Association for Women in Mathematics

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PRESIDENT'S REPORT

<u>Changing of the Guard</u>. As of January 1987, Rhonda Hughes, Professor of Mathematics at Bryn Mawr College, becomes president of AWM. It is a pleasure to leave this office to her very capable hands. Rhonda has long been an active member of the AWM. She was one of the main organizers of the Emmy Noether Symposium held at Bryn Mawr in the spring of 1982; she has served as a member-at-large of the executive committee. Welcome, Rhonda!

<u>San Antonio Meeting</u>. AWM has its usual collection of events in conjunction with the joint meetings of the American Mathematical Society and the Mathematical Association of America on January 21-24, 1987 in San Antonio, Texas. Rhonda Hughes has organized a panel discussion on *Responses to the David Report: Initiatives for Women and Minorities*. It will be moderated by Lida Barrett, and the speakers are Fern Hunt, John Polking, Louise Rafael and Barry Simon. It will be held Wednesday, January 21 at 3:20 p.m. The business meeting will follow at 4:20 p.m. The Emmy Noether Lecture will be given by Professor Joan Birman of Columbia University and Barnard College on Thursday, January 22 at 9:00 a.m. There will be a dinner in her honor that evening; the sign-up sheet for dinner will be at the AWM table. We will host a reception Wednesday evening at 9:30 p.m. The AWM table is an important place to meet, greet and find out about AWM. Please join us there and sign up to staff the table.

The plea for open discussion of funding issues for mathematics which was made in this column last year has had some effect. There will be a panel discussion on *The effect of Department of Defense funding on mathematics* on Thursday, January 22 at 7:30 p.m. It is organized by Bill Browder and Ron Douglas and sponsored by the AMS. There are also motions which will be presented to the AMS Council and the AMS business meeting on these issues. They will be printed in the January *Notices*.

<u>Where we stand statistically</u>. The November issue of the *Notices* contains the Annual Survey. One interesting figure is that the percentage of Americans receiving the Ph.D. who are women has almost doubled since 1974-5. However, the number of such women has decreased (83 down to 82). The relevant fact is that the number of Americans earning doctorates is now half of the total number of people earning doctorates in the U.S., and even the total number of doctorates is down. One conclusion is that relatively few of the foreign students are women. Another conclusion is that we still have our work cut out for us in encouraging women students to go into mathematics. In the report on salaries, starting salaries are up slightly from last year. Nine-month teaching starting salaries are comparable for men and women, but in all other categories of starting salaries, women lag behind!

<u>Last words</u>. This is my final President's Report. I would like to take the opportunity to thank all the people I've worked with over the past two years in the AWM who have lent their enthusiasm, support and energy. I'd also like to thank those people in the AMS, the MAA, the CBMS and the ICM-86 Organization I've worked with, who have given us their encouragement and support.

Linda Keen
Department of Mathematics
and Computer Science
Herbert H. Lehman College, CUNY
Bronx, New York 10468

AWARDS AND HONORS

news from the National Research Council

Ford Foundation Grants have been awarded to minority doctoral students. A new program designed to increase the number of underrepresented minorities on the nation's college and university faculties has awarded fellowships to 50 predoctoral students and 15 doctoral candidates working on dissertations. The National Research Council administers the program for the Ford Foundation.

The 65 graduate students in the arts and sciences were selected from a field of 931 finalists — far more than had been anticipated when the program was established last year. In response to the overwhelming number of qualified applicants, Ford increased the number of originally planned fellowships by 15.

Predoctoral and dissertation fellowships consist of annual stipends of $10,000 and $18,000, respectively. The predoctoral awards also include an allowance to the awardee's university in lieu of tuition and fees.

Congratulations to Laura R. Garcia for earning a Ford Foundation Grant! She is working on computer science at Texas A&M University.

Congratulations to Susan L. Addington and Barbara R. Peskin, who are 1986-1987 Science Scholars at the Mary Ingraham Bunting Institute of Radcliffe College. Addington, University of California, Santa Cruz, will study *Abelian Varieties in Automorphic Forms and Soliton Equations.* Peskin, Mount Holyoke College, in her second year as Science Scholar will pursue *Studies in the Modular Representation of Finite Groups.*

Ruth Charney, Ohio State University and Susana Salamanca Riba, Massachusetts Institute of Technology, are visitors at the School of Mathematics, Institute for Advanced Study in Princeton for 1986-87.

The Boston Sunday *Globe*, October 19, 1986, contained a very nice article "Girls' lower math scores don't tell the whole story" by Barbara Beckwith. The story was an interview with Alice Schafer, AWM co-founder and past president.

Here are a couple of excerpts:

Schafer, ... professor emeritus of Wellesley College and currently math professor at Simmons College, is convinced of one point: that boys' superior scores should not be taken as an indication that girls have less ability to do math. "Nobody has ever been able to make an exam to test native ability versus what one knows," says Schafer. "The College Board aptitude tests have never measured native ability. The test is really based on knowledge and opportunity." ...

Schafer is optimistic that women will eventually equal men in math scores. Women now make up 45 percent of undergraduate math majors, according to the association — up from 37 percent in 1970. Eighteen percent of math [Ph.D.'s] are now awarded to women, compared to 8 percent 15 years ago.

Schafer hopes women will stop avoiding math and then regretting it. "I've had women students come back in their thirties saying they want to 'bone up on their math' in order to get into law or business school," says Schafer. "I have to tell them they need to take entire courses to make up what they missed. It's sad."

MEETINGS OF INTEREST

Pat Kenschaft is moderating a session at the Joint Mathematical Meetings in San Antonio, 2:15-5:00, Saturday, January 24, 1987. The session is entitled "Retaining and Recruiting Undergraduate Women in Mathematics Courses: Aspirations and Experiences." The schedule is as follows:

"An Anecdote from the 1939 William Lowell Putnam Competition"
    Don Hill, Florida A&M University, Tallahassee, FL

"Recruiting and Retaining Math Majors in a Women's College"
    Miriam P. Cooney, Saint Mary's College, Notre Dame, IN

"Attracting and Retaining Undergraduate Women Math Majors: A Career Night Approach"
Jacqueline M. Dewar, Loyola Marymount University, Los Angeles, CA

"Support Groups and Study Groups of College Math Students"
Amy Cohen and Brenda Latka*, Rutgers University, New Brunswick, NJ

"How Hemispheric Lateralization Can Be Used to Predict and Promote Success in College Mathematics Courses"
Cynthia Miller, Spelman College, Atlanta, GA

"Non-traditional Students at a Women's College: Preparing Older Women for Mathematics"
Vivian Kraines, Meredith College, Raleigh, NC

"The Math Lab Experience — Academic Support in an Urban Community College"
Elise Carter Hartman, Tulsa Junior College, Tulsa, OK

"Preparation, Support, and Challenge: The Keys to Recruitment and Retention of Undergraduate Women in Mathematics Courses"
Barbara Li Santi, Mills College, Oakland, CA

Discussion With and Contributions From the Audience.

AAAS Symposia, Annual Meeting, Chicago, Hyatt Regency, February 14-19, 1987

Beginning at 9:00 a.m., Monday, February 16, there will be a symposium "The Participation of Women in Science Since Antiquity." It was organized by Caroline L. Herzenberg (Physicist, Energy and Environmental Systems Division, Argonne National Laboratory) and Margaret Butler (Director, National Energy Software Center, Argonne National Laboratory). The goal of this symposium is to change the perception that women were not involved in science prior to the 19th century. The agenda is as follows:

"Hypatia's Heritage: An Overview of the History of Women in Science"
Margaret Alic (author and graduate student, Dept. of Chemical and Biological Science, Oregon Graduate Center, Beaverton, OR)

"Women's Participation in Science during Antiquity and the Middle Ages"
Caroline Herzenberg

"Jewish Women in Science"
Susan V. Meschel (Science Information Specialist, Crerar Library, The University of Chicago)

"Early Russian Women Scientists"
Ann Hibner Koblitz (Assistant Professor of History, Wellesley College)

"Black Women in Mathematics"
Patricia C. Kenschaft (Associate Professor of Mathematics, Montclair State College)

"Bias in Sex Differences Research" will be held Tuesday, February 17. The main objective of this symposium is to critically survey the concepts, methods, and interpretations of sex differences research in the neurosciences, medicine, physiology, psychology, genetics, and mathematics. The agenda is as follows:

"Sex Differences in Laterality"
Marcel Kinsbourne (Director, Dept. of Behavioral Neurology, Eunice Kennedy Shriver Center, Waltham, MA)

"Sex Differences Research in the Neurosciences"
     Ruth Bleier (Professor, Neurophysiology & Women's Studies, Univ. of Wisconsin)

"Menstrual Cycle Research"
     Ann Fausto-Sterling (Professor, Medical Sciences, Division of Biology & Medicine, Brown University)

"Do Sex Related Differences in Spatial Abilities Exist?"
     Paula Caplan (Head of Center for Women's Studies in Education & Associate Professor of Applied Psychology, Ontario Institute for Studies in Education, Toronto)

"Sex Difference and Sex Equality"
     Allison Jaggar (Wilson Professor of Ethics, Dept. of Philosophy, University of Cincinnati)

"Ethical Norms in Science: Challenges and Opportunities" will be held on Tuesday beginning at 2:30 p.m. While public opinion surveys indicate that the professions continue to enjoy relatively high regard, recent challenges have precipitated attempts on the part of professional communities to discover and grapple with their ethical norms and expectations. This session will report on studies examining ethical issues in the graduate education of science and engineering students, in research, and in publication. Representatives from Sigma Xi and the AAAS Committee on Scientific Freedom and Responsibility will describe new initiatives under consideration by these organizations.

Central American Conference on Women in Science, Technology, and Medicine in Developing Countries

This conference will be held in Managua, Nicaragua, 24-28 1987 to discuss the experiences, prospects and strategies of women in science in developing countries. The focus will be on women in Central America, but participants are invited from other parts of the world, particularly North America.

The conference is sponsored by the Kovalevskaia Fund (USA), which is financing the participation of women from Central America outside Nicaragua, and by the Confederación Nacional de Profesionales (Nicaragua), which is hosting the conference. Unfortunately, neither organization can support the travel or expenses of people from outside Central America. However, inexpensive accommodations will be found in Managua for all registered participants.

Following the conference, an optional tour of Nicaragua will be provided at a reasonable extra charge. The tour will last several days, and will include visits to the university and medical school in León, laboratories, hospitals and production centers, as well as cultural and historical places of interest.

The main language of the conference will be Spanish. However, before each talk in Spanish or English an abstract will be posted in the other language. Thus, non-Spanish speakers are also encouraged to attend.

Papers should be suitable for a 20-minute presentation. A copy should be sent by June 30. All papers and abstracts will be included in the Proceedings, which will be sent to all participants. There will be a maximum of five papers presented by North Americans. If you wish to give a paper, please send your CV and a one-paragraph abstract. Also indicate whether or not your registration is contingent upon your giving a talk.

Because of limitations on facilities and the necessity of advanced planning, we ask that you register by January 15, 1987. Each participant from a developed country is asked to pay a registration fee of US$50. Write Prof. Ann Hibner Koblitz, Dept. of History, Wellesley College, Wellesley, MA 02181.

Sixth International Congress on Mathematical Education

ICME 6 will be help in Budapest, Hungary from July 23rd to August 3rd, 1988. The United States Commission on Mathematical Instruction seeks to encourage American participation in ICME 6. The presentations to be made at ICME 6 are organized into Action Groups and Theme Groups as follows:

Action Groups: Early Childhood Years (ages 4-8); Elementary School (ages 7-12); Junior Secondary School (ages 11-16); Senior Secondary School (ages 15-19); Tertiary/Post-Secondary/Academic Institutions (age 18+); Pre-Service Teacher Education; Adult, Technical and Vocational Education.

Theme Groups: The Profession of Teaching, Computers and the Teaching of Mathematics, Problem Solving, Modelling and Applications, Evaluation and Assessment, The Practice of Teaching and Research in Didactics, Mathematics and Other Subjects, Curriculum towards the Year 2000.

For more information about submitting abstracts for consideration, send your name, mailing address, affiliation, and name of the group to which you wish to make a contribution to:

Professor Eileen L. Poiani
Chairperson, USCMI
Department of Mathematics
Saint Peter's College
Jersey City, NJ 07306.

A panel presentation on ICME 6 will be held at the Joint Mathematics Meetings on Thursday, January 22 at 2:15 p.m.

IMPRESSIONS OF CHINA

by Miriam P. Cooney, CSC, Saint Mary's College, Notre Dame, IN
The author of this article visited China in July 1985. During a one-month visit to major cities, she spent several days consulting faculty at the Huazong Institute for Science and Technology in Wuhan and lectured for a week at Northeast Normal University, Changchun in Manchuria.

Faculty interviews at Huazong revealed that although half the mathematics faculty are women, they are predominantly in the lecturer rank. Of 100 associate professors, six are women. No professor is a woman. When questioned about this fact, one senior woman replied that men are "wiser" (more experienced? more political?).

One woman had enjoyed a year as a visiting scholar at UCLA working in functional analysis. Her daughter had just been admitted to the university on an unprecedented basis: first, she had a perfect secondary school record and so the national examination requirement was waived; also, she was not required to "work" before going on to university.

Regular faculty typically have responsibility for teaching one undergraduate course of about 80 students or a seminar of 9 or 10, for several graduate students' research and for ongoing research and publications. Many had written their own texts for their courses. Students frequently stay at their undergraduate university, earn advanced degrees and join the faculty. They own no personal libraries, but live in small apartments on the campus and use the libraries of their institutions. Each university publishes journals of research. Since only 40% of the entire population of China attend secondary schools (called middle schools) and only 1-2% of the population attend university, students are very serious about their studies.

