providence prior to August 3. After that date, no refund can be given.

Travel

In August, Salt Lake City is on Mountain Daylight Saving Time. The city is served by most major U.S. airlines; in particular, the hub of Western Airlines (recently merged with Delta). The airport lies about six miles west of downtown Salt Lake. There is regular bus service during daylight hours to downtown at $1.50. A cab to downtown should cost about $10, and to the university, it might run about $14.

For some years now, the AMS-MAA Joint Meetings Committee has engaged a travel agent for the January and August Joint Meetings in an effort to ensure that everyone attending these meetings is able to obtain the best possible airfare. This service is presently being performed by Meetings, Incentives, Conventions of America, Inc. (MICA); their advertisement can be found elsewhere in this meeting announcement. Although any travel agent can obtain Supersaver or other such published promotional fares, only MICA can obtain the special additional 5 percent discount over and above these fares, and the 35 - 40 percent off regular coach fare. The latter, of course, is financially beneficial only when one does not qualify for one of the promotional fares. Participants should pay particular attention to the cancellation policies stated in the ad. Winners of the two free tickets in San Antonio were David Buchanan and Ramesh Sharma.

If you drive to Salt Lake City you will arrive on I-15 (North or South) or I-80 (East or West). If you are coming from the west, you will intersect I-15 west of the city. Take the 6th South exit and proceed according to the following instructions.

Coming from the north or south on I-15, take the 6th South exit, heading East. If you want to go to the downtown hotels, turn left on West Temple, and proceed until you see your hotel. If you are heading for the university, proceed along 6th South until you reach 7th East; turn left (north) and proceed to 1st South. Turn right (east) and proceed until you reach University Avenue; then follow the map to your destination.

Coming from the east, you enter the Salt Lake Valley via Parley’s Canyon. Take the Foothill Drive exit (old route US 40, now Utah 186) and follow this main artery (which changes name several times) for about seven miles to the university (which will be well marked and lie to the right), or nine miles to the downtown area.

Weather

Salt Lake City lies at an altitude of approximately 4,500 feet at the foot of the Wasatch mountains on the eastern rim of the great basin. The climate is that of a desert: very little humidity, much sunshine, and a large daily variation in temperature. The average high in August is about 88 degrees F, and the low near 60. During the day the sun will be quite warm, but otherwise the weather should be very pleasant. In particular, the evenings could be cool, and some sort of outer wear is advisable. By mid-August the late summer thundershowers begin to come; we could see one during the meeting. This could be a spectacle, but of brief duration. Otherwise, there will be little inclement weather.

Hugo Rossi
Salt Lake City, Utah
Associate Secretary
Invited Speakers and Special Sessions

Invited Speakers at AMS Meetings

The individuals listed below have accepted invitations to address the Society at the times and places indicated. For some meetings, the list of speakers is incomplete.

Tacoma, June 1987
Branko Grünbaum
Henryk Hecht

Salt Lake City, August 1987
Donald G. Aronson
Robert Finn
Edward W. Formanek
David Jerison
Stephen Kerchoff
Paul C. Roberts

Michael Starbird
(AMS-MAA)
Karen Vogtmann
Brian C. White
Robert Lee Wilson
(Colloquium Lecturer)

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of Notices went to the printer. The section below entitled Information for Organizers describes the timetable for announcing the existence of Special Sessions.

June 1987 Meeting in Tacoma
Far Western Section
Deadline for organizers: Expired
Deadline for consideration: Expired
Henryk Hecht, Geometric methods in representation theory
Moshe Rosenfeld, Polyhedral and planar graphs

August 1987 Meeting in Salt Lake City
Associate Secretary: Hugo Rossi
Deadline for organizers: Expired
Deadline for consideration: April 21, 1987
Donald G. Aronson and Hans Othmer, Nonlinear evolution equations
Kenneth S. Brown, Geometric methods in group theory
Edward W. Formanek, Ring theory and invariant theory
Jacob Goodman and Erwin Lutwak, Discrete geometry and convexity
John M. Lee, Geometry and analysis on CR manifolds
Paul C. Roberts, Commutative algebra and algebraic geometry

October 1987 Meeting in Lincoln
Central Section
Deadline for organizers: April 15, 1987
Deadline for consideration: To be announced

November 1987 Meeting in Los Angeles
Far Western Section
Deadline for organizers: April 15, 1987
Deadline for consideration: To be announced

Fall 1987 Meeting
Eastern Section
No meeting will be held

Fall 1987 Meeting
Southeastern Section
No meeting will be held

January 1988 Meeting in Atlanta
Associate Secretary: W. Wistar Comfort
Deadline for organizers: April 15, 1987
Deadline for consideration: To be announced

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the general supervision of the Program Committee. They are administered by the Associate Secretary in charge of the meeting with staff assistance from the Society office in Providence.

Some Special Sessions arise from an invitation to a proposed organizer issued through the Associate Secretary. Others are spontaneously proposed by interested organizers or participants. Such proposals are welcomed by the Associate Secretaries.

The number of Special Sessions at a Summer or Annual Meeting is limited to twelve. Proposals, invited or offered, that are received at least nine months prior to the meeting are screened for suitability of the topic and of the proposed list of speakers, and for possible overlap or conflict with other proposals. (Specific deadlines for requesting approval for Special Sessions at national meetings are given above.) If necessary, the numerical limitation is enforced.

Proposals for Special Sessions should be submitted directly to the Associate Secretary in charge of the meeting (at the address given in the accompanying box). If such proposals are sent to the Providence office, addressed to Notices, or directed to anyone other than the Associate Secretary, they will have to be forwarded and may not be received before the quota is filled.

In accordance with an action of the Executive Committee of the Council, no Special Session may be arranged so late that it may not be announced in Notices early enough to allow any member of the Society who wishes to do so to submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration.
Special Sessions are effective at Sectional Meetings and can usually be accommodated. They are arranged by the Associate Secretary under the supervision of the Committee to Select Hour Speakers for the section. The limitation on the number of sessions depends on the space and time available. The same restriction as for national meetings applies to the deadline for announcing Special Sessions at sectional meetings: no Special Session may be approved too late for its announcement to appear in time to allow a reasonable interval for members to prepare and submit their abstracts prior to the special early deadline set for consideration of papers for Special Sessions.

The Society reserves the right of first refusal for the publication of proceedings of any special session. These proceedings appear in the book series Contemporary Mathematics.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single special session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

LIE ALGEBRAS AND RELATED TOPICS

D. J. Britten, F. W. Lemire, and R. V. Moody, Editors

As the Proceedings of the 1984 Canadian Mathematical Society's Summer Seminar, these papers focus on some recent advances in the theory of semisimple Lie algebras and some direct outgrowths of that theory. Of particular interest are notes for several courses presented at the meeting: an important survey article by R. Block and R. Wilson on restricted simple Lie algebras, a survey of universal enveloping algebras of semisimple Lie algebras by W. Bohro, a course on Kac-Moody Lie algebras by I. G. Macdonald, and a course on formal groups by M. Hazewinkel.

Send Proposals for Special Sessions to the Associate Secretaries

The programs of sectional meetings are arranged by the Associate Secretary for the section in question:

Far Western Section (Pacific and Mountain)
- Hugo Rossi, Associate Secretary
  Department of Mathematics
  University of Utah
  Salt Lake City, UT 84112
  (Telephone 801–581–8159)

Central Section
- Robert M. Fossum, Associate Secretary
  Department of Mathematics
  University of Illinois
  1409 West Green Street
  Urbana, IL 61801
  (Telephone 217–333–3975)

Eastern Section
- W. Wistar Comfort, Associate Secretary
  Department of Mathematics
  Wesleyan University
  Middletown, CT 06457
  (Telephone 203–347–9411)

Southeastern Section
- Frank T. Birtel, Associate Secretary
  Department of Mathematics
  Tulane University
  New Orleans, LA 70118
  (Telephone 504–865–5646)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.
Suggestions are invited from mathematicians, either singly or in groups, for topics of the various conferences that will be organized by the Society in 1989. The deadlines for receipt of these suggestions, as well as some relevant information about each of the conferences, are outlined below. An application form to be used when submitting suggested topic(s) for any of these conferences (except the Short Course Series) may be obtained by writing to the Meetings Department, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940, or telephoning 401-272-9500.

Individuals willing to serve as organizers should be aware that the professional meeting staff in the Society's Providence office will provide full support and assistance before, during, and after each of these conferences. Organizers should also note that for all conferences, except Summer Research Conferences, it is required that the proceedings be published by the Society, and that proceedings of Summer Research Conferences are frequently published. A member of the Organizing Committee must be willing to serve as editor of the proceedings.