At Changchun the mathematics faculty of 120 included 20 women, none of them professors. This university prepares teachers for secondary schools; mathematics teachers take minimally two years of calculus, two of algebra, a year of computer science and a half-year of statistics. Women students equal the number of men. Opinions expressed by students were that "the best students are girls, but boys concentrate better on independent work."

We were told everywhere that the government guarantees equality of men and women at jobs, in pay and in educational opportunity. But household duties fall to women. Despite small families, wives spend many hours a day on household duties. Most families lack modern appliances, notably refrigerators and laundry equipment, so, we were told, at least three hours a day is given to shopping, preparing food, and caring for house and clothing.

Since the revolution, academic people have a relatively low status. Scholarship is not regarded as "work" and so salaries of teachers are lower than those of "workers."

Chinese people we met spoke very openly about the "cultural revolution," some even saying it was good for them to speak of it. University faculties consist of people over 45 years of age; many undergraduates are in their late 20's. Everyone we met at universities had been sent to the countryside for periods ranging from 4 months to 5 years. Most academics considered it a complete waste of time and felt it did not accomplish its purpose of gaining respect for country people and/or learning how to do manual work. Their assessment of their captors was that they were like people everywhere: some good, some bad; some compassionate and embarrassed by their status, others abusive and carried away with their power.

The more powerful and privileged the professional person was perceived to be, the longer they spent in captivity. The director of a major chemical research institute was incarcerated in a cow shed for over three years and only released to return to his job because "he was needed to run the country." Meanwhile his wife (a chemist) and young children lived and worked with peasant families for five years. When the children were allowed to attend country schools they walked 15 miles each day, but only after tiring and sometimes dangerous chores were completed.

The cultural revolution lasted approximately from 1967 to 1976. Schools were closed, or run by children who taunted their teachers. Journals were discontinued; serious work was impossible. The effect on scholarship is that the generation who are now in their late 20's and 30's have either given up on scholarship or are still struggling to catch up. And the young graduate students want to come to the west to study, preferably to America.

Although the people speak openly about the experience, none complain or harbor resentment toward their captors, informers or accusers. We frequently heard from younger people that "we must forget the past, we must go forward, we have work to do to build a new China." Although all speak in support for the communist government and its economic gains, many are fearful and distrustful of communist extremists. They agree that the position of the present government is precarious; if Deng and his supporters lose control, a return to chaos is possible. Meanwhile they build and study and work with intensity and with great hope for China's future.

SCIENTIFIC EXCHANGES

The National Academy of Sciences (NAS) invites applications from American scientists who wish to make visits beginning during the period September 1, 1987 through December 31, 1988 to the U.S.S.R., Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Poland, Romania, and Yugoslavia. Long-term research visits of 3 to 12 months duration are encouraged, particularly if contact with colleagues in the other country has already been established. The minimum length of visits is 1 month in one country.

Applicants must be U.S. citizens and have a doctoral degree or its equivalent by June 1987 in physics; chemistry; mathematics and computer sciences; earth, atmospheric, and oceanographic sciences; agricultural, forestry, fishery, and plant sciences; biological and medical sciences; environmental sciences; engineering; archaeology and anthropology; geography; or psychology. Also included are science and technology policy studies and other aspects of the economic and social sciences that involve quantitative analysis. Other scientific disciplines not explicitly mentioned will be considered on a case-by-case basis. Necessary expenses will be met by the NAS and the foreign academy, including reimbursement for long-term visitors for salary lost up to a predetermined maximum and expenses for accompanying family members for visits exceeding 5 months.

Requests for applications should reach the National Academy of Sciences not later than February 13, 1987. Applications must be postmarked by February 28, 1987. Address application requests to:

National Academy of Sciences
Office of International Affairs
Soviet and East European Affairs (JH-218)
2101 Constitution Avenue, NW, Washington, D.C. 20418
(202) 334-2644.

THE GRACEFUL ADMIRAL

by Elizabeth Colt, Boston *Globe*, June 21, 1986
reprinted by courtesy of the Boston *Globe*

When Rear Admiral Grace Hopper stepped aboard the USS Constitution on Wednesday, the ship's bell rang nine times in accordance with tradition — one to mark her entrance plus eight indicating her rank.

But Adm. Hopper may deserve more than the customary welcome. Not only is she the oldest commissioned officer in the US Navy on active duty, but she is also a pioneer of computer science, a professor and an accomplished raconteur.

With Adm. Hopper seated below decks in the captain's quarters of the Constitution, the 79-year-old inventor and the oldest commissioned warship afloat in the world were united. "I love this ship," said Hopper as she settled into the dark leather of an Old Ironsides' wall bench. The admiral's luminescent smile matched the mahogany and polished brass of the meticulously kept ship. As the "oldest" in their respective fields, the two belong together.

Hopper was in Boston this week as the guest of honor at Wednesday's annual Navy Night at the Pops. She won't be back to the Constitution until Aug. 14 when she and an impressive selection of Navy brass will gather for her retirement ceremony.

Born on Dec. 9, 1906, Hopper grew up in New York City and Wolfboro, N.H. She graduated from Vassar in 1928, received a master's in mathematics from Yale in 1930, and a Ph.D. from Yale in 1934. She taught mathematics at Vassar beginning in 1931, leaving in 1942 as an associate professor. After a brief period at Barnard in 1943, the patriotic spirit of World War II inspired her to join the Navy.

"If you go back and look back, you will find that there were more women getting advanced degrees in mathematics before World War II than there are now," she said. "I wish somebody'd explain to me why that's happened. I do not understand except maybe a lot of them decided to learn computers instead."

Hopper's first assignment was with Cmdr. Howard H. Aiken in Cambridge where she was the third programmer on Mark I, the first large scale digital computer. She subsequently worked on Mark II and III, and is considered the mother of COBOL, the first compiler that used English words instead of mathematical symbols.

Was it difficult being a woman in the Navy?

"No, in fact you see, I worked in the academic world as a college professor, then during the time I was on inactive duty I worked for UNIVAC in the business world, then I came back in the Navy. Of the three environments," she said, "I'd say the opportunities for women are much greater in the Navy that they are in the academic environment or the business environment. You wear the same stripes and you get the same pay and the Navy is fantastic for opening up the opportunities."

Referring to her work on COBOL in 1959 Hopper said, "there were a lot of people trying to use computers and all the programming was being done in symbols. Well, there are a lot of people who don't like symbols — they use words — and so I said, 'Let's write the programs in English and I'll write a program that translates the English words into machine code.' And everybody said, 'You can't do that.' And we won."

"So we went ahead and did it, we built a pilot model [of COBOL] and then we went out to get the budget to go ahead and do it and that was when the real battle came. And even after we got it running nobody believed us. And then it took about three years to get anybody to use it," said Hopper with a chuckle.

Although she was never on board ship for the Navy — by the time women were eligible she was over the age limit — the admiral has certainly won many of her own battles. "If you have a good idea," she advised, "Go ahead and do it, because it's much easier to apologize than it is to get permission."

Her current job with the Navy started in 1967 when she was recalled from Reserve retirement. In addition to her involvement in ongoing computer and data processing research, Hopper gives more than 200 lectures each year around the country to audiences of all ages.

"I try to change people's minds," she said. "They have a terrible tendency to say 'We've always done it that way,' and I want them to try something new. So, I spend a lot of time keeping the Navy up to the future. It's a sort of marketing job, I guess, you have to sell new ideas."

As Hopper moves into retirement, her computer career is not over. Although she will not reveal the name of the computer industry firm she has signed with, she plans to start work on Sept. 2, just one day after her retirement takes effect.

"I have decided that I'm going to survive until I'm 94, at least," she said, "Because Dec. 31, 1999 will be the biggest New Year's Eve party ever held. I don't drink so the next morning I'll be cold sober. On the morning of 1 Jan. of the year 2000 I'm going to get on the phone and call all my friends and say, 'See, you underestimated me!' "

Although Hopper has received most of the awards given in the computer industry, she especially cherishes her career with the Navy: "I've always said that the highest reward I've ever received was the privilege and the responsibility of serving in the Navy."

In her office in Washington, D.C., Hopper has a clock that runs counterclockwise to constantly remind her staff to challenge the status quo. "Usually after a few days people realize that there was never any reason for it to run clockwise," she said.

A special love of machines has always inspired Hopper: "When I was a small girl, about 7 or 8 years old, up in Wolfboro, each room had one of the round clocks, with the 2 bells on top," she reminisced, gesticulating in a circular motion to describe the clock she remembers.

"Mother would go around the night before we were going out on a trip and set all those clocks. One night she went around and the clocks were all apart. What had happened was I had taken the first one apart and couldn't get it together again. Because I wanted to find out how it worked, all seven clocks were apart. After that I was limited to one clock.

"Well the thing is, I've always loved a good gadget. I always wanted to find out how anything worked. And when I saw Mark I, it was the biggest gadget I'd ever seen."

"Did you ever read 'Just So Stories'?" she asked, referring to the Rudyard Kipling favorites. "Do you remember the 'Elephant's Child'? The 'Elephant's Child' was very nosy and he poked into everyone's business and he went down to the great grey green greasy Limpopo River and he stuck his nose in to see what old Mr. Crocodile was up to. And the crocodile grabbed his nose and that's how the elephant got his trunk.

"What they said about the elephant's child was that he had 'satiable curtiosity [sic].' I've got 'satiable curtiosity.' I'm just like the elephant's child, I put my nose into things. I have to find out how they work."

This inquisitive nature has garnered Hopper a total of 49 honorary degrees including the one Northeastern University will present her Sunday in the Boston Garden at its 85th commencement.

"The University of Linkoping in Sweden was going to give me a doctor's degree," begins the accomplished storyteller, referring to yet another honorary doctorate received in 1980. "It was evening so it meant full dress. Have you ever seen our full dress uniform? Well it's a long straight black skirt, gold cummerbund, white shirt with ruffled front, little black velvet tie and a white mess jacket. Absolutely beautiful. And there's a tiara with the Navy insignia on it. ...

"The day before they had a rehearsal and they said, 'after the provost gives you your diploma and you turn to the King, the gentlemen will bow and the ladies will curtsy.' Well, you could no more curtsy in that skirt than jump over the moon — you would have had to hike it up to your knees — besides which I didn't know how to curtsy. But I didn't say a thing.

"So the next evening after the provost handed me the diploma, I saluted him, and he smiled, and bowed, and was *most* gracious because of course, [pause] he's a navy man."

Hopper smiled, glanced around the small captain's office in the stern of her favorite ship and reflected, "So if you get mixed up with computers there are a lot of adventures."

POSITIONS AT FUNDING AGENCIES

The Division of Mathematical Sciences of the National Science Foundation is looking for at least six Program Directors and a new Division Director. The Directorate for Science and Engineering Education which supports many activities in mathematics education is actively looking to recruit academic mathematicians. In addition, there will be vacancies at the other funding agencies. Finding the most qualified mathematical scientists to staff the federal funding agencies should be a matter of concern to the entire mathematical community. See the *Notices* for the names of people to contact regarding these positions.

LETTER

This letter was sent by AWM member Claudia Zaslavsky to the editor of the NCTM (National Council of Teachers of Mathematics) News Bulletin.

In the latest NCTM News Bulletin (September 1986), the article "Mathematics Is Important" cites defense programs, in particular the Strategic Defense Initiative (SDI), to emphasize the importance of mathematics in science, and the stimulus such programs provide for the study of mathematics.

The science which is the subject of this article is only one aspect of science, one which is specifically related to military programs. This emphasis on the militarization of mathematical interest can only detract from work in the broader areas of science, those which are concerned with improving the quality of life and with promoting good relations among the peoples of the world. On the other hand, the science involved in SDI, and in its related field of nuclear weapons is devoted to death and destruction. We should deplore the fact that so much federal money goes to fund such projects. Already 6500 physicists in the major universities have pledged not to accept funding for SDI research.

There are many interesting and exciting scientific applications of mathematics. Awareness of these applications can inspire high school students to specialize in the field of mathematics. The NCTM can best serve the teaching profession by continuing to publish information about such applications on a level that is accessible to teachers and students of pre-college mathematics.

It would be valuable to learn the opinions of NCTM members on this issue.

COMPUTER PROFESSIONALS FOR SOCIAL RESPONSIBILITY

CPSR is a non-profit, tax-exempt, educational organization of computer professionals concerned about society's use of computer technology. As society becomes increasingly dependent on the power of computers for its vital functions, it becomes vulnerable as well. For example, while computers facilitate law enforcement, they may also invade our privacy and restrict our civil liberties. A more serious danger is presented by the possible failure of critical systems such as those used to control air traffic, communications, or nuclear power plants. As we come to understand the potential power of computers, we need also to allow for their limitations. Failure to acknowledge these limitations leads to unrealistic assumptions about what computers can be counted on to do. When plans based on such assumptions involve critical systems, the dangers to society can become extreme.

Nowhere are the risks more pronounced than in the role that computer technology is assuming in the arms race. Computers are increasingly embedded in the decision-making processes associated with our defense system generally, and with the use of nuclear weapons in particular. Errors here have the potential for unprecedented catastrophe. Yet our dependency on computer control is growing, despite the universally acknowledged fact that it is impossible to build computer systems that can be guaranteed to perform properly under all circumstances. Basing international policy on the hope that we can build such systems is doubly dangerous.

Because computers are viewed as too complex for the general public to understand, decisions about their use are left to the "experts." But we believe that the dangers of misuse are large, and that public education is a necessary first step toward the provision of suitable safeguards. We also believe that the fundamental issues involved are not so complex as to be beyond the grasp of the lay person, and that the survival of society may in fact depend on citizen involvement in such issues. CPSR's purpose is to provide a forum within the profession for discussing problems that computer technology presents to society, and to give policy-makers and the general public a more informed understanding of what constitutes appropriate use of that technology. We do this by giving interviews to the press, radio, and television, by presenting public lectures and participating in panels, by meeting with public officials, by producing our own publications, and by writing articles for newspapers and journals. We have also petitioned various technical societies to take an ethical stand concerning the social responsibilities of members of the computing profession.

Annual dues are $30 regular or $10 student/low income. Tax-deductible check payable to CPSR Inc. should be sent to P.O. Box 717, Palo Alto, CA 94301. Members receive CPSR's quarterly newsletter [in which the following article appeared]. ·There are a number of local chapters.

THE STAR WARS COMPUTER SYSTEM: Part 1 of 2

by Greg Nelson and David Redell
Greg Nelson received a Ph.D. in Computer Science from Stanford University. A former lecturer in Computer Science at Princeton and researcher at Xerox PARC, he is presently employed at the Digital Equipment Corp. Systems Research Center.
David Redell received a Ph.D. in Computer Science from U.C. Berkeley. A former professor in Computer Science at MIT and software manager in Xerox's Office Systems Division, he is presently employed at the Digital Equipment Corp. Systems Research Center.
Published by Computer Professionals for Social Responsibility, P.O. Box 717, Palo Alto, CA 94301.

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— Major software vendor's standard disclaimer

[In response to Senator Joseph Biden's question about the possibility that the president might make a mistake in a nuclear crisis]
We might have the technology so that he couldn't make a mistake.
— Robert Cooper, Director of DARPA

Introduction

Computers play an endless variety of useful roles, and we rely on them to make life easier, more productive, and safer. Unfortunately, this makes us increasingly vulnerable to computer-related errors, which already cause aggravation, injury, and even death. As the state of the art of computing improves, and standards of professional discipline evolve, it should be possible to reap more and more benefits of the computer revolution without taking irresponsible risks. But the responsible balancing of risks and benefits is threatened by a general phenomenon in the world of computer systems: aspirations are rising faster than the technology that is expected to fulfill them.

Nowhere is this phenomenon more prevalent than in the design of computerized weapons systems, and no weapons system presents a more dramatic example than the computer system proposed for the Strategic Defense Initiative — the so-called "Star Wars" Anti-Ballistic Missile system. There are many serious difficulties with this computer system, falling into the following areas:

- System requirements: The ABM problem presents what may be the most difficult combination of mission requirements and hostile environment ever faced by a computer system.

- System complexity: The proposed system would be, in several ways, the most complex computer system ever built. Experience with previous large systems suggests that the project would be difficult and error-prone at best, and might well fail to achieve a deployable system at all.

- Testing difficulties: The nature of the ABM system prevents the kind of full-scale operational testing that is indispensable in the development of any large computer system. This difficulty is exacerbated by the fact that the ABM problem is inherently open-ended, involving as it does a cyclic contest of measure and countermeasure. This would lead to continual change and resulting instability in the software.

- Autonomous decision-making: The inherent time constraints in the ABM problem require a high degree of autonomy in the top-level decision-making software. This would introduce new levels of automation into the procedures for evaluating and responding to nuclear crises, and increase the danger that a flaw in the system could lead to an accidental nuclear war.

In the body of the paper we examine these problems from a technical perspective, focusing on the different ways in which the problems could cause the system to fail. We also briefly consider the uncertain strategic implications of the SDI effort.

Strategic and technical context. Research on anti-ballistic missile systems began in this country in the late 1950s, leading eventually to the Safeguard system which was deployed in the early 1970s but dismantled a few years later. The computational problems involved in tracking hundreds of objects were among the difficulties that were never satisfactorily resolved. In March, 1983, President Reagan gave ABM proponents a boost with his speech that envisioned a future in which nuclear weapons would be rendered "impotent and obsolete" because of advanced ABM systems. The speech led to the Strategic Defense Initiative, an ABM research program with an initial five-year, $26-billion budget.

The proposed Star Wars ABM system comprises a layered defense that would attempt to intercept enemy ballistic missiles during all phases of their flight, from boost phase through mid-course to reentry. A number of interception technologies have been proposed, including a variety of exotic beam weapons as well as kinetic energy devices, such as rockets and other projectiles. Similarly, a variety of sensors would be employed, including infrared and radar tracking devices. These technologies are described more fully in the references.[1, 6, 8, 15, 20, 21]

Some of the technical details of the Strategic Defense Initiative are contained in classified government documents, such as the full report of President Reagan's Defensive Technologies Study Team (the "Fletcher Report"). Most of the system's general design, however, is unclassified and has been published in the summary version of the Fletcher Report[20] as well as in books, newspapers and magazines.

The details of the computational system depend on the particular weapons employed, but the general requirements do not: prompt response is required to attack boosters; real-time requirements arise not only from servo controls for aiming sensors and weapons but also from the time constraints of the battle management schedule; a distributed system is required to provide redundancy and coordinate the different phases of the defense; and high computation rates and large volumes of data are required for the surveillance and tracking of tens or hundreds of thousands of objects in the mid-course and terminal-phase defense.

The computer system. The main source of information about the computational aspects of the Strategic Defense Initiative is Volume 5 of the Fletcher Report, "Battle management and data processing",[10] the only unclassified volume of the full report, and the only one to deal directly with data processing issues. The system description given there is very tentative, but the broad outlines are consistent with the obvious requirements that the computer system would have to satisfy.

The foundation of the proposed system is a ground-air-space packet-switching communications network, made reliable by replication of the communications links and computing nodes. Connected to the network are controllers for radars and optical sensors, controllers for directed energy weapons, activators for other intercept weapons, high-speed processors, data storage devices, and terminals for human operators. As its name implies, the network is intended to comprise components distributed on the earth, in airplanes, and in satellites.

Probably the most computation-intensive task required is "track formation". Phased array radars are capable of emitting many thousands of individually-aimed pulses per second; under appropriate computer control, these could be used to resolve a threat cloud into a set of tracks of individual objects. Optical or infrared sensors, whose shorter wavelengths offer the potential for sharper angular resolution, also require high-bandwidth controllers. Because the computing requirements are so high, both in absolute terms and in asymptotic growth rate, these algorithms may become saturated by large numbers of decoys. The Fletcher Report estimates that the computing nodes controlling radars and optical sensors must perform between ten million and one billion floating-point operations per second.[10a] The report also calls for research into realistic algorithms for track formation.[10b]

As individual objects' tracks are identified, they are stored in a global database that is accessible by boost-phase, mid-course, and terminal-phase battle management software. For reliability, several replicas of the database are maintained, since many node and link failures can be expected during an attack, due both to disruption by radiation and other effects, and to outright destruction of numerous components of the system.

The battle management software includes a scheduler that allocates defensive resources (*e.g.*, sensors and weapons) to targets. This allocation must be coordinated across the various elements of the system, and must be resilient in the face of damage to the network, the computers, and the

resources themselves. Moreover, the resource allocation must occur in the context of a coherent battle plan that takes into account the nature of the attack and a host of other variable parameters. The Fletcher Report is quite explicit about the central role of the computer system: "The battle management system will, through its software, define and control the functioning of the entire defense and, thereby, define its effectiveness and establish performance requirements for weapons and sensors."[10c]

The programs for the system and the orders for the human operators would have to ensure that the appropriate battle plan be activated within seconds of a warning, since the crucial boost phase, during which missiles are vulnerable to attack, is so brief. Because of these time constraints, several battle plans would be programmed in advance, so that in the event of a crisis that threatened to lead to an attack, human operators would simply select one or more battle plans and specify their important parameters, leaving their activation and execution to the computer system. Thus, the highest level of the battle management software would exercise a decision-making function of the utmost importance, constituting the most important decision ever delegated to a computer program.

Technical Risks

There are several ways in which the SDI software project might fail: (1) The attempt to build and deploy the system might fail outright, because of its complexity. (2) The system might be successfully deployed, but fail under attack. (3) The system might be successfully deployed, and then activate itself under unanticipated circumstances.

Outright failure to develop and deploy the system. Assuming that computation rates and radiation hardness continue to improve at current rates, the individual hardware components of the SDI computer system are likely to become feasible in the next decade or so. On the other hand, the problems of designing the entire system, writing the software, and integrating the various components are much less likely to be satisfactorily resolved. Programming large software systems is more an art than a science, and progress in this art has been disappointingly slow.

One potential source of software complexity lies with the processors themselves. In principle, the complexity of high-performance fault-tolerant processors should be confined to the lowest levels of the system. In practice, fault-tolerant systems have been harder to program than conventional ones. In this way, the very measures designed to guard against failures in the hardware can induce a new class of failures in the software. For example, one of the first flights of the space shuttle was stopped at the last moment by a software error that caused a synchronization problem between the shuttle's redundant processors.

The major source of complexity in the SDI system, however, would be in the construction of the complete distributed software system, combining as it does fault tolerance, networking, distributed databases, real-time control and signal processing, resource allocation, artificial intelligence, and complex human interface issues.

There is little doubt that it is possible to build the lowest level of the proposed ground-air-space network, allowing simple data flow from point to point in the network. It is much harder to design and implement protocols that maintain communication in the face of failures in individual nodes and communication links, particularly when the failure rate is high, as it would be during a nuclear war. Even more complexity stems from the requirement that separate nodes share access to a replicated database and maintain the database in a consistent fashion. Moreover, the requirement that the system satisfy stringent real-time constraints introduces additional problems and complicates existing ones.

These difficulties represent challenging research problems even when restricted to a local area network with homogeneous nodes clustered within a few kilometers of one another. The SDI system requires solutions for a heterogeneous network spanning thousands of kilometers. The Fletcher Report issues a "word of caution" because the diameter of the network in light-milliseconds would be large enough that speed-of-light limitations would create inherent latency delays in synchronizing shared data that were large compared with the reciprocal bandwidth of the servo control systems.[10d] In practice, this would be only the tip of a larger iceberg, since much longer delays would be introduced by the network's packet-switching system and the processing in the higher levels of the software.

In addition to the design problems outlined above, the builders of a distributed system meeting the Fletcher Report's specifications would face a number of difficult logistical problems in the deployment, operation, and maintenance of such a large and complex software system. Work on a large computer system does not end with initial installation, but continues over the entire useful life of

the software. This would be particularly true of the SDI system, in which software changes would be needed not only to fix problems, but to enhance the system in the face of new threats and countermeasures by an adversary. The distribution of software updates, a difficult problem in any case, is rendered more difficult when the target computers are part of a network of orbiting satellites. The typical current practice for space-based computers is to send a small machine language patch to repair each flaw. Obviously, this error-prone practice would be totally inadequate for such a large system on which so much would depend. The Fletcher Report acknowledges that a "problem with space-based assets is the difficulty of upgrading the software and then verifying that the system is operating correctly",[10e] but makes no attempt to address this difficulty.

A useful sense of perspective is provided by comparing the SDI plans with past and present computer systems. Two systems that are particularly relevant are the Safeguard ABM computer system and the World-Wide Military Command and Control System (WWMCCS — pronounced "Wimmix").

The Safeguard system controlled the radars, missiles, and human command interface for one reentry phase ABM installation. It contained about two million lines of software running on ten 1.5 MIPS processors.[3] The real-time portion of the system contained three-quarters of a million instructions. It was characterized in the Bell System Technical Journal as one of the most complicated real-time systems ever built, although it was much smaller and simpler than the proposed SDI system.

WWMCCS is the Pentagon's world-wide communication system, built at a cost of between ten and fifteen billion dollars and involving more than ten million lines of software. It is thus about the same size as the proposed SDI system, but is much less tightly integrated and does not encounter the kinds of real-time constraints that are inherent in the ABM problem. The system has not been reliable: according to Atlantic Monthly editor James Fallows, "Once or twice a month, the newspapers carry a story about the WWMCCS computers breaking down. When the system was thoroughly tested in 1977, attempts to send messages ended in 'abnormal terminations' — that is breakdowns — 62 percent of the time."[9] Major General D. L. Evans, head of the WWMCCS effort, concedes that studies by Congress and the General Accounting Office "were very critical of the current WWMCCS ADP systems. By and large, the criticism was well founded".[11a]

These two comparisons suggest that the Fletcher Report is not unrealistic in estimating the size of the software for the SDI system at six to ten million lines.[10f] They also suggest pessimism about the prospects for successfully deploying the system. Empirical studies of large software systems have led to models of cost and error density as a function of program size; Lin[16] applies these models to the proposed SDI computer system and concludes that it would take tens of thousands of man-years to design and implement, and would be impossible to deliver free from errors.

There is a common tendency to expect rapid progress in software technology, simply because there are no physical constraints that need to be overcome. "All" that is required is mental mastery of complexity. Such optimism is misplaced, and is one of the major causes of aspirations overreaching capabilities in computer projects. There are many areas in software engineering where the state of the art is depressingly similar to the state twenty years ago. Despite gradual improvement in our understanding of large software systems, it is likely that any SDI computer system deployed within the next two decades would display the same kinds of shortcomings that are rampant in most large software systems deployed today.