All suggestions must include (1) the names and affiliations of proposed members and chairman of the Organizing Committee; (2) a two- or three-page detailed outline of the subject(s) to be covered, including the importance, timeliness of the topic, and estimated attendance; (3) a list of the recent conferences in the same or closely related areas; (4) a tentative list of names and affiliations of the proposed principal speakers; (5) a list of likely candidates who would be invited to participate and their current affiliations; and (6) any other observations which may affect the size of the conference and the amount of support required. Any suggestions as to sites and dates should be made as early as possible in order to allow adequate time for planning. By action of the AMS Board of Trustees, the Meetings Department of the Society is responsible for the final selection of the site for each conference and for all negotiations with the host institution. Individuals submitting suggestions for the conferences listed below are requested to recommend sites or geographic areas which would assist the Meetings Department in their search for an appropriate site. In the case of Joint Summer Research Conferences in the Mathematical Sciences, a one-, two-, or three-week conference may be proposed.

Refer to the accompanying box titled Topics of Current and Recent Conferences for lists of topics.

### Topics of Current and Recent Conferences

**AMS Summer Institute**

- 1985 – Algebraic geometry, organized by DAVID EISENbud of Brandeis University.
- 1986 – Representations of finite groups and related topics, organized by JONATHAN L. ALPERIN of the University of Chicago.
- 1987 – Theta functions, organized by LEON EHRENPREIS of Yeshiva University and ROBERT GUNNING of Princeton University.
- 1988 – Operator theory/Operator algebras and applications, organized by WILLIAM B. ARVESON of University of California, Berkeley, and RONALD G. DOUGLAS of State University of New York at Stony Brook.

**AMS-SIAM Symposium on Some Mathematical Questions in Biology**

- 1985 – Plant biology, organized by ROBERT M. MIURA of the University of British Columbia.
- 1986 – Modeling circadian rhythms, organized by GAIL A. CARPENTER of Northeastern University.
- 1987 – Models in population biology, organized by ALAN HASTINGS of the University of California, Davis.
- 1988 – Dynamics of excitable media, organized by HANS G. OTHMER of the University of Utah.

**AMS-SIAM Summer Seminar**

- 1987 – Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation, organized by RANDOLPH BANK of the University of California, San Diego.
- 1988 – Computational solution of nonlinear systems of equations, organized by EUGENE ALLGOWER of Colorado State University.
1989 AMS Summer Institute

Summer institutes are intended to provide an understandable presentation of the state of the art in an active field of research in pure mathematics, and usually extend over a three-week period. Dates for a summer institute must not overlap those of the Society’s summer meeting, which at the time of this printing have not yet been determined, there should be a period of at least one week between them. Proceedings are published by the Society as volumes in the series Proceedings of Symposia in Pure Mathematics.

Deadline For Suggestions: August 15, 1987

1989 AMS-SIAM Summer Seminar

The goal of the summer seminar is to provide an environment and program in applied mathematics in which experts can exchange the latest ideas and newcomers can learn about the field. Proceedings are published by the Society as volumes in the series Lectures in Applied Mathematics.

Deadline For Suggestions: August 15, 1987

1989 Joint AMS-IMS-SIAM Summer Research Conferences in the Mathematical Sciences

These conferences are similar in structure to those held at Oberwolfach, and represent diverse areas of mathematical activity, with emphasis on areas currently especially active. Careful attention is paid to subjects in which there is important interdisciplinary activity at present. Topics for the sixth series of one-week conferences, being held in 1987, are Categories in computer science and logic, Hamiltonian dynamical systems, Graphs and algorithms, Geometry of group representations, The connection between infinite dimensional and finite dimensional dynamical systems, Geometry of random motion, Crystal growth and pattern formation in phase transitions, Complex analytic dynamics, and Statistical inference from stochastic processes. If proceedings are published by the Society, they will appear as volumes in the series Contemporary Mathematics.

Deadline For Suggestions: February 1, 1988

Call for Topics for 1989 AMS Short Course Series

The AMS Short Courses consist of a series of introductory survey lectures and discussions ordinarily extending over a period of one and one-half days starting immediately prior to the Joint Mathematics Meetings held in January and August each year. Each theme is a specific area of applied mathematics or mathematics used in the study of a specific subject or collection of problems in one of the physical, biological or social sciences, technology or business. Topics in recent years have been Moments in Mathematics (January 1987), Approximation Theory (January 1986), Actuarial Mathematics (August 1985), Fair Allocation (January 1985), Environmental and Natural Resource Mathematics (August 1984). Proceedings are published by the Society as volumes in the series Proceedings of Symposia in Applied Mathematics, with the approval of the Editorial Committee.

Deadline For Suggestions: Suggestions for the January 1989 course should be submitted by July 1, 1987; suggestions for the August 1989 course should be submitted by December 1, 1987.

Submit suggestions to: Professor Stefan A. Burr, Chairman, AMS Short Course Subcommittee, Department of Computer Sciences, CUNY, City College, New York, New York 10031.

COMBINATORICS AND ORDERED SETS

Ivan Rival, Editor

(Contemporary Mathematics, Volume 57)

For the mathematician interested in discrete mathematics, from the senior undergraduate to the professional level, this volume provides first-rate surveys of the important combinatorics themes in ordered sets.

These expository lectures, given at a 1985 Joint Summer Research Conference, cover a wide range of topics include: the three-machine problem to illustrate the order-theoretic aspects of scheduling theory; the techniques used in settling the "matching conjecture"; the decomposition of ordered sets into few chains; the reorientation of graphs; the varied occurrences of the meet-distribution property: surveys techniques used in settling binary sorting problems; the formulation of a general view point for retraction: the survey of cutsets; and the role played by subdiagrams in ordered sets.

1980 Mathematics Subject Classifications: 06, 05
ISBN 0-8218-5051-2, LC 88-8006. ISSN 0271-4132
354 pages (softcover), 1986.
List price $29, Institutional member $23. Individual member $17
Code CONM/57

Shipping/Handling: 1st book $2, each add'l $1.
$25 max. By air, 1st book $5, each add'l $3.
$100 max. Prepayment required. Order from AMS, P.O. Box 1571, Annex Station, Providence, RI 02901-9930, or call 800-556-7774 to use VISA or MasterCard.

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THIS SECTION contains announcements of meetings of interest to some segment of the mathematical public, including ad hoc, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. Information on meetings of the Society, and on meetings sponsored by the Society, will be found both in this section and on the inside front cover. All meetings listed here, to the best of our knowledge, are open meetings and the public is invited to attend.

AN ANNOUNCEMENT will be published in Notices if it contains the place, date, and the subject (when applicable); a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared.

IN GENERAL, announcements of meetings held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on special meetings should be sent to the Editor of Notices, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of Notices prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.


Program: A series of graduate courses and seminars will be offered by regular faculty and special visitors, including R. Brualdi, A. Hajnal, P. Pudlak, G. Turan, and R. Wilson.
Information: W. Maass, U. Peled, or V. Pless, University of Illinois at Chicago, Department of Mathematics, Statistics, and Computer Science, Box 4348, Chicago, Illinois 60680, 312-996-2372, 312-996-4826, or 312-996-4828 respectively.


Information: H. Weinberger, Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church Street S.E., Minneapolis, Minnesota 55455.

Information: R.T.G.T., Department of Mathematics, University of Manchester Institute of Science and Technology, Post Office Box 88, Manchester, M60 1QD, England.

APRIL 1987


24-25. Harald Bohr Centenary Symposium, Copenhagen, Denmark. (February 1987, p. 358)


27-May 1. Espaces Fibrés: Leur Utilisation en Physique, Trieste, Italy. (February 1987, p. 358)

27-May 2. Combinatorics and Computer Science, Montréal, Québec, Canada. (February 1987, p. 358)

27-May 23. Fluidodynamics, Pisa, Italy. (February 1987, p. 359)


30-May 7. AMS-SIAM Summer Seminar on Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, Minnesota. (February 1987, p. 359)

MAY 1987

Mid-May. Conference on Aspects of Analysis, University College, Cork, Ireland. (February 1987, p. 359)

4-6. Research Conference in Geometric Design, Wayne State University, Detroit, Michigan. (February 1987, p. 359)

4-8. Conference on Nonlinear Diffusive Waves, Provo, Utah. (February 1987, p. 359)
4-8. Workshop on High Mach Number Combustion, Cornell University, Mathematical Sciences Institute, Ithaca, New York.

Organizer: J. Buckmaster.