In summary, it is possible that the attempt to build the computer system for the SDI would fail outright. It strains the state of the art in so many areas that it could easily get out of control, as so many large software projects do. But it is equally possible that a stubborn attempt would lead to the deployment of an unreliable system. In this context it is worth quoting C. A. R. Hoare's 1980 Turing Award Lecture, in which he remarked of another large software project:

> At first I hoped that such a technically unsound project would collapse, but I soon realized it was doomed to success. Almost anything in software can be implemented, sold, and even used given enough determination. There is nothing a mere scientist can say that will stand against the flood of a hundred million dollars. But there is one thing that cannot be purchased in this way — and that is reliability.[14]

The possibility of failure under attack. The main reason for this second concern is the impossibility of testing the system under full-scale operational conditions. It is the universal experience of computer system designers that reliability cannot be achieved without such testing. Since we have no spare planets on which to fight trial nuclear wars, operational testing of a global ABM system is impossible. The system would have to work the first time. No computer system even a fraction of the size of the SDI system has ever worked perfectly in its first operational use.

The Fletcher Report acknowledges that "there will be no way, short of conducting a war, to test fully a deployed BMD system", and that therefore "the credibility of a deployed system must be established by credible testing of subsystems and partial functions".[10g] Experience shows, however, that this technique is a totally inadequate substitute for testing under operational conditions. The first real use of any large computer system inevitably uncovers flaws that did not show up previously in simulations and partial tests. Some early examples are cited by McCracken:[17] after extensive in-house testing, the first release of IBM's OS/360 revealed five thousand errors. Similarly, the SABRE airline reservation system was carefully tested in small cities before its first large release in New York. The system worked well in the small tests, but in the high-volume situation it sold two hundred seats on 90-seat airplanes all over the country. All subsequent experience has shown such results to be typical: real operational use invariably reveals scaling, saturation, and other problems that would never have been discovered by limited testing or simulation.

Any large system that has been exercised only in partial tests and simulations will lack credibility, but in addition, there are special problems with an ABM system that make simulation-testing particularly difficult. There are no complete specifications for the problem being solved by the battle management system, because we cannot know exactly what countermeasures the Soviets would use to fool, disable, destroy, overload, and penetrate the defense system. There is no way to simulation-test the system against such unanticipated attacks. Related to this problem is the fact that the system would be subject to frequent updates. Its battle management software would encode detailed plans for dealing with particular Soviet threats: as these threats changed, so would the software. The Fletcher Report cautions that "when a system is upgraded with new capabilities, the probability of introducing new errors is very high".[10h] The ability of a massive ongoing simulation project to establish and maintain the credibility of such a large and continuously evolving body of software is questionable, to say the least. A third difficulty is that simulation testing of an ABM system must be carried out effectively in real time if it is to reveal timing errors. Therefore, simulated stimulus data that are computed in advance must be delivered during the test in simulated real time. Unfortunately, if the system interacts with its environment during the test in ways that affect its input stream, this technique won't work. In short, credible simulation testing of any real-time closed-loop system is extremely difficult, and for a system as large as that envisioned for the SDI, may simply be impossible.

The Apollo project is sometimes cited as an example of a similar system where simulation testing succeeded in producing reliable operation on its first use. In addition to ignoring the special problems cited above, however, this argument is based on a questionable representation of the Apollo software development: many errors in the NASA control programs were weeded out by operational testing in the Mercury and Gemini projects. For example, Gemini 5 came down 100 miles from its intended reentry point, because a programmer had neglected to account for the orbital motion of the earth around the sun.[12] Thus software errors that might have been disastrous in the Apollo missions were discovered by earlier operational testing. Even so, during the first moon landing, the computer in the Apollo 11 Lunar Module failed due to software problems: only emergency manual intervention by the pilot saved the mission from a last minute abort.

It is sometimes argued that operational testing will be made unnecessary by the development of automatic program verifiers that certify the correctness of formal mathematical proofs of the consistency of programs with their specifications. Unfortunately, progress in automatic verification has been slow, and the prospect of proving the consistency of a ten million line program with its functional specification is extremely remote. A more fundamental weakness of the argument is that many kinds of flaws in large systems represent errors in specifications rather than inconsistencies between programs and specifications: for example, error-prone features in user interfaces, or the neglect of relevant physical phenomena (e.g., the orbital motion of the earth around the sun). Because of the complexity of the requirements for the SDI computer system, which are influenced by targeting doctrines, battle management plans, constraints of user interfaces, and the physical environment of weapons and sensors in space, any formal specification derived from the requirements would contain flaws that could be revealed only by operational testing.

The message of responsible proponents of program verification and similar disciplines of programming is not that mechanical verification can replace operational testing of large systems, but that a disciplined design employing formal specifications and *a priori* correctness arguments is necessary in addition to operational testing. In the case of the SDI computer system, the state of the art is limited to informal specifications and at best partially-convincing correctness arguments for the major components of the system, such as replicated data bases, failure-resilient communications

protocols, and fault-tolerant high-performance architectures. In short, the required computer system is too complicated to be designed by the disciplined methodology advocated by programming formalists. Thus, if it somehow did become possible to perform repeated operational tests of the ABM system, we can predict the outcome: the system would exhibit unanticipated failures that might or might not be amenable to later repair.

An illustrative example of the unreliability arising from even moderate complexity occurred when the DIVAD (Division Air Defense) computer-controlled cannon was demonstrated to a military review panel. The drone target flew by, the gun swung into action, passed right by the drone, swung all the way around, and pointed itself straight at the review stand, whose occupants scattered for cover. This suggests that the DIVAD test team had not done an adequate job, since thorough testing should have revealed the error under less embarrassing circumstances. There is another possibility: perhaps the testing team did a thorough job, but the design was so complex that the bug revealed in the demonstration was too obscure for the tests — the kind of bug that strikes only when the forward radar is wet, the target is flying north, and the date is February 29. In this case, the blame would lie with the weapon's designers, who failed to master the complexity of their design.

In passing we call attention to a nontechnical but very serious problem: the Department of Defense (like many other institutions) rarely tests its systems as thoroughly as it plans to. A discussion of this problem and a list of references is contained in a 1983 General Accounting Office report to Congress on DoD testing.[7] The report makes it clear that weapons systems that prove difficult or impossible to test adequately are often deployed anyway, with the predictable result: chronic unreliability.

In summary, it is folly to rely on any computer system that has not been subjected to full-scale operational testing; if the system is as large and complicated as the proposed ABM system, the folly is monumental: all experience teaches us that flaws would surface in the first operational use of the system — in a real nuclear war.

WOMEN'S STUDIES: CAREER FOCUS BOOKLETS

Series I, II, and III. Women's Studies offers benefits to students which, combined with a background in either Communications (English, Journalism, Communication), Social Sciences, Math, or Science, will enable them to develop marketable skills and effectively pursue their field of interest. Whether students plan to use their Women's Studies training to create employment opportunities directly related to women's issues, or to pursue a career path that is not specifically oriented towards women, a Women's Studies background will be invaluable.

These booklets have been designed to help students think about how they can apply their background to their future career path, look at some of the career options open to people with their skills and interest, describe specific steps they might take to decide on and prepare for the career of their choice, and examine profiles of women with backgrounds similar to theirs and learn how these women have pursued their fields of interest.

Job Survival Skills for Women's Studies Students: A Career Development Training Manual is designed to give instructors (Women's Studies professors and Career Development personnel) concrete ideas and activities for teaching job survival skills to Women's Studies students. The manual includes ten modules, each of which provides background information on the topic, discussion guides, several exercises and assignments, and more. The module topics range from "Making Your Women's Studies Degree Work For You, Not Against You" to "Goal-setting," "Networking," and the "Job Game." While the training manual is designed to be presented in a classroom situation or through a workshop series, individual students will also benefit from reading and following through on the suggested exercises.

To order the whole packet (total cost with postage, $3) or individual booklets, write to:

> Junior Year at Douglass Program in Women's Studies
> Voorhees Chapel, Room 4B
> Douglass College
> New Brunswick, NJ 08903.

SOCIETY OF WOMEN ENGINEERS

The Society of Women Engineers is a non-profit educational service organization of graduate engineers and men and women with equivalent engineering experience. The specific objectives of the Society are:

* to inform young women, their parents, counselors, and the general public of the qualifications and achievements of women engineers and the opportunities open to them;

* to assist women engineers in readying themselves for a return to active work after temporary retirement;

* to serve as a center of information on women in engineering; and

* to encourage women engineers to attain high levels of education and professional achievement.

SWE was founded in 1949-50 when small groups of women engineers started meeting in New York, Boston, Philadelphia, and Washington, D.C. The Society was incorporated in 1952. In 1961, SWE established its headquarters office in the United Engineering Center in New York, joining many of the engineering disciplines. SWE is a Charter Member of the engineering umbrella organization, the American Association of Engineering Societies (AAES); an Affiliate of the National Society of Professional Engineers (NSPE); and a Member of the Federation of Organizations for Professional Women (FOPW).

In 1976, SWE membership was opened to men. All SWE membership grades and qualifications are the same for men as they are for women. The Society has an international membership of more than 14,000. SWE Sections are located in 59 areas of the United States and Puerto Rico. SWE Student Sections have been chartered at more than 230 colleges, universities, and engineering institutes located throughout the United States, the District of Columbia and Puerto Rico.

The Society of Women Engineers holds its annual convention and student conference during June. In addition to Society business meetings, the convention and student conference include technical sessions, professional workshops, tours, industrial exhibits, and award presentations. SWE sponsors national conferences that address issues and concerns of women in engineering. Previous conferences have focused on career guidance, reentry, upward mobility, and leadership.

SWE Corporate Membership is available to organizations which employ engineers and are interested in supporting the goals of the Society.

The Society of Women Engineers administers several award, certificate, and scholarship programs.

The SWE Achievement Award, granted annually since 1952, honors a woman for outstanding achievement in engineering. Nominations are not restricted to SWE members and are solicited from industry, government, and education. Judges represent a wide variety of engineering activities.

The Distinguished New Engineer Awards, established in 1978, are awarded to active Members and Senior Members of SWE with less than 10 years of experience who have demonstrated outstanding performance in engineering and leadership.

The Distinguished Engineering Educator Award, an annual recognition of excellence in engineering education, was granted for the first time in 1986.

The Rodney D. Chipp Memorial Award recognizes significant contributions to the advancement of women in the engineering profession by an individual, group, or corporation. It was established in 1966 as a memorial to Rodney D. Chipp, prominent engineer and strong supporter of SWE goals, and has been presented nine times.

The Society annually recognizes Sections and Members-at-Large for their outstanding programs in Career Guidance and Continuing Development.

As part of its educational activities, SWE administers more than 40 scholarships annually in two National Scholarship Programs. Applications for sophomore, junior, and senior scholarships are accepted from October through January. Applications for freshmen and reentry scholarships are accepted from March through June. All grants are awarded to women engineering students for use in the following academic year.

Corporate contributors to SWE's scholarship program include: Bell Laboratories, Digital Equipment Corp., General Electric Foundation, Grumman Corporation, Hewlett-Packard Co.

Foundation, Northrop Corp., RCA Corp., TRW Foundation, Union Carbide Corp., United Technologies, and Westinghouse Education Foundation.

The SWE-Union Carbide Best Student Section Awards, established in 1975, are awarded to outstanding SWE Student Sections for their efforts in fulfilling SWE goals. Selection is based on annual reports of Student Section activities.

The Society's Certificate of Merit program, administered by Sections and Members-at-Large in their localities, was established in 1973 to honor high school women who have demonstrated three years of excellence in mathematics and science.

The Certificate of Achievement, established in 1974, is administered locally to recognize high school women who have demonstrated special achievement in technical and science studies or projects.

The SWE Award at the International Science and Engineering Fair was established in 1979 to recognize outstanding engineering projects by high school women.

The Corning Glass Works High School Program Award, established in 1983, recognizes the three best Student Section career guidance programs for high schools. Monetary prizes are used by the Student Sections to develop further career guidance programs in their localities.

SWE conducts surveys of women graduate engineers, publishes and distributes the results of these surveys in *A Profile of the Woman Engineer*, produces publications relating to career guidance and professional development for women in engineering, and publishes an informative magazine, the *U.S. Woman Engineer*.

DOUGLASS PROJECT FOR RUTGERS WOMEN IN MATH AND SCIENCE

Douglass College has received a three-year, $123,500 grant from the New Jersey Department of Higher Education to begin a program aimed at encouraging women students to persist in the study of mathematics and science in college. Called the Douglass Project for Rutgers Women in Math and Science, the program will begin this fall under the direction of Dr. Ellen F. Mappen, who currently directs the Junior Year at Douglass Program in Women's Studies. While the project will be based at Douglass, it is intended for all women at the State University of New Jersey's New Brunswick campuses who are interested in mathematics and science. Mappen will be working with university faculty members in mathematics, the sciences and women's studies to develop the project.

According to Dr. Mary S. Hartman, dean of Douglass, a national need exists to encourage young people to enter scientific and mathematical fields. Studies show woman are underrepresented in these areas, she noted. "A recent Congressional study points to the social factors which discourage women from entering careers that are considered non-traditional for them," said Hartman. "Through our intervention, we hope to help our students overcome some of the barriers which prevent them from making a contribution in mathematics and science-based professions."

The project is funded by a variety of sources, including a three-year grant from the New Jersey Department of Higher Education's Fund for the Improvement of Collegiate Education and gifts from the Joe and Emily Lowe Foundation, The Douglass Fund, the Adrienne and Ellis B. Anderson Science Enrichment Fund, and Professor B. Elizabeth Horner (Douglass '38) of Smith College. Additional funds are provided by Douglass College and the Provost's Office of Rutgers-New Brunswick.