4-9. Theorie des Nombres, Marseille, France. (February 1987, p. 359)


Information: C. Shaddock, Department of Mathematics, University of Edinburgh, Mayfield Road, Edinburgh EH9 3JZ, Scotland.


Information: W. Proebster, IBM Lab, Post Office Box 80 08 80, D-7000 Stuttgart 80, Federal Republic of Germany.


Information: For further details, see the Meetings section of this issue of Notices.


Information: Agence de l'Infomatique, Tour Fiat Cedex 16, 92084 Paris-La Defense, France. Telephone: (33)147 96 43 14.

14-15. Statcomp 87, Melbourne, Australia. (February 1987, p. 359)


Program: This conference in honor of Lars V. Ahlfors will survey developments in the many areas of geometric function theory to which he has contributed.


Information: G. Christensen, Department of Mathematics, University of Michigan, Ann Arbor, Michigan 48109-1003.


Program: This ninth International Invitational Symposium will address, through a series of invited lectures, the unification of Theory & Test in different stages of the Finite Element Methods.

Information: R. Pryputniewicz, UFEM Symposium, Department of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Massachusetts 01609, 617-793-5536.

15. Ninth Nestor M. Riviire Memorial Lecture, University of Minnesota, Minneapolis, Minnesota. (February 1987, p. 359)

18-20. Journees de Statistique 1987, Lausanne, Switzerland. (February 1987, p. 359)


18-23. Sous-Varietes Riemanniennes, Marseille, France. (February 1987, p. 359)


Organizer: P. Holmes.

20-23. Combinatorial Matrix Analysis Conference, University of Victoria, Victoria, British Columbia, Canada. (October 1986, p. 843)


Information: Association for Symbolic Logic, Department of Mathematics, University of Illinois, 1409 West Green Street, Urbana, IL 61801.


25-30. Seminaire Sud-Rhodanien, Marseille, France. (February 1987, p. 359)

25-June 20. Mathematical Models in Chemistry and Biology, Pisa, Italy. (February 1987, p. 359)

26-28. Multiple-valued Logic, University of Massachusetts, Boston, Massachusetts. (January 1987, p. 133)


27-29. Institute of Mathematical Statistics Eastern Regional Meeting, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. (February 1987, p. 359)


27-30. Seventh Great Plains Operator Theory Seminar, University of Kansas, Lawrence, Kansas. (February 1987, p. 360)


Purpose: The goals of this conference are to promote research in graph theory, to strengthen contacts between mathematicians in the region interested in graph theory, and to enable professionals in all areas to broaden their understanding of graph theory.

Information: J. Gimbel, Department of Mathematics, Colby College, Waterville, Maine 04901, 207-872-3576.

28-30. Annual Summer Meeting of the Canadian Mathematical Society, Queen's University, Kingston, Ontario, Canada. (February 1987, p. 360)


31-June 3. 1987 Annual Meeting, Statistical Society of Canada, Quebec City, Canada. (November 1986, p. 962)
JUNE 1987


1-5. National Science Foundation-Conference Board of the Mathematical Sciences on Gauge Theory, Washington University, Saint Louis, Missouri.

Invited Speaker: K. Uhlenbeck.

Information: G. Jensen, Department of Mathematics, Washington University, Saint Louis, Missouri 63130.

1-5. Ramanujan Centenary Conference, University of Illinois at Urbana-Champaign, Urbana, Illinois. (February 1987, p. 360)

1-6. Teorie de Hodge, Marseille, France. (February 1987, p. 360)


4-6. Computer Experimentation in Nonlinear Analysis, University of Missouri, Columbia, Missouri. (January 1987, p. 133)

4-6. Congress on Educational Computing in Mathematics, Università di Roma I, Roma, Italy. (February 1987, p. 360)

7-12. Discrete Geometrie, Oberwolfach, Federal Republic of Germany. (February 1987, p. 360)


8-12. AI, Mathematics and the Microcomputer, Salisbury State College, Salisbury, Maryland. (February 1987, p. 360)

8-13. Arithmetique des Systemes Codes, Marseille, France. (February 1987, p. 360)


Information: For further details, see the Meetings section of the February 1987 issue of Notices.


15-19. Mathematical Association of America's North Central Section Summer Seminar on Graph Theory and Linear Algebra, University of Minnesota, Duluth, Minnesota. (January 1987, p. 133)


Invited Speaker: M. Eaton.

Information: R. Muirhead, Department of Statistics, University of Michigan, Ann Arbor, Michigan 48109-1027.


17-23. Symmetry Methods in Differential Equations, Utah State University, Logan, Utah. (February 1987, p. 361)

18-20. 835th Meeting of the AMS, Tacoma, Washington. Information: For further details, see the Meetings section of this issue of Notices.


Information: For further details, see the Meetings section of the February 1987 issue of Notices.


22-27. Mathematiques et Sciences Humaines, Marseille, France. (February 1987, p. 361)


22-July 2. NSF Workshop on Extremes of Random Processes in Applied Probability, University of California, Santa Barbara, California.

Information: J. Gani, Statistics Program, University of California, Santa Barbara, California 93106.


Purpose: It is intended that this meeting should provide a forum for interaction between mathematicians and computer scientists interested in theoretical foundations of computation.  


29-July 4. Fonctions Automorphes, Marseille, France. (February 1987, p. 361)


JULY 1987

July-August. Low Dimensional Topology Symposium, University of Sussex, Brighton, Great Britain. (August 1986, p. 654)


5-18. Conference Internationale de Théorie des Nombres (CITN), Université Laval, Québec, Canada. (February 1987, p. 361)

5-25. Research Workshop on Banach Space Theory, University of Iowa, Iowa City, Iowa. (February 1987, p. 361)

6-10. Third Gregory Symposium on Differential Equations, University of Wales, United Kingdom. (October 1986, p. 844)


6-24. Summer Research Institute on Theta Functions, Bowdoin College, Brunswick, Maine.  

Information: For further details, see the Meetings section of this issue of Notices.

10-11. Logic and Linguistics Conference, Stanford University, Stanford, California. (January 1987, p. 134)


13-17. National Science Foundation-Conference Board of the Mathematical Sciences Regional Conference on Group Actions on Manifolds, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.  

Invited Speaker: S. Cappell.  

Information: F. Quinn, Department of Mathematics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.


13-23. Group Actions on Manifolds, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. (February 1987, p. 362)


Information: W. Krieger, SFB 123, University of Heidelberg, Im Neuenheimer Feld 294, 6900 Heidelberg, Federal Republic of Germany.

20-25. 1987 European Summer Meeting of the ASL, Logic Colloquium 1987, University of Granada, Spain.  

Topics: Set Theory, Model Theory, Recursion Theory, Nonstandard Analysis, Logic in Computer Science, Natural Language Semantics, History of Logic, Logic Teaching Systems, and Philosophy of Logic.  

Information: J. J. Acero, Apartado 120, 18080 Granada, Spain or C. Garcia T revijano, Revista Teorema, Apartado 61.159, 28080 Madrid, Spain.


Information: D. Evans, Mathematics Institute, University of Warwick, Coventry CV4 7AL, England.

27-29. SLU-GTE Conference on Commutative Harmonic Analysis, Saint Lawrence University, Canton, New York.  


AUGUST 1987

National Science Foundation-Conference Board of the Mathematical Sciences Regional Conference on Theory and Applications of Multivariate Splines, Howard University, Washington, District of Columbia.  

Invited Speaker: C. Chui.

Information: D. Williams, Department of Mathematics, Howard University, Washington, District of Columbia 20059.


3-7. Georgia Topology Conference, University of Georgia, Athens, Georgia. (January 1987, p. 134)


3-21. Mathematical and Statistical Developments of Evolutionary Theory, Université de Montréal, Montréal, Canada. (January 1987, p. 134)


4-7. Sixth International Conference on Mathematical Modelling: An Interdisciplinary Integrative Forum for Researchers and Educators in Engineering, Economics, Biological, Medical, Environmental, Social and other Sciences, Washington University, St. Louis, Missouri. (February 1987, p. 362)
Invited Speaker: H. Wif.
Information: J. Watkins, Department of Mathematics, Colorado College, Colorado Springs, Colorado 80903.

5-7. Workshop on Generic Families of Vector Fields, Montreal, Canada. (February 1987, p. 362)

5-8. Joint Mathematics Meetings, Salt Lake City, Utah. 
Information: For further details, see the Meetings section of this issue of Notices.


10-13. Sixth International Conference on Mathematical Modelling, Washington University, Saint Louis, Missouri. (February 1987, p. 362)

Invited Speaker: R. Gardner.
Information: G. Harris, Department of Mathematics, Texas Tech University, Lubbock, Texas 79409.