The Douglass Project offers numerous opportunities for young women who are interested in math and science to enhance their chances for success. In September, the project sponsored a session for entering women students "Math and Science and You...Figure It Out" which included a panel of women in science who spoke enthusiastically about their careers in science. In addition, the Douglass Project is offering Peer Study Groups in Calculus which provide a cooperative and supportive learning environment in this subject. Other activities include lab visits, internship information and career planning workshops, special advising geared towards women in math and science, film/discussion sessions, speakers, and informal seminars in which advanced undergraduate students as well as graduate students can both present their work to other students and to women scientists and mathematicians from academia and from industry. The Douglass Project also includes a role model component which will highlight women achievers in math and science. In addition, students will have the option of participating in a mentor program. This coming spring, a pilot high school program will be developed and funds sought to begin a Summer Science Institute for high school students.

NATIONAL WOMEN'S HISTORY MONTH

When Women's History Week was first initiated in 1980 there was so little information available on women's history that some teachers wondered if there was, in fact, enough material on the subject to fill an entire week. Over the past six years, however, women's history has come to be accepted as a valid academic field, extensive research has been undertaken on a wide variety of its topics, hundreds of books have been published at every level, and the contributions of women to the building of our communities have been rediscovered and celebrated widely.

National Women's History Week celebrations have taken many forms in schools, communities and workplaces, honoring women who have participated in history by living out their lives, whether in ways grandly eloquent or steadfastly ordinary, and in so doing made their contributions to our shared history.

In fact, the wonderful programming ideas and the wealth of information which have been generated to recognize the unique multi-cultural history of women in the U.S. have made it impossible to contain the celebration within the confines of a single week. For the past several years, many states and cities have been celebrating March as Women's History Month, with community programs, museum exhibits, media pieces and school events occurring throughout that time. Many people have urged Congress to expand the observance's focus to the entire month of March because of the logistical problems and expense of organizing exhibits, programs and events for just one week.

Therefore, due to popular demand, for 1987 Sen. Orrin Hatch (R-UT) and Rep. Barbara Boxer (D-CA) will call upon their colleagues in Congress to issue their annual Resolution, this time designating the entire month of March as National Women's History Month. International Women's Day, March 8, will continue to be the focal date. The National Women's History Project, originators and primary suppliers of women's history materials, will encourage schools and communities to expand their program planning into the whole month of March. Their catalog of materials will again be available for $1 from National Women's History Project, P.O. Box 3716, Santa Rosa, CA 95402.

National Women's History Month designates the month of March as a time to recognize and celebrate the many contributions women have made to our nation's history. When we identify and honor the countless women who have helped and are now helping to build America, we fill in the gaps which have misled us about the many significant roles women play in our society. This year, the theme to focus our recognition of women's history is "Honoring generations of compassion, courage and conviction." Communities nationwide will be using this theme for their women's history programs.

We're increasingly familiar with examples of these traits as a countless procession of women's names reach down through the years. In our personal lives, too, we're beneficiaries of uncounted, and often unnoticed, acts of compassion, courage and conviction by women in our communities.

We see compassion in the lives of women from the past like Eleanor Roosevelt and Sarah Winnemucca. We see it in our communities today, too, in the unrelenting efforts of health professionals, social workers, teachers and, of course, mothers and grandmothers.

Courage is present in the example of women in our shared history, like Harriet Tubman and Liliuokalani. In our own lifetimes we have seen many women courageously become "the first woman" in a wide range of endeavors from space flight to political office; we see women with the courage to take an unpopular stand on controversial political or social issues.

Conviction? Our models must certainly include Mary McLeod Bethune and Susan B. Anthony, whose entire active life was committed to equal rights for women. Locally, we all find women in our communities committed to their particular visions; we find women operating businesses, Sunday school teachers — and other teachers as well, motivated by their own continuing sense of conviction.

This year, five women are honored on the National Women's History Month commemorative poster for their clear demonstration of these three attributes: Ada Deer, Frances Willard, Mary Shadd Cary, Tye Leung Schulze and Felisa Rincon de Gautier. In living out their individual lives, each became a model for others to emulate in turn.

National Women's History Month encourages us to recognize all of the women in our communities and our nation, now and in the past, who have been beacons of compassion, courage and conviction — often of all three at once. National Women's History Month provides an opportunity to balance the historical record, to create a public awareness of women's contributions in every sphere of our shared history and contemporary life.

OF POSSIBLE INTEREST

Women's Studies. University of Illinois Press, 54 E. Gregory Dr., Champaign, IL 61820.

Gender and Culture Series. Columbia University Press, 136 S. Broadway, Irvington, NY 10533.

Atlas of American Women. Macmillan Publishing Company, 866 Third Ave., NY, NY 10022.

Feminist Theory in Education, new book series. Proposals and manuscripts invited. Lois G. Patton, Editor-in-Chief, State University of New York Press, State University Plaza, Albany, NY 12246.

Margaret Rossiter's *Women Scientists in America*, paper, $10.95. Women's Studies. The Johns Hopkins University Press, 701 W. 40th St., Suite 275, Baltimore, MD 21211.

Women's Studies. Rutgers University Press, 109 Church St., New Brunswick, NJ 08901.

Women's Studies. Lawrence Erlbaum Associates Inc., 365 Broadway, Hillsdale, NJ 07642.

Feminist Studies. University of Minn. Press, 2037 Univ. Ave. S.E., Minneapolis, MN 55414.

Women's Studies. Scarecrow Press, P.O. Box 4167, Metuchen, NJ 08840.

Culture, Society, and Menstruation. Women's Health. Hemisphere Publishing Corp., 1010 Vermont Ave., N.W., Washington, DC 20005.

Psychology of Women Quarterly. Women's Studies. Cambridge University Press, 32 E. 57th St., NY, NY 10022.

DEADLINES: Jan. 24 for Mar.-Apr., Mar. 24 for May-June, May 24 for July-Aug.
AD DEADLINES: Feb. 5 for Mar.-Apr., Apr. 5 for May-June, June 5 for July-Aug.
ADDRESSES: Send all Newsletter material **except ads** to Anne Leggett, Dept. of Math.
                             Sci., Loyola University, 6525 N. Sheridan Rd., Chicago, IL 60626.
                             Send everything else, **including ads**, to AWM, Box 178, Wellesley
                             College, Wellesley, MA 02181.

JOB ADS

Institutional members of AWM receive two free ads per year. All other ads are $10.00 apiece and must be prepaid. The vacancies listed below appear in alphabetical order by state. All institutions advertising below are Affirmative Action/Equal Opportunity employers.

University of Alabama, Birmingham. Dept of Math, Birmingham, AL 35294. Assoc professorship 9/1/87. Want to establish a group of Numerical P.D.E./Scientific Computation over next 5 years. Will seriously consider other areas which will enhance our proposed PhD in applied math. Expect demonstrated leadership in research. Send as soon as possible a curriculum vitae, list of publications, a few selected reprints & names of 3 references to Search Committee.

University of Alabama, Huntsville. Dept of Math & Stat., Huntsville, AL 35899. P. M. Gibson, Chmn. Tenure track position 9/1/87. Rank & salary depend on credentials of appointee. Required: PhD in math or related field with emphasis in applied math, evidence of good teaching & excellent research ability. Prefer fields of numerical analysis, differential equations, mathematical modeling, fluid dynamics, discrete math & prob/stat. Send application, vita & 3 letters of reference to Chmn by 2/16/87.

University of Alabama. Dept of Math, Box 1416, Tuscaloosa, AL 35487-1416. (1) Three asst professorships (or higher rank for candidates with high qualifications) 8/16/87. PhD required by 8/16/87. Required: excellence in both teaching & research. Prefer those in applied areas. Applications invited both for tenure track & visiting positions. Women & minorities encouraged. Send curriculum vitae, reprints and/or preprints & at least 3 letters of recommendation to Search Committee at above address. (2) Four two year instructorships 8/16/87. Required: Masters Degree. Salary around $19,000. Positions not tenure track but renewable. Staff benefits for 2 year appointees include health, life & disability ins. & teacher retirement. Send curriculum vitae & arrange to have 3 letters of recommendation about teaching sent to Search Committee at above address.

University of Alaska, Anchorage. 3211 Providence Dr, Anchorage, AK 99508. Fall, 1987 - Tenure track. Phd in Stat (or math with emphasis in Stat) required; candidates finishing their dissertations by Aug., 1987 will be considered; evidence of successful teaching at post-secondary level. Duties: service, research, & teaching 9 credits (3 courses) or its equivalent each semester. By 2/21/87 send resume, transcripts & 3 letters of recommendation to Personnel Service Office at above address.

Arizona State Univ. Dept of Math, Tempe, AZ 85287. Four asst professorships (tenure track) 8/1987. Required: excellence or potential for excellence in res. & teaching. Salary competitive. Postdoctoral experience preferred but not necessary. (1) One position in applied differential equations. (2) Second position in applied math with res. area including at least one of applied probability, computational math, discrete math or stochastic processes. (3) Third position in statistics; interest in discrete data analysis or time series, & application of stat. desirable. PhD in math or stat required for above 3 positions. (4) Fourth position in control & systems science. PhD in math required. Send vita & have 3 references write

appropriate search committee chair: (1) Hal Smith, (2) B. Anderson, (3) D. Young, & (4) C. Byrnes. Closing date for (1), (2), (3) is 2/16/87 & for (4) 2/28/87.

CA State University, Los Angeles. Dept of Math & Comp Science, Los Angeles, CA 90032. Tenure track position, any rank. Required: PhD in math, math educ or in comp sci with strong background in math. Strong comp sci background desirable & ABD toward PhD in comp sci will be considered for one year temporary. One year visiting position also available in math with PhD & strong record. Starting date 9/1987. Salary: $28,300 - $53,500 with add'l summer employment possibilities. By 2/1/87 contact Wayne Bishop, Chair, at above address.

CA State Polytechnic Univ. Math Dept, Pomona, CA 91768-4033. (1) Applied Mathematics: tenure track asst/assoc. Salary dependent on qualifications. PhD in applied math or math w/applied experience required. Prefer teaching experience and research, industrial experience. By 2/1/87 send resume, 3 reference letters, application & official transcripts to Applied Search Committee at above address. (2) Math Education: tenure track; salary dependent on qualifications; Doctorate in Math Education or Math; Secondary teaching experience required; related research desired. By 2/1/87 send resume, 3 references, application & official transcript to Math Education Search Committee at address above.

CA State Polytechnic Univ. Comp Sci Dept, 3801 West Temple Ave, Pomona, CA 91768. Three tenure track asst/assoc professorships, Fall 1987 at $32,328 to $40,704. PhD in comp sci preferred but will consider an MS & demonstrated teaching ability. Demonstrated effectiveness in teaching at both undergrad. & graduate levels. Interest & qualifications in 2 or more of following areas: software engineering, database, comp systems, artificial intelligence, computer organization & microprocessors, computer graphics, theoretical computer science. Teaching and/or industrial experience desirable. Send resume and 3 letters of reference to Search Committee, Tenure Track, at above address by 3/1/87.

California State Univ, Chico. Dept of Math, Chico, CA 95929-0525. Thomas A. McCready, Chair. (1) One or more temporary leave replacement positions Fall, 1987. Required: PhD in math or stat & evidence of teaching excellence. Salary $25,812 - $49,548. Duties: teaching undergraduate math courses & doing scholarly research. By 3/15/87 send resume, transcripts, supporting documents & 3 letters of recommendation. (2) Full time tenure track position in math education Fall, 1987. Required: PhD or EdD in math or math education with strong background in math & evidence of teaching excellence. Duties: teaching undergrad math, preparing & implementing grant applications in math educ & carrying out research in math educ. Salary $25,182 - $31,044. By 2/1/87 submit resume, transcripts, supporting documents & at least 3 letters of recommendation to Chair. (3) Full time tenure track position in applied math Fall, 1987. Required: PhD in math & potential for teaching excellence. Duties: teach undergrad math, develop & teach courses in applied math & mathematical modeling & carry out scholarly research. Salary $25,812 - $31,044. By 2/1/87 send resume, transcripts, supporting documents & 3 letters of recommendation to Chair.

Loyola University. Dept of Math, Los Angeles, CA 90045. Two asst professorships tenure track Fall, 1987. PhD required. May be 1 or 2 visiting positions. Will consider all areas of specialization, but prefer those in numerical analysis, applied math & math educ. Teach 9-12 hrs per semester. Teach wide variety of undergraduate courses. By 2/1/87 send cover letter (indicate if you plan to attend AMS/MAA annual meetings in San Antonio, TX), resume & 3 letters of recommendation (at least one on teaching) to S. Scarborough, Chair, Hiring Committee.

Mills College. Dept of Math & Comp Science, Oakland, CA 94613. Tenure track asst, assoc or full professorship Fall, 1987. Required: demonstrated superior teaching & research abilities. Rank & salary dependent on experience & qualifications. 3 year contract. Send vita & direct 3 letters to Diane McEntyre, Math Search Committee.

San Diego State University. Two tenurable positions in math, and one each in math education & computer science. Rank open. Required: PhD by 9/87, strong research background & good teaching references. Duties: teaching undergraduates & graduates, curriculum development, directing masters' research & conductiong one's own research. Closing dates: 2/2/87 for math & computer science & 12/15/86 for math education. Send vita & have 3 letters of recommendation sent to appropriate one of math, math educ & comp science Search Committee, Math Sciences Dept.

San Jose State Univ. Dept of Math & Comp Sci, San Jose, CA 95192. Veril L. Phillips, Chmn. (1) Four openings for asst or assoc professor (professor in exceptional case). PhD in any math science, but prefer numerical analysis, math education, stat, applied math or comp sci. Salary approx. $25,000 - $49,000. (2) Three tenure track openings, rank open. PhD in comp science preferred. PhD in any math science with substantial teaching/research experience in comp sci may also be acceptable. Salary $35,000 - $55,000. Apply by 2/3/87.