19-21. Third Conference on Numerical Methods and Approximation Theory, University of Niš, Niš, Yugoslavia. (January 1987, p. 135)


24-29. Meeting on Geometry of Banach Spaces, Mons, Belgium. (August 1986, p. 655)

Organizing Committee: J. Rustagi, P. Goel, D. Wolfe, and J. Klein (Ohio State University). 
Information: J. Rustagi, P. Goel, D. Wolfe, and J. Klein (Ohio State University). 
Call for Papers: Persons wishing to contribute should send their abstracts to any member of the Ohio State University Organizing Committee by May 31, 1987, to the address below.

3-5. Satellite Meeting at the 40th Session of the International Statistical Institute, Kyoto, Japan. 
Call for Papers: Contributed papers on Stochastic differential equations, Limit theorems in probability and statistics, Stochastic analysis and Modelling are welcome.
Information: M. Husisi, Chairman of the Organizing Committee, Department of Information Sciences, Tokyo Institute of Technology, O-okayama, Meguro-ku, Tokyo 152 Japan.


7-11. International Symposium on Harmonic Analysis, Centre Universitaire de Luxembourg, Luxembourg. (February 1987, p. 363)


14-18. National Science Foundation-Conference Board of the Mathematical Sciences Regional Conference on Fractal Geometry, University of Cincinnati, Cincinnati, Ohio. 
Invited Speaker: B. Mandelbrot.
Information: K. Meyer, Department of Mathematics, University of Cincinnati, Cincinnati, Ohio 45221.


29-October 2. Fifth International Symposium on Data Analysis and Informatics, Versailles, France. (February 1987, p. 363)
OCTOBER 1987

October. 87 ICAR-International Conference on Advanced Robotics, Paris or Nice, France. (August 1986, p. 655)


Information: Z. Miller, Department of Mathematics and Statistics, Miami University, Oxford, Ohio 45056.

Information: M. Cox, Department of Mathematics and Statistics, Miami University, Oxford, Ohio 45056.


NOVEMBER 1987

9–December 18. College on Riemann Surfaces, Trieste, Italy. (February 1987, p. 363)

14–15. 838th Meeting of the AMS, Los Angeles, California. Information: D. Smith, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02904.

DECEMBER 1987


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JANUARY 1988

6–9. Joint Mathematics Meetings, Atlanta, Georgia. Information: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02904.


Information: A. Stone, University of New Mexico, Department of Mathematics and Statistics, Albuquerque, New Mexico 87131.

FEBRUARY 1988


MARCH 1988


APRIL 1988

17–30. The First Canadian Number Theory Society Conference, Banff, Alberta, Canada. (February 1987, p. 364)

MAY 1988

30–June 3. International Conference on Numerical Mathematics, Kent Ridge, Republic of Singapore. Program: One-hour survey talks and 30-minute talks will be given. There will also be oral/poster presentations of contributed papers on topics related to numerical mathematics. Information: Secretary, International Conference on Numerical Mathematics, Department of Mathematics, National University of Singapore, Kent Ridge, Republic of Singapore 0511.

JUNE 1988


JULY 1988


17–27. Ninth Congress of the International Association of Mathematical Physics, Swansea, Wales. (February 1987, p. 364)


23–August 3. Sixth International Congress on Mathematical Education, Budapest, Hungary. (February 1987, p. 364)

AUGUST 1988

8–12. AMS Centennial Celebration, Providence, Rhode Island. Information: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02904.

9–12. International Symposium in Real Analysis, University of Ulster, Coleraine, Northern Ireland. (February 1987, p. 364)

21–27. Seventeenth International Congress of Theoretical and Applied Mechanics, Grenoble, France. (January 1987, p. 135)

JANUARY 1989

11–14. Joint Mathematics Meetings, Phoenix, Arizona. Information: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02904.

JANUARY 1990

17–20. Joint Mathematics Meetings, Louisville, Kentucky. Information: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02904.
This special issue of Mathematics of Computation (Volume 48, Number 177, January 1987) is dedicated to Daniel Shanks on the occasion of his 70th birthday. Since 1959, when Shanks joined the Editorial Committee for this journal, he has been a guiding force in shaping the computational number theory component of the journal, and has had an immense influence in the field. This volume contains papers by some of the top researchers in the field and covers such topics as elliptic curves, primality testing, congruences, class groups, and cyclotomic fields. Although a numbered issue of the Mathematics of Computation journal, it will serve as a stand alone reference work for computational number theory.

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THE LEFSCHETZ CENTENNIAL CONFERENCE, Part I:
Proceedings on Algebraic Geometry
D. Sundararaman, Editor
(Contemporary Mathematics, Volume 58.1 (Part I))

This volume contains many of the papers in the area of algebraic geometry presented at the 1984 Solomon Lefschetz Centennial Conference held in Mexico City. It is the first in a three volume series. The conference focused on this topic along with the areas of Algebraic Topology and Differential Equations where Lefschetz made significant contributions. The proceedings begins with two interesting articles: A Page of Mathematical Autobiography that has been reprinted from an early edition of the Bulletin of the AMS and “Solomon Lefschetz, a biography” by William Hodge that is reprinted from the Bulletin of the London Mathematical Society.

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THE LEFSCHETZ CENTENNIAL CONFERENCE, Part II:
Proceedings on Algebraic Topology
Samuel Gitler, Editor
(Contemporary Mathematics, Volume 58.2 (Part II))

This book is the second in a three volume series of proceedings of the Solomon Lefschetz Centennial Conference, held in 1984 in Mexico City to celebrate Lefschetz’s 100th birthday. The conference focused on the three main areas of Lefschetz’s research: algebraic geometry, algebraic topology, and differential equations. Part II contains papers in the fields of algebraic and differential topology. Some of the topics covered are: fixed points and the Segal conjecture, continuous cohomology, immersion of manifolds, vector fields on manifolds, BP-obstruction theory, K-theory, homotopy groups of spheres, diffeomorphism groups of surfaces, normed bilinear maps, surgery theory, cohomology of BO, and the Atiyah-Hirzebruch spectral sequence.

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THE LEFSCHETZ CENTENNIAL CONFERENCE, Part III: Proceedings on Differential Equations
A. Verjovsky, Editor
(Contemporary Mathematics, Volume 58.3 (Part III))

This book is the third in a three volume series of proceedings of the Solomon Lefschetz Centennial Conference, held in 1984 in Mexico City to celebrate Lefschetz’s 100th birthday. The conference focused on the three main areas of Lefschetz’s research: algebraic geometry, algebraic topology, and differential equations. The present volume contains papers presented in differential equations and dynamical systems. Some of the topics covered are dynamical systems and bifurcation, complex differential equations, homology applied to dynamics, and harmonic maps. Aimed at graduate students and researchers in dynamical systems and geometric dynamics, the book requires a knowledge of differential equations, differential topology, complex manifolds, and algebraic topology.

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Gary M. Seitz
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Topics in Complex Analysis

Dorothy Brown Shaffer, Editor

The unifying theme of the lectures, presented at the AMS meeting in October, 1983, at Fairfield University was Geometric Function Theory. Some of the papers concern: the class $\Sigma$, its support points and extremal configuration; support points for the class $S$; Loewner chains and the process of truncation; estimates on the radial growth of the derivative of univalent functions; and a conjecture of Bombieri proved for some cases. Because the proof of the Bieberbach conjecture was not known at the time of preparation of the papers, many of the authors, as well as experts in the field, were interviewed regarding the effect of the proof of the conjecture. Their ideas regarding future trends in research in complex analysis are presented in the epilogue. A graduate level course in complex analysis provides a sufficient background for understanding this material.
Recent Appointments

<table>
<thead>
<tr>
<th>Committee members’ terms of office on standing committees expire on December 31 of the year given in parentheses following their names, unless otherwise specified.</th>
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Irwin Kra (1990) has been elected to the Executive Committee of the Council by the Council members. The other members are Hyman Bass (1987), Irving Kaplansky (ex officio), G. D. Mostow (ex officio), chairman, Everett Pitcher (ex officio), Jean E. Taylor (1988), and William A. Veech (1989).

The Committee on Employment and Educational Policy is now a joint committee; the AMS-MAA Committee on Employment and Educational Policy. Edward A. Connors (AMS, 1988) has been appointed chairman. Other members of the committee are Morton Brown (MAA, 1989), Stefan Burr (AMS, 1989), Philip C. Curtis, Jr., (MAA, 1987), David J. Lutzer (MAA, 1989), Donald C. Rung (AMS, 1987), and Audrey A. Terras (AMS, 1988).