Santa Clara Univ. Dept of Math, Santa Clara, CA 95053. Two tenure track asst or assoc professorships 9/1987. PhD required; area of specialization open. Excellent teaching & continuing research commitment necessary. Undergrad. teaching only; 7 courses per year on a quarter calendar. Contact G. L. Alexanderson at above address.

University of the Pacific. Dept of Math, Stockton, CA 95211. David T. Hughes, Chmn. Tenure track asst professorship. Prefer specialties in algebra, combinatorics, probability & statistics or operations research, but not essential. Applicant must be dedicated to undergrad. teaching & on-going professional development. Salary negotiable. Send resume, transcript & 3 references to Chmn by 2/15/87.

Trinity College. Dept of Math, Hartford, CT 06106. D. A. Robbins, Chmn. Asst professorship 1987-88. Required: PhD in one of math sciences & demonstrated excellence as a teacher. Will consider any specialty, but prefer complex analysis, differential equations, numerical analysis, applied math or comp sci. Teaching load: 5 courses per year (2 semesters). By 1/30/87 send curriculum vitae, academic record & at least 3 reference letters to Chmn.

Connecticut College. Math Dept, Box 1566, New London, CT 06320. E. C. Schlesinger, Acting Chairperson. Asst professorship in math & comp sci Aug. 1987. Two year renewable appt. PhD required. Teaching comprises introductory & advanced courses in math & comp sci (3 courses per semester). Send resume & 3 letters of recommendation to Acting Chairperson.

University of Delaware. Dept of Computer & Information Sciences, 103 Smith Hall, Newark, DE 19716. Prof B. F. Caviness, Chairperson. Tenure track & visiting positions. Strong applicants in all areas of comp sci please apply. Prefer candidates with research expertise in artificial intelligence, languages & architectures for parallel processing, networking, symbolic computation, graphics, data base systems, theoretical computer science & software engineering. Send curriculum vitae & names of 3 references to Chairperson.

Florida State University. Dept of Mathematics, Tallahassee, FL 32306-3027. Ralph McWilliams, Chairman. We invite applications for two tenure-track assistant professorships in pure or applied mathematics. Candidates should have strong research programs & excellent teaching ability. Salary competitive. Send resume & arrange to have 3 letters of recommendation sent to Chmn.

Rollins College. Dept of Math Sciences, Winter Park, FL 32789. John Bowers, Chmn. (1) Two tenure track asst professorships 9/1987. Specialization open, but must have a strong commitment to teaching undergraduates. Teaching load is 8-10 hours per week. Salary competitive. Doctorate required for tenure. (2) One year visiting asst professorship 9/1987. Specialization open. Must have strong commitment to teaching undergraduates, especially freshmen. Teaching load 8-10 hours per week. Salary competitive. Doctorate preferred. For all positions send resume, transcripts, and 3 letters of recommendation to Chmn by 2/15/87.

Emory University. Dept of Math & Comp Science, Atlanta, GA 30322. Peter Winkler, Chmn. Two tenure track asst professorships (or higher). Required: PhD, strong record (or promise) of research & should be committed to teaching. Fields of special interest: geometric analysis, algebra, numerical analysis & differential equations. By 1/31/87 contact Chairman.

University of Hawaii. Dept of Math, Honolulu, HI 96822. Prof. Ronald P. Brown, Chmn. Possible positions in math, both visiting & tenure track. Rank open. Required: strong commitment to teaching & research. Salaries for full profs range up to $4317, for asst profs from $1894 to $2804. Teaching load 6 hrs. per semester. By 1/15/87 send curriculum vitae & have 3 references sent to Chmn.

Boise State University. Dept of Math, 1910 University Dr, Boise, ID 83725. Dr. Charles Kerr, Chair. Tenure track position 8/20/87. Required: PhD. Duties: teach normal range of undergrad. math courses; teaching load 12 hrs per semester. Interested in all areas of math. Send application, resume, graduate transcripts & 3 letters of reference to Chair. Screening will begin 2/1/87 & continue until position is filled.

Northwestern University. Dept of Math, Evanston, IL 60201. Two tenure track asst professorships. Required: strong research records. Prefer those in fields which complement present faculty. For one position special attention will be given to applicants in field of partial differential equations. Send curriculum vitae, list of publications, and have 3 reference letters sent to Chmn, Personnel Committee.

Western IL University. Dept of Math, Macomb, IL 61455. Larry Morley, Chmn. (1) One or more tenure track asst/assoc professorships 8/24/87. Required: PhD in a math science. Expected: excellent teaching & research. Teach 9-10 semester hours. Competitive salary & fringe benefits. (2) Tenure track asst professorship 8/24/87. Required: earned PhD with emphasis on learning theory & teaching of math. Duties: teach & do research in developmental math program. Salary negotiable. For all positions send resume, photo copies of transcripts & 3 reference letters to Chmn by 2/15/87.

Butler University. Dept of Math Sciences, 4600 Sunset Ave, Indianapolis, IN 46208. Several tenure track asst/assoc professorships in math & comp sci/information systems (CS/CIS). PhD preferred for math positions & PhD in CS/CIS or a PhD in math plus a master's degree in CS/CIS is preferred for the CS/CIS positions. However, a master's in CS/CIS plus significant teaching or industrial experience will be considered. All positions require demonstrated teaching ability. Send curriculum vitae, graduate transcripts & 3 reference letters, one addressing teaching abilities, to Dr. James P. Fink at above address.

Indiana Univ - Purdue Univ at Indianapolis. Dept of Math Sciences, 1125 E. 38th St, P O Box 647, Indianapolis, IN 46223. Prof Bart Ng, Chmn. Two tenure track positions in pure & applied math 8/1987. Required: Doctorate & execllent research record or potential. Prefer applicants in dynamical systems, numerical analysis, mathematical physics, classical & functional analysis, mathematical economics, index theory of elliptic operators, operator algebras, probability & applied stat. Teaching load 2 courses per semester. Excellent fringe benefits & competitive salary. By 1/15/87 send resume & 3 letters of recommendation to Chmn.

Purdue University. Dept of Education, West Lafayette, IN 47907. Asst professorship of math educ. (Higher rank available depending on adequate funding.) This position has excellent opportunities for those with interest in math educ research & teacher training. Applicants with strong qualifications in math may teach courses in math thru joint appt. with Dept of Math. By 1/15/87 send vita, official transcripts, reprints, statement of research plans & 3 letters of recommendation to Dr. J. Dudley Herron at above address, or call (317) 494 5889.

Purdue University. Dept of Math, W. Lafayette, IN 47907. M. S. Baouendi, Head. (1) Several regular or research professorships 8/1987. Required: Exceptional research promise & excellence in teaching. (2) Possibly one position at the assoc prof/prof level 8/1987. Excellent research credentials required. For all positions send resume & 3 letters of recommendation.

Iowa State Univ. Dept of Math, Ames, IA 50011. K. A. Heimes, Chmn. One or more asst professorships (or above) 8/21/87. Preferred specialty: numerical

analysis & discrete math. Other areas of interest are control theory, math educ. & partial differential equations. Required: PhD or equivalent, strength in teaching & research, good communication skills, & ability to direct research in a graduate program. Send application, resume & 3 reference letters to Chmn.

Univ of Northern Iowa. Dept of Math & Comp Science, Cedar Falls, IA 50614. Dr. David Duncan, Head. Asso/assoc professorship in Comp. Sci. Qualifications: strong academic record, demonstrated success in teaching, scholarly activity or promise & Master's in Comp Sci. PhD in Comp Sci or related field preferred. Departmental computer facilties include two Micro VAXs, several PCs & microcomputers. Salary & benefits competitive. Apply by 3/15/87. For complete announcement contact Head.

University of Iowa. Dept of Math, Iowa City, IA 52242. William A. Kirke, Chair. Tenure track, tenured positions and visiting positions at all levels, 1987-88. Selections based on evidence of applicants' effective teaching & research achievements & potential; instructional needs of Dept; potential for interaction with faculty at research level. Required: PhD or equivalent. Prefer those in partial differential equations, differential geometry & numerical analysis. Send vita & 3 letters of recommendation to Chair.

Kansas State Univ. Dept of Math, Cardwell Hall, Manhattan, KS 66506. Louis Pigno, Head. Several tenure track & visiting asst professorships 8/18/87. All fields considered, but one position will be in computational math. Required: PhD or dissertation accepted with only formalities to be completed, strong research & excellence in teaching. Send application, resume & description of research & 3 letters of recommendation to Head by 2/1/87 for first consideration; then monthly to 8/1/87.

University of Maine. Dept of Math, Orono, ME 04469. Chair of Dept of Math which serves Dept of Comp Sci & College of Engioneering & Science. Expected to strtengthen graduate program at Master's level as well as program for undergraduate majors. Successful record of teaching and scholarship will qualify candidate for a senior tenurable position. Apply by 2/1/87to Michael C. Gemignani, Dean, College of Arts & Sciences, Stevens 100, at above address.

University of Southern Maine. Dept of Math, 96 Falmouth St, Portland, ME 04103. One or more tenure track positions 9/1/87. Required: PhD (or PhD near completion) in stat, probability or operations research. Rank & salary negotiable. Send applications, graduate transcripts & 3 letters of reference to Dr. Merle Guay at above address. Review of applications begins immediately.

Towson State Univ. Math Dept, Baltimore, MD 21204. Dr. Robert Hanson, Chairperson, Search Committee. Tenure track asst professorship in math education Fall 87. Teach 12 hrs/semester of undergraduate courses. Required: PhD in math educ & commitment to teaching and research. Prefer applicants with 3 years teaching/research experience in elementary and/or early childhood education. Salary range: low 20's to low 30's. Send resume, 3 letters of recommendation & transcripts by 2/1/87 to Dr. Hanson.

University of Maryland Baltimore County. Dept of Math, Catonsville, MD 21228. James M. Greenberg, Chmn. (1) Tenure & tenure track faculty positions in applied math 9/1/87. Required: PhD & research & teaching experience commensurate with position applied for. Seeking candidates with strengths in combinatorics, control & communication, operations research, scientific computing & applied analysis. (2) Tenure & tenure track faculty positions in statistics 9/1/87. Required: PhD, strong teaching ability & demonstrable research potential in either mathematical or applied stat. For all positions send curriculum vitae, reprints and/or preprints, names of at least 3 referees & summary of current research to Chmn by 1/15/87.

Holy Cross College. Dept of Math, Worcester, MA 01610. Thomas E. Cecil, Chmn. (1) One tenure track position 9/1987 for mathematician interested in teaching at an undergraduate liberal arts inst. PhD required. Teaching load 3 courses each semester.(2) One tenure track position in dept which is developing a concentration in computing. Required: PhD in C.S. or in math with strong interest & background in comp sci. Rank & salary open. Special funds available to assist computer scientist in forming ties with appropriate private corporation. Send resume, undergraduate & graduate transcripts & 3 letters of reference to Chmn.

Williams College. Dept of Math Sci, Williamstown, MA 01267. Robert M. Kozelka, Chaircreature. Anticipated openings for regular appts in math, Fall '87, requiring PhD or equiv.: One asst prof. 3-yr appt., field open. One appt with rank open; senior level possible for demonstrated res. & teaching ability, especially in applied mathematics or statistics. Teach 5 term courses per yr. plus alternate Jans. Fringe benefits include TIAA-CREF, Life & Med. Ins. Both appts include long-term possibilities. Closing date 1 Mar. '87 or until positions are filled.

Central Michigan Univ. Dept of Math, Mt. Pleasant, MI 48859. R. J. Fleming, Chmn. Tenure track position in math education Fall, 1987. Required: promise of excellence in teaching & interest in research; doctorate or near doctorate; expertise in elementary, middle or secondary school mathematics education; recent teaching experience at precollege level; ability to teach undergrad math classes; conduct research in math educ. Salary competitive & benefits good. By 2/16/87 send resume, transcripts & 3 letters of recommendation to Chmn. If position not filled, later applications will be considered.

Hope College. Math Dept, Holland, MI 49423. Tenure track position 8/1987. PhD in math required. Research & scholarly activity involving undergraduates is encouraged. Rank & salary depend on qualifications. Competitive salary and full benefit package offered. Forward vita, transcripts & have 3 recommendation letters sent to John R. Stoughton, Math Dept, by 1/1/87.

Michigan State Univ. Dept of Math, East Lansing, MI 48824. Prof Kyung Whan Kwun, Chmn. (1) Two postdoctoral fellowships in math (2 yr appt). Duties: teach one course per term & devote rest of time to research. These fellowships normally offered to persons (regardless of age) who have had doctorates less than 2 years. Some instructor positions available. Apply by 1/17/87. (2) Several tenured asst/assoc professorships (maybe full professorship) 9/1/87. PhD in math, excellence in research (numerical analysis & other fields) & in teaching. For both positions send resume & have 3

letters of recommendation sent to Chmn by 12/22/86.

Michigan State Univ. Dept of Stat & Probability, East Lansing, MI 48824-1027. Professor Dennis Gilliland, Chairperson. Asst, Assoc or Full Professorship (tenure track) Fall, 1987. Required: PhD in stat or probability & strong commitment to excellence in research & teaching. Send resume & 3 letters of recommendation to Chairperson.

Oakland University. Dept of Math Sciences, Rochester, MI 48063. Donald E. G. Malm, Chair. One year positions Fall, 1987 or later. Level depends on qualifications. Required: PhD & demonstrated excellent record in res. or strong potential for res. Prefer those whose interests coincide with those in Dept. Duties: teach 2 courses each semester. Send resume & 2 letters of reference to Chair by 2/10/87. Late applications considered if positions are not filled.