Report from the Committee on Human Rights of Mathematicians

Berkeley Mathematician Imprisoned in Turkey

The headline is strange, but accurate. The mathematician in question is Hüseyin Ali Nesin, or simply Ali Nesin, a Ph.D. in logic from Yale, who was appointed to the University of California at Berkeley Mathematics Department in 1985. His father, Aziz Nesin, is a writer well-known for his unembarrassed, courteous, and rather belated enthusiasm for the story is as strange as the headline.

Ali Nesin returned from the United States to Turkey in 1986 to perform a routine four-month stint of military service. In May, more than half-way through this tour of duty, he was arrested on charges of breach of discipline, along with his friend Sevan Bedros Nisanyan (an ethnic Armenian). The charge, originally minor, was successively escalated, possibly out of pique with Aziz Nesin for writing to the General of the Turkish Army to denounce the first proceedings as unfair. Soon the case had become serious: a trial in military court on charges of "inciting the Turkish Army to rebelliousness." The prosecutor demanded at least five years sentence and did not set an upper limit.

Within two months of Nesin’s arrest, word of his danger had spread among mathematicians in other countries. Inquiries were sent to the Turkish government by the American Mathematical Society’s Committee on Human Rights of Mathematicians, and by numerous other scientific and human rights organizations. Personal and professional friends wrote on his behalf, in particular, a group who had been his colleagues in the Yale logic seminar and a group of twenty-one professors at the University of California, Berkeley.

Meanwhile, the case came to trial. There was some sparring (replacement of a hostile judge; an acquittal nullified by replacement of that judge). Then followed the trial proper, with an outcome that could hardly have satisfied either prosecutor or accused. Nesin and Nisanyan were found guilty and sentenced to five months; in view of the time already spent in prison awaiting trial, they were excused from further imprisonment and were also excused from the rest of their term of military service. One supposes that such a ruling, for an offense normally requiring a much stiffer sentence, may represent an attempt to minimize embarrassment.

The case might have ended there. Ali Nesin might have asked for the renewal of his passport so he could take up his teaching at Berkeley, and he probably would have been allowed to go. Instead, he elected to appeal his conviction. His decision, he explains, was partly because a record of conviction for a major offense could greatly prejudice his future career in Turkey, partly because he hates to let people get away with arbitrary persecution in this way. "I want to prove that there is an independent justice system in Turkey. I will also ask for reparations." During the appeal process, the military is refusing to give him release documents which are prerequisite for applying for a passport. He remains in Turkey unwillingly.

The many people who had addressed the Turkish government in the matter received an unembarrassed, courteous, and rather belated (20 October) reply. It states that if his conviction is sustained on appeal, he will be called back for another 2.5 months of military service, and will then be allowed to go abroad; while if his conviction is overturned on appeal, he will be allowed to go abroad at once. "I am confident that you share my conviction of the rule of law in democratic countries."

Mathematicians wishing to help Dr. Nesin may write to the Prime Minister, Basbakan Turgut Özal, Basbakanlik, Anakara, Turkey, reminding him of the circumstances and asking if he could not arrange for a temporary passport to be issued to Nesin to allow him to resume his normal scientific life at Berkeley.

Chandler Davis
Ofﬁcers of the Society, 1986 and 1987

Except for the Members-at-Large of the Council, the month and year of the ﬁrst term and the end of the present term are given. For Members-at-Large of the Council, the last year of the present term is listed.

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**As a result of his election to the Executive Committee, he will be a Member-at-Large in 1989 and 1990.

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The Mathematical Reviews Editorial Committee invites applications and recommendations for two-year appointments as Associate Editor of MR, to commence as soon as possible, but no later than the summer of 1987. Applications will be welcomed from persons taking leave from other positions, and in particular from tenured faculty members who could take leave to come to MR for two years.

The MR office is located in Ann Arbor, Michigan, adjacent to the campus of the University of Michigan, and the editors enjoy many faculty privileges at the university. At present, MR employs eleven editors, about a dozen consultants, and over fifty noneditorial personnel. It produces Mathematical Reviews and Current Mathematical Publications and various indexes, as well as the online service MathSci. The responsibilities of Associate Editors fall primarily in the day-to-day operations of classifying articles and books, assigning these items to reviewers, and editing the reviews when they are returned. Other responsibilities evolve in accordance with the individual’s experience and capabilities. At this time, no particular area of mathematical specialization is sought, although strength in applied areas is desirable. Considerable breadth in mathematics, rather than special skill, is sought. A reading knowledge of two main foreign languages is important, but not essential. (Russian and Chinese are especially desirable.)

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Applications (including curriculum vitae, bibliography, data on experience, and names and addresses of three references) and recommendations should be sent to Dr. R. G. Bartle, Executive Editor, Mathematical Reviews, P. O. Box 8604, Ann Arbor, MI 48107. Telephone 313-996-5250. Those interested in applying for this position are urged to inquire immediately.

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The Department has major research efforts in scientific computing with emphasis on numerical linear algebra, the solution of PDEs, and VLSI simulation; computer systems with emphasis on computer architectures, modeling of fault-tolerant systems, systems performance, and communications; artificial intelligence, particularly in the areas of natural language interface, search methodologies, and expert systems; and theory and algorithms with emphasis on combinatorial and graph-theoretic studies. Special motivation for the research efforts comes from the areas of medical applications (in collaboration with the Duke Medical Center), and VLSI (in collaboration with the Microelectronics Center of North Carolina, of which Duke is a Participating Institution).

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DEPARTMENT OF MATHEMATICS

Applications are invited for the position of Associate Professor or Professor of Mathematics to begin September 1, 1987. The department is especially interested in establishing a group in Numerical P.D.E./Scientific Computation over the next five years. Other areas which will enhance our proposed Ph.D. in Applied Mathematics will be seriously considered. Demonstrated leadership in research is expected of applicants. Send as soon as possible a curriculum vitae, list of publications, a few selected reprints, and the names of three references to Search Committee, Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294. UAB is an Affirmative Action/Equal Opportunity Employer.

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The Department of Mathematical Sciences seeks applications for a tenure-track opening in Operations Research for Fall 1987. Applications at all levels and in all areas of Operations Research will be considered, however preference will be given to junior applicants with interests in the combinatorial aspects of optimization. Candidates are sought with demonstrated potential in both teaching and research. Applications should be submitted to Professor John E. Dennis, Jr., Department of Mathematical Sciences, P. O. Box 1992, Rice University, Houston, Texas 77251. Application materials should include a statement of research interests and the names of at least three individuals to serve as references.

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Subject to budgetary approval, the Department of Mathematics and Statistics at University of California is seeking to fill two tenure track Assistant Professorships in September 1987 and a further two in September 1988. Candidates should have a Ph.D. and a solid record of achievement in research.

The application should be sent to:
Professor Bun Wong, Chair
Department of Mathematics and Statistics
University of California
Riverside, CA 92521

Applications are invited for a tenure-track or tenure position in Mathematics beginning Fall 1987. Candidates must have demonstrated excellence in research and teaching. Research areas of particular interest to our department are Algebraic Geometry, Mathematical Physics, Lie Theory, and applied areas of Analysis. Applicants should send a curriculum vitae and see that at least three letters of recommendation are sent to:
Professor Bun Wong, Chair
Mathematics Search Committee
Department of Mathematics and Computer Science
University of California
Riverside, CA 92521

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Department of Mathematics and Statistics
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Department of Mathematics
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Applications are invited for one tenure-track position in Approximation Theory and closely related areas at the Assistant Professor level starting July 1, 1987. Requirements are a Ph.D. and proven ability or demonstrated potential for research and teaching. Current salary range is from $31,612 (Canadian) per annum depending upon qualifications. Send vitae and arrange for three letters of reference to be sent to: Professor H. I. Freedman, Acting Chairman, Department of Mathematics, University of Alberta, Edmonton, Canada, T6G 2G1. The University of Alberta is an equal opportunity employer, but in accordance with Canadian Immigration requirements, priority will be given to Canadian citizens and permanent residents. Closing date for applications is June 1, 1987. Please refer to File AMD10 when responding to this advertisement.
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Applications and nominations are invited for the position of Chair of the Department of Mathematics and Statistics. Applicants should have a doctorate in Mathematics or Statistics, a record of successful teaching and research in Mathematics or Statistics, strong leadership and communication skills, and a commitment to promoting research, teaching, and other creative activities.

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Kyoshi Itô is a co-winner of the 1987 Wolf Prize in mathematics and professor emeritus of mathematics at Kyoto University.

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H. Blaine Lawson

(CBMS Regional Conference Series. Number 58 Supported by the National Science Foundation)

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ST = Statistics TO = Topology

B Career Objectives

AR = Academic Research AT = Academic Teaching
NR = Nonacademic R&D NC = Nonac. Consulting
NS = Nonacademic Supervision

H Duties

T = Teaching U = Undergraduate
G = Graduate R = Research
C = Consulting A = Administration
S = Supervision IND = Industry
GOV = Government DP = Data Processing

Location

E = East S = South
C = Central M = Mountain
W = West O = Outside U.S.
I = Indifferent

L U.S. Citizenship Status

C = U.S. Citizen P = Permanent Resident
T = Temporarily in U.S. N = Non-U.S. Citizen

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**Summer List of Applicants**

Mathematical Sciences Employment Register  
August 1987  
Salt Lake City, Utah

(Please see instructions on facing page)

---

**APPLICANT:** Name: ____________________________________________  
Mailing address (include zip code) ____________________________________________  

A Specialties:  

B Career objectives and accomplishments  

ACADEMIC:   □ Research, □ Teaching  
NON-ACADEMIC: □ Research and Development, □ Consulting, □ Supervision  
Near-term career goals: ____________________________________________________  
Significant achievements or projects, including role: ________________________________  
Honors and offices: ___________________________________________________________  
Other (e.g., paper to be presented at THIS meeting): _______________________________  
Selected titles of papers, reports, books, patents: __________________________________  

C Degree  

Year  

Institution  

D No. of abstracts, internal reports  

No. of papers accepted  

No. of books and patents  

EMPLOYMENT HISTORY:  

Present  

Previous  

Previous  

G Employer: ______________________________________________________________  
Position: ________________________________________________________________  
Duties: ________________________________________________________________  
Years: ______________________ to ______________________  

H Duties: ________________________________________________________________  
Years: ______________________ to ______________________  

I Desired position: ________________________________________________________  
Duties: ________________________________________________________________  
Available mo./yr.: ______________________  
Location: ________________________________________________________________  
Salary: _________________________________________________________________  

K Reference(s): (Name and Institution)  

L Citizenship: _____________________________________________________________  

M I plan to attend the Summer Meeting: yes □ no □

---

**SUMMARY STRIP**

<table>
<thead>
<tr>
<th>Family Name</th>
<th>First Name</th>
<th>Mailing Address</th>
<th>Address (cont'd.)</th>
<th>Address (cont'd.)</th>
<th>State &amp; Zip Code</th>
<th>Specialties</th>
<th>Specialties</th>
<th>Career objectives</th>
<th>Highest Degree</th>
<th>Yr.</th>
<th>Institution</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
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<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>No. of recent employer</th>
<th>Present duties</th>
<th>Desired duties</th>
<th>Available mo./yr.</th>
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</table>
MAA MINICOURSE PREREGISTRATION FORM, Salt Lake City, Utah
August 5-8, 1987

Please complete this form and return it WITH YOUR PAYMENT to:

John Gilliland
Mathematical Association of America
1529 Eighteenth Street, N.W.
Washington, DC 20036
Telephone: 202-387-5200

(Please print) Surname First Middle

Street address City State Zip

IMPORTANT NOTES:
1. Deadline for Minicourse preregistration: June 1, 1987
2. Deadline for 50% refund: July 31, 1987
3. Registration for the Joint Meetings is a requirement in order to participate in the Minicourses.
   Complete the Preregistration/Housing form included in the meeting announcement and return it to Providence with the applicable Joint Meetings preregistration fee. DO NOT SEND MINICOURSE FORM OR FEES TO PROVIDENCE.
4. Each participant must fill out a separate Minicourse form.
5. Enrollment is limited to two Minicourses, subject to availability.
6. Please complete the following and send both form and payment to John Gilliland at the above address:

   a. I would like to attend ( ) 1 Minicourse
      ( ) 2 Minicourses
   b. Please enroll me in MAA Minicourse(s): #___ and #____
   c. In order of preference, my alternatives are: #___ and #____

7. PAYMENT:
   a. Check enclosed: $____________
   b. Credit card type: ( ) MasterCard ( ) VISA
      Credit card number ___________________________ Expiration date

Employing institution ___________________________ Signature (as it appears on credit card)

Number Minicourse Organizer Fee
1. Applied mathematics via classroom experiments Herbert R. Bailey $30
2. Using computer spreadsheet programs in calculus, differential equations, and combinatorics Donald R. Snow $40
   Howard Anton $40
   David P. Kraines $40
   Vivian Kraines $40
3. A microcomputer linear algebra course using Linear-Kit Joan P. Wyzkoski $40
   Harley Flanders $40
   Solomon A. Garfunkel $30
4. A survey of educational software
5. Introduction to computer graphics
6. A calculus lab course using MicroCalc
7. For all practical purposes

( ) I plan on preregistering for the Joint Meetings only in order to attend the MAA Minicourse(s) indicated above. It is my understanding that, should the course(s) of my choice be filled, full refund of the Joint Meetings preregistration fee will be made.

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PREREGISTRATION AND HOUSING FORM, SALT LAKE CITY, UTAH
August 5-8, 1987

MUST BE RECEIVED IN PROVIDENCE NO LATER THAN JUNE 1987
Please complete this form and return it with your payment to Mathematics Meetings Housing Bureau

P. O. Box 6887, Providence, Rhode Island 02940 - Telephone 401-272-9500, Ext. 290 Telex: 797192

DEADLINES:
- Preregistration: June 1
- Residence Hall Room Payments: June 1
- 50% Refund on Preregistration: August 4*
- 90% Refund on Residence Hall Room: August 4
- 50% Refund on MAA Banquet: July 31*
- 50% Refund on Snowbird Outing: August 5*

* No refunds after this date.

REGISTRATION FEES
- Pre-registration (by mail prior to 6/1): $59
- At Meeting: $77
- Residence Hall Room: $16
- MAA Banquet: $90
- Snowbird Outing: $117

* All full-time students currently working toward a degree or diploma qualify for the student registration fees, regardless of income. The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is not intended to include persons who have voluntarily resigned from their latest position. The emeritus status refers to any person who has been a member of the AMS or MAA for twenty years or more and is retired on account of age from his or her latest position.

1) Nickname for badge: ____________________________
   (Please print) Surname ___________________ First ________ Middle ________

2) ADDRESS: Number and street ___________________ City __________ State __________ Zipcode __________
   Address for confirmation of room reservation, if other than above __________________________

3) Employing institution __________________________ Emeritus member ( ) Unemployed ( )

4) I am a student at _____________________________ 6) Name of spouse __________ 7) Number of children ________
   (List only if accompanying to the meeting)

5) Member of AMS ( ) MAA ( ) IIME ( ) Nonmember ( ) (Member discount applies only to members of
   AMS, MAA, or IIME.) Members of other organizations: AWM ( ) NAM ( )

PAYMENT(S) ENCLOSED:
9) Joint Meetings fee $ _______ 10) MAA 25-year Banquet ticket(s) _______ @ $17.00
11) Snowbird Outing:
   a. Adult ticket(s) _______ @ $15.00 _______ ( ) Indicate if vegetarian meal is required
   b. Children's ticket(s) _______ @ $9.00 _______ ( ) Indicate if vegetarian meal is required

12) FULL PAYMENT for residence hall accommodations enclosed $ _______

13) TOTAL AMOUNT ENCLOSED FOR 9 through 12 $ _______ (Make checks payable to AMS; Canadian checks must be marked "In U.S. Funds"). VISA or MasterCard credit cards may also be used for payment.

VISA ( ) MasterCard ( ) Card Number ___________________ Exp. date ________

Signature (name as it appears on credit card) ____________________________

( ) PLEASE CHECK HERE IF YOU WILL NOT REQUIRE A ROOM
( ) PLEASE CHECK HERE IF YOU WILL BE USING A CAR AND WILL REQUIRE A PARKING STICKER
( ) PLEASE CHECK HERE IF YOU WILL REQUIRE DAYCARE FACILITIES WHILE IN SALT LAKE CITY
( ) PLEASE CHECK HERE IF YOU WILL BE RIDING THE BUS TO SNOWBIRD

Please be sure to complete the section on next page if you will require housing.

For office use only:

<table>
<thead>
<tr>
<th>Codes:</th>
<th>Options:</th>
<th>Dates:</th>
<th>Residence Hall:</th>
<th>Room Type</th>
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</thead>
<tbody>
<tr>
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<td>Special:</td>
<td>Amount pd:</td>
<td>CC ( )</td>
<td>Check ( )</td>
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</tbody>
</table>

593
UNIVERSITY HOUSING SECTION: (Please complete Sections I through IV below.)

NOTE: Full prepayment for room and board is required as noted in Item 12 on the reverse. Please make checks payable to AMS. Canadian checks must be marked "In U.S. Funds". VISA and MasterCard credit cards will also be accepted.