University of Michigan. Dept of Math, Ann Arbor, MI 48109-1003. Prof D. J. Lewis, Chmn. (1) Six tenure or tenure track senior asst professorships 9/1987. At least 3 in mathematics of computational or applied math. Other areas not specific, but special consideration given to representation theory, combinatorics, differential geometry & analysis. Exceptional research & teaching background required. Applications considered on a continuing basis. Salary & rank negotiable. (2) Two T. H. Hildebrandt Research Asst Professorships 9/1987. 3 year appt; reduced teaching load. Prefer persons of any age having PhD less than 2 years. Expect several 3-year terminal asst professorships. Area not specific. Seek applicants with strong research program & serious commitment to teaching. Salary competitive. Apply to Head by 1/6/87.

University of Michigan, Dearborn. Dept of Math & Stat, 4901 Evergreen Rd, Dearborn, MI 48128. Ronald Morash, Chmn, Search Committee. (1) Tenure track asst professorship 9/1987. Required: PhD in math with res. interest in an applied area. Teaching capability in applied area is desirable. (2) Possible assoc professorship in comp sci. PhD in math acceptable. Research interest in comp sci is preferred for this position; some teaching capability in math is required. Teaching load 9 credit hrs per term. Send resume & have 3 letters of recommendation sent to Chmn, Search Committee.

Macalester College. Dept of Math & Comp Science, St. Paul, MN 55105. John Schue, Chmn. Tenure track position Fall, 1987. Required: PhD or near completion of PhD in math or comp sci. Teach upper level courses. Applicants must be devoted to excellence in undergraduate teaching & scholarship. Salaries & benefits competitive. Apply to Chmn.

Moorhead State Univ. Math Dept, Moorhead, MN 56560. Milton Legg, Chair. Tenure track asst/assoc professorship 9/1987. Required: PhD in math or stat. Applicants should have background in stat sufficient to teach undergraduate statistics courses at all levels. Besides teaching, appointee will advise students & do univ and departmental committee work. Apply to Chair by 2/15/87.

St Cloud State University. Dept of Math & Stat, St Cloud, MN 56301. Gail Earles, Chairperson. Four tenure track asst & assoc professorships 9/1987.

One position in math education, other position open to all areas of specialization. Required: Commitment to undergraduate education, excellent teaching credentials & record of/or strong potential for research. PhD preferred, but ABD's should apply. By 2/15/87 send resume, graduate transcripts & 3 letters of reference to Chairperson.

University of Minnesota, Duluth. Dept of Math & Stat, MG 320, 10 University Drive, Duluth, MN 55812. Harlan Stech, Search Committee Chair. Applied/Computational Mathematics. Tenure track asst or assoc. Start 9/1/87. Teach 2 courses per quarter; assist in master's program, conduct research, dept & college responsibilities. Required: PhD in math or related field by 9/1/87. Send resume, grad transcripts & 3 letters of reference by 2/1/87 (218-726-8272)

Winona State Univ. Winona, MN 55987. (1) Full time tenure track asst/assoc professorship in Dept of Math & Stat 9/1987. Salary dependent on qualifications & experience. Teach upper division applied stat courses, service statistics & undergrad. math courses. Duties may include off-campus teaching and/or outreach to regional institutions & industries. Prefer PhD in stat but will consider MS in stat. Prefer candidates in biostatistics & health care stat. Industrial statisticians meeting degree requirements will be given full consideration. Competencies: knowledge of stat & applied stat, excellence in teaching, willingness to serve on dept & univ. committees, desire to advise & help students, ability to work cooperatively with colleagues. Send transcripts, resume & 3 to 5 recent letters of recommendation to Stat Search, Affirmative Action Officer, at above address. Position will remain open until filled. (2) Tenure track appt in Dept of Computer & Information Sciences. Duties: teach undergrad. computer and/or inf. science courses & help develop comp. educ. program for teacher educ. PhD preferred but will consider Master's Degree in comp sci or inf. science or comp sci education. Competencies: knowledge of comp sci with special emphasis in areas of systems analysis, software engineering or comp sci educ. Other competencies are same as those listed in first position. (3) Tenure track appt in Dept of Comp & Information Sciences. Duties: teach undergrad computer and/or inf. science courses in curriculum based on ACM guidelines. Required: PhD in comp sci or related engineering field. Will also consider Master's Degree in comp sci with add'l qualifications. Prefer applicants with evidence of teaching experience and/or business-industrial comp sci experience. Competencies: knowledge of comp sci & its applications. Other competencies as listed in first position. For positions 2 & 3 send transcripts, resume & 3 to 5 recent letters of recommendation to Comp. Sci. Search, Affirmative Action Officer, at above address. Positions will remain open until filled.

Northeast Missouri State Univ. Div. of Math & Comp Science, Kirksville, MO 63501. Four tenure track positions in math and one in comp sci. 8/1987. Also 2 or more temporary positions. Rank, salary & teaching load depend on qualifications, experience & research activity. Required: strong commitment to excellence in teaching. Permanent positions require PhD. Send resume, transcripts of all undergraduate & graduate study & 3 reference letters to Lanny Morley, Head.

University of Missouri, Columbia. Dept of Math, Columbia, MO 65211. Three tenure track positions at all faculty levels. Required: PhD & distinguished research. Dept wants person in harmonic or probabilistic analysis at rank of assoc prof or above. Selections based on demonstrated res. achievement & quality teaching. By 1/15/87 send vita & 3 letters of recommendation to Keith Schrader at above address.

Dartmouth College. Dept of Math & Computer Science, Hanover, NH 03755. (1) 3 year tenure track position. Research in algebra (including algebraic geometry, algebraic number theory) of most interest, followed by combinatorics, probability & topology; applications welcome in all fields. Teaching: four ten-week courses spread over 2 or 3 quarters; may supervise graduate students. Send application, statement of res. activities & plans, graduate transcript, resume & 4 letters of recommendation to Recruiting Committee at above address. (2) John Wesley Young Research Instructorship, a 2 year postdoctoral appt for new or recent PhD's whose interests overlap those of a dept member. Teaching: 4 ten-week courses spread over 2 or 3 quarters. Nine-month salary: $26,000; $3000 summer research stipend. Send application, resume, graduate transcript, thesis abstract & 3 or preferably 4 letters of recommendation to Recruiting Committee at above address by 1/31/87.

Rutgers University. Campus at Newark, Dept of Math & Comp Sci, Smith Hall, Newark, NJ 07102. Jane Gilman, Chair. (1) Full Professorship 7/87. Required: strong research accomplishments. Teaching load & salary negotiable. (2) Several tenure track asst & assoc professorships 7/1987. Required: strong res. accomplishments or potential. Teaching load & salary negotiable. For all positions send curriculum vitae & have 3 references sent to Chair.

New Mexico State Univ. Dept of Math Sciences, Las Cruces, NM 88003. Carol L Walker, Head. Visiting positions & possible tenure track asst professorships in pure & applied mathematics, numerical analysis, statistics & computer vision 8/24/87. Salary competitive. PhD (or equivalent) & strong commitment to teaching & research essential. Send vita & have 3 reference letters sent to Head.

Colgate University. Dept of Math, Hamilton, NY 13346. Dan Saracino, Chmn. Two one year visiting appts at Instructor/Asst Prof level. One may be renewed for 2nd year. Research interests of dept include commutative ring theory, low-dimensional topology, combinatorics, statistics & model-theoretic algebra. All fields of specialization welcome. Send vita & 3 letters of recommendation by 3/15/87 to Chmn.

Cornell University. Dept of Math, Ithaca, NY 14853-7901. (1) H. C. Wang Asst Prof 7/1/87. Non-renewable, 3-year term. (2) Possible tenure track position asst prof. or above 7/1/87. For positions 1 & 2 send vitae & 3 letters of recommendation to Chair by 2/1/87. (3) Visiting positions anticipataed acad yr 1987/88. Send vitae & 3 letters of recommendation to Chair by 2/15/87. (4) Visiting positions acad yr 1987/88 for math profs on sabbatical or other leaves from private liberal arts colleges East of the Mississsippi, sponsored by the Charles A. Dana Foundation. Salary $15,000 plus summer stipend. Teach 12 identical freshman calculus classes. Send 2 teaching references, vitae, proposal for research and/or study program, & how visit would benefit home institution to Chair by 1/15/87.

Cornell University. Dept of Education. Twelve month tenure track asst professorship in Dept of Educ with close ties to Dept of Math. 50% teaching & 50% research. Expected: To maintain strong research program in math educ, advise grad students, help implement a small high-quality teacher-preparation program & basic college math course. Qualifications: PhD in educ. and/or math with demonstrated interest in teaching and in research in math education. By 2/1/87 send vita, academic transcripts & 3 letters of recommendation to Jason, Millman, Chair, Search Committee, 301 Roberts Hall, Cornell University, Ithaca, NY 14853.

Hamilton College. Dept of Math & Comp Sci, Clinton, NY 13323. Larry Knop, Chair. Two year tenure track position. PhD required. 3 years teaching experience desirable. Duties: teach 6 courses per year. Required: excellence in teaching & continued scholarly research. Send curriculum vitae & 3 reference letters (one about teaching) to Chair. (315) 859 4783.

Rensselaer Polytechnic Inst. Dept of Math Sciences, Troy, NY 12180. J. G. Ecker, Chmn. Seek high quality applicants for several tenure track openings at all levels in areas of applied math, including mathematical programming, 9/1987 or earlier. PhD & very strong research potential required for junior-level appts & demonstrated outstanding record for senior-level appts. Also anticipate 2 or 3 Visiting & Postdoctoral appts at all levels.

SUNY-Albany. Dept of Math & Stat., Albany, NY 12222. Joe W. Jenkins, Chair. (1) Tenured & tenure track positions. Fields of interest: algebraic number theory & geometry, complex analysis in several variables, geometry/topology, and/or Lie theory. Outstanding res. accomplishments required. (2) Malcolm F. Smiley Instructorship. 3 year position with reduced teaching load of 3 courses a year. Exceptional res. promise required. All candidates should have strong commitment to good teaching. By 1/15/87 send vita & have 3 letters of reference sent to Chair.

SUNY College at Brockport. Dept of Math & Comp Sci, Brockport, NY 14420. Dr. Kazumi Nakano, Chairperson. (1) Tenure track asst/assoc professorship 9/1987. Required: PhD in math with expertise in discrete math, probability, applied math, or operations research & strong commitment to teaching at undergraduate & masters' level. Contact Dr. K. Nakano at 716-395-2194. To apply send application, resume & have 3 letters of reference sent by 2/6/87 to Office of Faculty Staff Relations. (2) Tenure track position in comp sci 9/1987. Strong commitment to comp sci education needed. PhD in comp sci or related area required. Masters' level expertise in comp sci necessary. Prefer specialization in operating systems, microprocessors, networking, or computer graphics. Contact Dr. K. Nakano at 716-395-2194. To apply send application & resume and have 3 letters of reference sent to the Office of Faculty/Staff Relations.

East Carolina University. Dept of Math, Greenville, NC 27858-4353. Tenure track asst/assoc professorship in math education 8/19/87. Candidates should have a Phd or EdD in math or math ed.; recent elementary or secondary teaching experience desirable, plus a knowledge & interest in the use of microcomputers in math ed. & research interests.Send resume, official transcripts, and 3 letters of reference by 2/1/87 to Dr. Robert L. Bernhardt, Chmn, at above address.

SUNY - Buffalo. Dept of Math, 106 Diefendorf Hall, Buffalo, NY 14214. Dr. Jonathan Bell, Search Committee Chairman. Tenured assoc prof/professorship 9/1/87. Salary competitive. Seeking applicants with outstanding research in areas of applied math, applied analysis & numerical analysis. By 3/15/87 send curriculum vitae & other supporting information to Dr. Bell.

Univ of North Carolina, Greensboro. Dept of Math, Greensboro, NC 27412. (1) Tenure track Asst Professorship of Math 8/1/87. Qualifications: PhD in Math. Prefer candidates with research in algebra or number theory & teaching experience. Competitive salary. By 1/15/87 send resume & names & addresses of 3 references to Search Committee at above address. (2) Tenure track Asst Professorship of Comp Sci 8/1/87. Required: PhD in Comp Sci or PhD in related field with MS in Comp Sci. Duties include teaching & research. Competitive salary. Send resume & names & addresses of 3 references to Search Committee at above address. Will accept applications until position is filled.

Bowling Green State Univ. Dept of Math & Stat, Bowling Green, OH 43403-0221. Arjun K. Gupta, Chair. (1) Two tenure track asst professorships. Position I in analysis & Position II in combinatorics or research area compatible with present faculty. Required: PhD by 8/15/87, strong research record & strong commitment to teaching. Duties: research, undergraduate & graduate level teaching & active participation in our PhD program. Salary competitive. Indicate which position applied for and send vita, graduate transcript & have 3 reference letters sent to Chair by 2/2/87. (2) Instructorship 8/15/87. Temporary position renewable up to 5 years. Master's degree in math required with previous teaching experience desirable. Salary competitive. By 3/2/87 send vita, transcripts & 3 reference letters to Chair.

Case Western Reserve Univ. Dept of Math & Stat, Cleveland, OH 44106. W. A. Woycznski, Chmn. Tenure track, possibly senior, positions 8/15/87. Required: outstanding research record and/or proven research potential & teaching excellence. Preferred areas: stat & numerical methods, but for junior positions will consider areas of global analysis, dynamical systems, control theory, probability & functional analysis. Visiting positions most likely in area of applications of probability & graph theory to chemistry. Send vita plus 3 letters of recommendation to Chmn.