I. Please reserve the following residence hall accommodations and send confirmation to me at address below:

<table>
<thead>
<tr>
<th>Residence Hall (a/c)</th>
<th>SINGLE ROOM</th>
<th>DOUBLE ROOM</th>
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</thead>
<tbody>
<tr>
<td>Austin Hall (a/c)</td>
<td>$13.00</td>
<td>$19.00</td>
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<tr>
<td>Ballif Hall (no a/c)</td>
<td>$12.00</td>
<td>$17.00</td>
</tr>
<tr>
<td>Van Cott Hall (no a/c)</td>
<td>$12.00</td>
<td>$17.00</td>
</tr>
</tbody>
</table>

Number of nights _____

II. I will arrive on __________ at _______ a.m./p.m. and depart on __________ at _______ a.m./p.m.

I will share a double room with __________________________ who will arrive on __________

at _______ a.m./p.m. and depart on __________ at _______ a.m./p.m.

Children (5 yrs. and younger using sleeping bag - same rm. as parents) _____ days @ $5.00 per day = $

(Children 6 yrs. and older pay adult rate.)

III. ADDRESS FOR CONFIRMATION OF ROOM RESERVATION:

__________________________________________

Telephone number: ________________________
(area code)

IV. TRAVEL INFORMATION:

( ) I plan to arrive by plane on ___________________ scheduled to arrive at ___________________

airport on ___________________ at _______ a.m./p.m.

( ) I plan to drive to the meeting.

Note: This additional information is being requested in order to assist the university's housing office in planning for heavy arrival times.
Order Form

American Mathematical Society
P.O. Box 6248
Providence, Rhode Island 02940
(401) 272-9500

Ordered by ________________________________

Mail to (if different) ________________________________

Use your peel-off Notice label.

<table>
<thead>
<tr>
<th>QTY</th>
<th>CODE</th>
<th>AUTHOR and TITLE</th>
<th>PRICE</th>
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Shipping and Handling

☐ Surface ☐ Air

Total due (All orders must be prepaid) $____

☐ Check Method of Payment

☐ Check or Money Order ☐ VISA ☐ MasterCard

Card Number ________________________________

Card Expiration Date __________ Signature ____________________________

Shipping and Handling

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<th>First Book</th>
<th>Each Additional</th>
<th>Maximum</th>
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<tr>
<td>Surface</td>
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<td>$1</td>
</tr>
<tr>
<td>Air</td>
<td>$5</td>
<td>$3</td>
</tr>
</tbody>
</table>

NOT1

Prices are subject to change without notice.

Books are sent via surface mail (UPS to U.S. addresses and printed matter elsewhere) unless air delivery is requested. The shipping and handling charges for book orders are shown at the right. Journal back numbers, Mathematical Reviews indexes and review volumes are sent via surface mail to any destination unless air delivery is requested. Postage for surface mail is paid by the AMS. Air delivery rates, which will be quoted upon request, must be paid by the purchaser. Software: Nonindividual customers need not prepay provided a Purchase Order number is given with the order. Software/Books are sent via UPS to U.S. addresses, first class mail to Canada, and air delivery elsewhere. Add shipping and handling for Software/Books: $6 per order in the U.S. and Canada; $25 per order air delivery outside the U.S. and Canada.
AMERICAN MATHEMATICAL SOCIETY

Please read the reverse side of this form to determine what membership category you are eligible for. Then fill out this application and return it as soon as possible. Your name will be added to our mailing lists upon our receipt of your completed application, and payment for member dues. Subscriptions to the Notices and the Bulletin (New Series) are included as part of your membership.

Family Name    First    Middle

Please indicate below the way your name should appear in the Combined Membership List.

Family Name    First    Middle or Initial

Place of Birth
City    State    Zip/Country

Date of Birth
Day    Month    Year

If formerly a member of AMS, please indicate dates

Check here if you are now a member of either MAA or SIAM

Degrees, with institutions and dates

Present position

Firm or institution

City    State    Zip/Country

Fields of Interest (choose five from the list at right)

Address for all mail

Signature

Prepayment Methods and Mailing Addresses

Send checks, money orders, UNESCO coupons to American Mathematical Society, P.O. Box 1571, Annex Station, Providence, R.I. 02901-1571.

To use VISA or MasterCard, fill in information requested and mail to American Mathematical Society, P.O. Box 5248, Providence, R.I. 02940.

For Foreign Bank Transfers: The name and address of the AMS bank is Rhode Island Hospital Trust National Bank, Account #000-753-111, One Hospital Trust Plaza, Providence, R.I. 02903, U.S.A.

VISA ☐ MasterCard ☐ Account number    Expiration date

Application for Membership 1987

Date...

Fields of interest

If you wish to be on the mailing lists to receive information about publications in fields of mathematics in which you have an interest, please consult the list of major headings of the 1980 Mathematics Subject Classification below. Select no more than five category numbers and fill in the numbers where indicated on the left. These categories will be added to your computer record so that you will be informed of new publications or special sales in the fields you have indicated.

00 General
01 History and biography
02 Mathematical logic and foundations
04 Set theory
05 Combinatorics
06 Order, lattices, ordered algebraic structures
08 General mathematical systems
11 Number theory
12 Field theory and polynomials
13 Commutative rings and algebras
14 Algebraic geometry
15 Linear and multilinear algebra; matrix theory
16 Associative rings and algebras
17 Nonassociative rings and algebras
18 Category theory, homological algebra
19 K-theory
20 Group theory and generalizations
22 Topological groups; Lie groups
26 Real functions
28 Measure and integration
30 Functions of a complex variable
31 Potential theory
32 Several complex variables and analytic spaces
33 Special functions
34 Ordinary differential equations
35 Partial differential equations
39 Finite differences and functional equations
40 Sequences, series, summability
41 Approximations and expansions
42 Fourier analysis
43 Abstract harmonic analysis
44 Integral transforms, operational calculus
45 Integral equations
46 Functional analysis
47 Operator theory
49 Calculus of variations and optimal control; optimization
51 Geometry
52 Convex sets and related geometric topics
53 Differential geometry
54 General topology
55 Algebraic topology
57 Manifolds and cell complexes
58 Global analysis, analysis on manifolds
60 Probability theory and stochastic processes
62 Statistics
65 Numerical analysis
68 Computer science
70 Mechanics of particles and systems
73 Mechanics of solids
76 Fluid mechanics
78 Optics, electromagnetic theory
80 Classical thermodynamics, heat transfer
81 Quantum mechanics
82 Statistical mechanics, structure of matter
83 Relativity
85 Astronomy and astrophysics
86 Geophysics
90 Economics, operations research, programming, games
92 Biology and behavioral sciences
93 Systems theory; control
94 Information and communication, circuits

M7N0
Membership Categories

Please read the following to determine what membership category you are eligible for, and then indicate below the category for which you are applying.

For ordinary members whose annual professional income is below $26,000, the dues are $64; for those whose annual professional income is $26,000 or more, the dues are $84.

For a joint family membership, one pays ordinary dues, based on his or her income, and the other pays ordinary dues based on his or her income, less $20. (Only the member paying full dues will receive the Notices and the Bulletin as a privilege of membership, but both members will be accorded all other privileges of membership.) Minimum dues for contributing members are $126.

For either students or unemployed individuals, dues are $21, and annual verification is required.

The annual dues for reciprocity members who reside outside the U.S. and Canada are $42. To be eligible for this classification, members must belong to one of those foreign societies with which the AMS has established a reciprocity agreement, and annual verification is required. Reciprocity members who reside in the U.S. or Canada must pay ordinary member dues ($64 or $84).

The annual dues for external members, those who reside in developing countries which do not have any mathematical society, are $45.

Members can purchase a multi-year membership by prepaying their current dues rate for either two, three, four or five years. This option is not available to either unemployed or student members.

1987 Dues Schedule

For any category of membership where two dues prices are given, the higher one is to be paid by persons whose annual professional income is $26,000 or more.

Ordinary member ...................................................... $64 $84
Joint family member (full rate) .............................. $64 $84
Joint family member (reduced rate) ....................... $44 $64
Contributing member (minimum $126) ..................
Student member (please verify)¹ ................................ $21
Unemployed member (please verify)² ....................... $21
Reciprocity member (please verify)³ .................... $42 $64 $84
External member ...................................................... $45
Multi-year membership ........................................ $ for years

1 Student Verification (sign below)

I am a full-time student at ......................................................................................................................
Current major(s) .................................................................................................................................
currently working toward a degree.

2 Unemployed Verification (sign below) I am currently unemployed and actively seeking employment. My unemployment status is not a result of voluntary resignation or of retirement from my last position.

3 Reciprocity Membership Verification (sign below) I am currently a member of the society indicated on the right and am therefore eligible for reciprocity membership.

Reciprocating Societies

Altaahabad Mathematical Society
Asociacion Matematica Espanola
Australian Mathematical Society
Berliner Mathematische Gesellschaft e.V.
Calcutta Mathematical Society
Danske Matematisk Forening
Deutsche Mathematiker-Vereinigung e.V.
Edinburgh Mathematical Society
Gesellschaft fur Angewandte Mathematik und Mechanik
Glasgow Mathematical Association
Indian Mathematical Society
Iranian Mathematical Society
Islenzka Staerdrafafelagid
Israel Mathematical Union
Korean Mathematical Society
London Mathematical Society
Malaysian Mathematical Society
Mathematical Society of Japan
Mathematical Society of the Philippines
Mathematical Society of the Republic of China
New Zealand Mathematical Society
Nigerian Mathematical Society
Norsk Matematisk Forening
Osterreichische Mathematische Gesellschaft
Polskie Towarzystwo Matematyczne
Punjab Mathematical Society
Real Sociedad Matematica Espanola
Sociedad Colombiana de Matematica
Sociedad de Matematica de Chile
Sociedad Matematica de la Republica Dominicana
Sociedad Matematica Mexicana
Sociedade Brasileira de Matematica
Sociedade Brasileira de Matematica Aplicada e Computacional
Sociedade Paranaense de Matematica
Sociedade Portuguesa de Matematica
Societat Catalana de Ciencies Fisiques, Quiriques i Matematiques
Societe de Mathematiques Appliquees et Industrielles
Societe Mathematique de Belgique
Societe Mathematique de France
Societe Mathematique Suisse
Southeast Asian Mathematical Society
Suomen Matemaattinen Yhdistys
Svenska Matematikersamfundet
Union Matematica Argentina
Unione Matematica Italiana
Vijnana Parishad of India
Wiskundig Genootschap

Signature
Change of Address

Members of the Society who move or who change positions are urged to notify the Providence Office as soon as possible.

Journal mailing lists must be printed four to six weeks before the issue date. Therefore, in order to avoid disruption of service, members are requested to provide the required notice well in advance.

Besides mailing addresses for members, the Society's records contain information about members' positions and their employers (for publication in the Combined Membership List). In addition, the AMS maintains records of members' honors, awards, and information on Society service. Information of the latter kind appears regularly in Notices.

When changing their addresses, members are urged to cooperate by supplying the information requested below. The Society's records are of value only to the extent that they are current and accurate.

If your address has changed, or will change within the next two or three months, please place the peel-off label from the back cover (which contains your name, member code, and address) in the rectangle provided below (or on a copy of this page), supply any other information appropriate for the AMS records, and mail to the address given below.

Place Notices label here

Change effective as of: ________________________________

New mailing address: ______________________________________
________________________________________________________________________
________________________________________________________________________

New position: ____________________________________________

If mailing address is not that of your employer, please supply the following information:

New employer: __________________________________________

Location of employer: _____________________________________
City State/Province Country Zip Code

Recent honors and awards: ___________________________________
________________________________________________________________________
________________________________________________________________________

Personal items for publication in Notices: ______________________
________________________________________________________________________
________________________________________________________________________

Mail completed form to:
Membership Department, AMS, P.O. Box 6248, Providence, RI 02940

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Near-Rings and Near-Fields
Proceedings of a Conference, Tübingen, F.R.G.,
August 1985
Edited by G. Betsch
North-Holland Mathematics Studies, 137
Most topics of current interest in near-ring and near-field theory are
treated here, along with an extensive introduction to the
present state of the theory. There are two invited lectures: "Non-
Commutative Geometry, Near-Rings and Near-Fields" which
indicates the relevance of near-rings and near-fields for geometry,
while "Pseudo-Finite Near-Fields" shows the impressive power of
model theoretic methods. The remaining papers cover such topics as
D.G. near-rings, radical theory, KT-near-fields, matrix near-rings,
and applications to systems theory.
1987 xvi + 298 pages Price: US $62.25/Dfl. 140.00

Patterns and Waves
Qualitative Analysis of Nonlinear Differential Equations
Edited by T. Nishida, M. Mimura and H. Fujii
Studies in Mathematics and its Applications, 18
Part I of this volume surveys the developments in the analysis of
nonlinear phenomena in Japan during the past decade, while Part
II consists of up-to-date original papers concerning qualitative
theories and their applications. Dealt with are nonlinear
problems related to general analysis, fluid dynamics, mathematical
biology and computer sciences, and their underlying mathematical
structures, e.g. nonlinear waves and propagations, bifurcation
phenomena, chaotic phenomena, and fractals. The volume is
dedicated to Professor Masaya Yamaguti in celebration of his 60th
birthday.
1987 xii + 692 pages Price: US $166.75/Dfl. 375.00
ISBN 0-444-70144-3
In Japan: Kinokuniya Co. Ltd., Tokyo

Obstacle Problems in Mathematical Physics
By J.-F. Rodrigues
North-Holland Mathematics Studies, 134
The aim of this research monograph is to present a general
account of the applicability of elliptic variational inequalities to the
important class of free boundary problems of obstacle type from a
unifying point of view of classical Mathematical Physics. The first
part of the volume introduces some obstacle type problems which
can be reduced to variational inequalities. Part II presents the
main aspects of the theory of elliptic variational inequalities, from
the abstract hilbertian framework to the smoothness of the
variational solution, discussing in general the properties of the free
boundary and including some results on the obstacle Plateau
problem. The last part examines the application to free boundary
problems.
1987 xvi + 352 pages Price: US $71.00/Dfl. 160.00
ISBN 0-444-70187-7

The Jacobson Radical of Group Algebras
By G. Karpilovsky
North-Holland Mathematics Studies, 135
Let G be a finite group and let F be a field. It is well known that
linear representations of G over F can be interpreted as modules
over the group algebra FG. Thus the investigation of ring-theoretic
structure of the Jacobson radical (JFG) of FG is of fundamental
importance. During the last two decades the subject has been
pursued by a number of researchers and many interesting results
have been obtained. This volume examines these results. The
main body of the theory is presented, giving the central ideas, the
basic results and the fundamental methods.
1987 x + 532 pages Price: US $86.75/Dfl. 195.00
ISBN 0-444-70190-7

Proof Theory
Second Revised Edition
By G. Takeuti
Studies in Logic and the Foundations of Mathematics, 81
This book is unique in treating both the technical and
philosophical aspects of proof theory. The development is in the
Hilbert-Gentzen tradition. Also included is a discussion of the
applications of proof theory, i.e. combinatorial independence
problems on arithmetic from the proof theoretic angle, and a
discussion of the proof theory of new logics such as determinate
logic, infinitary logic, and Henkin quantifiers.
1987 viii + 496 pages Price: US $111.00/Dfl. 250.00
ISBN 0-444-87943-9

Theory of Linear Operations
By S. Banach†
North-Holland Mathematical Library, 38
Translation of Théorie des Opérations Linéaires (PWN, Warsaw,
1932). Translated by F. Jellett
Includes "Comments" by A. Pelczynski and Cz. Bessaga
This classic work by the late Stefan Banach has been translated
into English so as to reach a yet wider audience. It contains the
basics of the algebra of operators, concentrating on the study of
linear operators, which corresponds to that of the linear forms
a1x1 + a2x2 + ... + anxn of algebra. A new fifty-page section
("Some Aspects of the Present Theory of Banach Spaces")
complements this important monograph.
1987 x + 238 pages Price: US $75.50/Dfl. 170.00

North-Holland

US $ prices are valid only in the USA and Canada. In all other countries the Dutch Guilder price is definitive.
Customers in the Netherlands, please add €6.6% B.T.W. In New York State applicable sales tax should be added.
All prices are subject to change without prior notice.
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J. Grasman
This is the first book to survey the literature covering the topic's historical developments. In addition, relaxation oscillations are analyzed using the tools of modern dynamical system theory. Subjects explored by the contributors include: the method of matched asymptotic expansions, conditions for entrainment, phase wave solutions, the dynamics of free and forced oscillations, and the influence of stochastic perturbations upon the period of oscillation. The book is intended for graduate students and researchers interested in the modeling of periodic phenomena in physics and biology.

1987/App. 181 pp./Paper $28.00 (tent.)
ISBN 0-387-96513-0
Applied Mathematical Sciences, Vol. 63

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