Univ of Cincinnati. Dept of Math Sciences, Mail Location #25, Cincinnati, OH 45221. C. W. Groetsch, Head. Several asst professorships. Some possible visiting positions. For 2 of the tenure track positions we prefer applicants in numerical analysis & applied math. Other candidates with outstanding potential for research, scholarship & teaching will be considered. Send vitae & 3 reference letters to Head.

Kent State University. Dept of Math Sciences, Kent, OH 44242. Olaf P. Stackelberg, Chmn. Tenure track asst or assoc professorship in numerical analysis and computational math 9/1987. PhD in numerical analysis or closely related field required by starting date. Salary competitive & negotiable. The Dept operates a computer laboratory with a VAX 11/780 (on CSNET), and a VAX 11/750, both under UNIX; a STARAN-E 512 processors parallel SIMD computer; four fully configured HP Labs AI 9000/300 workstations with the latest software; a Tektronix 4404 advanced AI work station; laser printers; and other micro computers & peripheral equipment. Univ facilitieks include an IBM 3081D

(on BITNET); a cluster of two VAX 11/780s under VMS; a Honeywell DPS 66; and other equipment.) By 3/2/87 send resume & have 3 letters of recommendation sent to Chmn. If position is not filled by 3/2/87, the deadline will be extended to 8/17/87.

Kenyon College. Math Dept, Gambier, OH 43022. Stephen Slack, Chair, Search Committee. (1) Tenure track asst professorship 87/88. Candidates must have some experience & have PhD by 8/87. Prefer candidates in prob/stat or applications. Good background in C.S. or combinatorics or modeling is an asset. Required: strong commitment to undergrad teaching & scholarship. Teach 3 courses per semester. (2) Tenure track asst/assoc professorship 87/88. Required: PhD & broad background in math. preference for math applications. Background in C.S. or combinatorics or modeling or prob/stat is an asset. Strong commitment to undergrad teaching & scholarship is required. Teach 3 courses/sem. For both positions send vitae, transcripts, & 3 reference letters (at least one regarding teaching) to Chair, Search Committee. Call (614) 427-2244 X2267 for information. Contact us by 1/1/87 to arrange interview at AMS meeting in Jan. Deadline is 2/8/87.

Oberlin College. Dept of Math, Oberlin, OH 44074. Robert M. Young, Chmn. Three year position at rank of instructor or asst professor 7/1/87. Appointee will teach one advanced course in discrete math & other introductory & intermediate courses to make a total of 5 each year. Required: PhD by 9/1987. Previous experience as a teacher desirable. Will help with Senior Honors Program & participate in academic advising, service on committees & scholarly research. Send vitae, transcripts & 3 reference letters to Chair.

Lewis & Clark College. Dept of Math, Box 110, Portland, OR 97219. Roger B. Nelsen, Chair. Tenure track asst professorship 9/1987. Prefer applicants in geometry, graph theory and/or combinatorics. Required: PhD, experience teaching undergraduates & continuing research. Teaching load averages 10 hrs per week with 2 or 3 preparations. Send letter indicating career interests, priorities, & goals; resume & 3 letters of recommendation to Chair by 2/13/87.

Oregon State University. Dept of Math, Corvallis, OR 97331. (1) Possible assoc professorship in applied math or numerical analysis 9/1987. Salary negotiable depending on qualifications. Closing date 1/15/87. (2) Possible asst professorship in applied math, numerical analysis, geometry or probability 9/1987. Salary negotiable depending on qualifications. Closing date: 1/15/87. (3) Visiting appts 1987/88. PhD or equivalent training & experience. All ranks considered. Prefer applicants who augment res. areas in Dept & meet instructional needs. Renewals possible. No closing date. For all positions write to P. M. Anselone, Staff Selection Committee.

Bryn Mawr College. Math Dept, Bryn Mawr, PA 19010. Prof. Mario Martelli, Chmn. Three year (possibly renewable tenure track) Asst Professorship in Math & Comp Sci 9/1/87. Required: PhD in one of the two fields with ability to teach intermediate & advanced undergraduate level courses in both. Selection based on teaching effectiveness & research promise. Send application, resume, & have at least 3 reference letters sent to Chmn by 2/1/87.

Bryn Mawr College. Dept of Math, Bryn Mawr, PA 19010. Emmy Noether Lectureship for one semester 1987-88. The Lectureship is financially

supported by the Noether Fund, which was established at the time of Emmy Noether's death, and has been augmented by generous contributions since the Noether Symposium at Bryn Mawr in 1982. The award is given in this form for the first time. Candidates must be women having a PhD in math. Expected to teach one graduate/advanced undergraduate course and to actively pursue her research interests. Salary will depend upon the candidate's qualifications. Submit vita, plan of research, & have 3 letters of recommendation sent to Frederic Cunningham, Jr., Chmn, Selection Committee, at above address by 2/1/87.

Indiana Univ of PA. Dept of Math, Indiana, PA 15705. Asst/assoc (tenure track) professorship 9/1987. Teach grad & undergrad courses with emphasis on operations research or applied math; help direct graduate internship program in applied math & participate in other activities of dept. Required: PhD in an applied math field or in math with experience in operations research or applied stat. By 1/10/87 send resume & names, addresses & tel. nos. of 3 references to Search Comm. at above address.

Rhode Island College. Math & Comp Sci Dept, Providence, RI 02908. Helen E. Salzberg, Chair. (1) Tenure line appt Fall, 1987. Required: PhD in math or math educ with sufficient math background to teach wide variety of math courses at all levels. Salary $20,000-$29,000. Attractive fringes. By 3/2/87 at 4:00 p.m. send resume, transcripts & 3 current letters of reference to Chair. (2) Tenure line appt Fall 1987. Required: PhD in math with ability to teach a variety of comp sci courses or PhD in comp sci. Will consider applicants with Master's & teaching experience for a 3 year appt. Salary & rank competitive, commensurate with qualifications. Attractive fringes. By 3/23/87 send resume, transcripts & 3 current letters of reference to Chair.

College of Charleston. Dept of Math, Charleston, SC 29424. William L. Golightly, Chmn. At least 3 tenure track asst professorships Fall, 1987. Qualifications: PhD in one of math sciences, commitment to undergraduate teaching & potential for continuing research. Teaching: 9 hrs a week for those engaged in research. Salary competitive. Send resume & have 3 letters of recommendation sent to Chmn.

Univ of South Carolina. Dept of Math, Columbia, SC 29208. Dr. Colin Bennett, Chmn. Tenure track positions at all levels. Will consider all areas of math. Prefer applicants in applied & computational math. Required: PhD; commitment to excellence in res. & teaching at both undergraduate & graduate levels. Dept operates its own computation center (VAX 8300 & 11/750); terminals in each faculty office provide access to VAX complex & to Univ's IBM 3081 mainframes & FPS 264 array processor. Send resume, summary of res. & goals & 4 letters of recommendation to Chmn.

Memphis State University. Dept of Math Sciences, Memphis, TN 38152. Ralph Faudree, Chmn. Tenure track positions in math, computer science & statistics, Fall, 1987. Required: PhD by 91/87 & strong potential for excellence in teaching & research. Dept offers degrees at all levels including PhD, very favorable research environment in terms of library & computing facilities, teaching load, travel opportunities etc. Send resume & 3 letters of reference to Chmn. Selection starts 2/1/87 and will continue until positions are filled.

Tennessee Technological Univ. Dept of Math, Cookeville, TN 38505. Alice Mason, Chmn. Tenure track asst/assoc professorship 9/1/87. Seeking applicants in applied math but will consider those in other areas. Required: PhD in math, stat or related area; strong commitment to excellence in teaching (grad & undergrad levels); serious interest in research. Send application, vitae (including citizenship and/or visa status) & transcripts of graduate work & have 3 letters of recommendation sent to Chmn. Applications accepted until position is filled.

Rice University. Dept of Math, P. O. Box 1892, Houston, TX 77251. One or more asst professorships (or higher) in fields of algebra, analysis, geometry, or topology. Two Griffith Conrad Evans Instructorship postdoctoral appts for 2 to 3 yrs for one whose interests augment res. areas at Rice. One visiting position in fields of algebra, analysis, geometry or topology. By 2/15/87 contact Appts Committee at address above.

University of Texas, Arlington. Dept of Math, Arlington, TX 76019. Several asst professorships 9/1/87. Will consider higher ranks for those who qualify. Appointees must have excellent teaching & research credentials. Desired areas of expertise are numerical & applied math, discrete math, differential geometry & math education. Send resume with 3 letters of recommendation to Dr. Chien-Pai Han at above address.

Univ of Utah. Dept of Math, Salt Lake City, UT 84112. (1) Three or four non-renewable 3 year instructorships. Persons of any age receiving PhD's in 1986 or 1987 are eligible. Selections made on basis of ability & potential in teaching & research. Starting salary $24,000. (2) One or more visiting positions of one year or less. (3) Two tenure track asst or assoc professorships & one tenure track assoc or full professorship. Applications must include curriculum vitae, bibliography & 3 letters of reference. (Instructorship applications must include abstract of thesis & list of graduate courses completed or transcripts.) By 2/28/87 send application to Committee on Staffing, Dept of Mathematics.

Univ of Vermont. Dept of Math & Stat, Burlington, VT 05405. Donald E Moser, Chmn. (1) Visiting Prof or Assoc Prof with strong res. program in algebraic number theory, algebraic geometry, approximation theory, combinatorics, graph theory or harmonic analysis. Send resume, abstract of current res. & names of 3 references to Chmn. (2) Tenure track asst prof. in applied math or areas listed in (1) above. Expect significant res. accomplishments or outstanding res. promise & excellence in teaching. Send resume, transcripts, & 3 letters of recommendation to Chmn.

University of Vermont. Dept of Math & Stat, Burlington, VT 05405. Donald E. Moser, Chmn. One or two lectureships 9/1/87. Temporary one year, non tenure track appts, possibly renewable for second year. Duties: teach undergrad. math thru linear algebra & differential equations. PhD preferred but M.S. acceptable. Salary competitive & commensurate with experience. Send resume, transcripts & 3 letters of recommendation to Chmn.

Eastern Washington Univ. Computer Science Dept, MS #86, Cheney, WA 99004.Tenure track assoc professorship 9/1987. Salary commensurate with qualifications & experience. Preferred: PhD or equivalent in comp sci or

related field. Industrial experience considered. Send vita, resume & name of 3 recommendations to Dr. S. F. Robinson at above address.

Washington State University. Pure & Applied Math, Pullman, WA 99164-2930. Prof. Duane W. DeTemple, Chmn, Search Committee. Two openings, one tenure track & one temporary 8/1987. Tenure track position requires PhD with active research interests in computational math, numerical analysis or operations research/combinatorial optimization. Area of research is more open for temporary position. By 2/15/87 send vitae & 3 letters of reference to Chmn.

Western Washington Univ. Dept of Math, Bellingham, WA 98225. Thomas T. Read, Chmn. Tenure track & visiting positions Fall, 1987. Required: PhD in math. Seeking candidates especially in ordinary or partial differential equations or in geometry with emphasis on convexity or combinatoric enumeration, but will consider others. Necessary: ability to work with existing faculty, be good teacher and do active research. Rank & salary open. Send vita, transcript, 3 letters of recommendation to Chair by 2/1/87.

Univ of Wisconsin, Eau Claire. Dept of Math, Eau Claire, WI 54702. Dr. Marshall E. Wick, Chmn. At least 2 tenure track positions. All specialties considered, but prefer those in algebra or geometry. PhD strongly preferred. 12 hour teaching load in undergraduate teaching. Necessary: evidence of potential for excellence in teaching. One or two year initial appt. By 2/15/87 (or until positions are filled) send resume, graduate & undergraduate transcripts & 3 letters of recommendation to Chmn.

Univ of Wisconsin, Milwaukee. Dept of Math Sciences, P O Box 413, Milwaukee, WI 53201. Robert H. Moore, Chmn. Tenure track asst professorship Fall, 1987. Seek candidates especially in applied analysis including ordinary & partial differential equations and numerical methods. Required: proven ability or demonstrated potential for research as well as good teaching qualifications. Send credentials & have 3 letters of recommendation sent by 2/1/87 to Chmn.

Queen's Univ at Kinston. Dept of Math & Stat, Kingston, Ont, Canada K7L 3N6. Prof. L. L. Campbell, Head. One three year renewable (tenure track) position 7/1/87. A 3 year Queen's National Scholarship which might become tenure track. Required: demonstrated potential in res. & teaching. Dept particularly interested in those in fields of analysis, probability, or statistics. Salary dependent on experience & qualifications. By 1/31/87 send vita to Head & have 3 letters of recommendation sent also, one of which should comment on teaching ability. This advertisement is directed to Canadian citizens & permanent residents.

York University. Dept of Math, 4700 Kkeele St, North York, Ont. M3J 1P3 Canada. Joan Wick Pelletier, Chair. One or more tenure track or limited term positions, rank & field open, 7/1/87. Required: Proven ability or demonstrated potential for research & teaching. Prefer candidates in stat or operations res. By 1/15/87 send resume & at least 3 letters of recommendation to Chair.

Association for Women in Mathematics
Box 178, Wellesley College, Wellesley, MA 02181
617-235-0320 Ext 2643

Application Blank

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    AWM for the first time.) For each of 1st 2 years $10_____
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      (Includes nomination of 5 students for free membership for 1 year)
    Regular $25 _____

Name _____

Address _____

Institutional Affiliation, if any _____

Marie A. Vitulli
Univ of Oregon
Dept of Math
Eugene   OR 97403