PRESIDENT'S REPORT

Dr. Marguerite Lehr, Professor Emerita of Mathematics at Bryn Mawr College, died on December 14, 1987. I first met Miss Lehr when I was interviewing for a position at Bryn Mawr. She enthusiastically attended my talk and most of our colloquia for the next few years; some of you may remember her from the panel discussion at the Emmy Noether Symposium. Several years ago, Pat Kenschaft wrote an article about Miss Lehr that appeared in this *Newsletter*. Pat tells me that Marguerite liked the article very much, and so we are reprinting it in this issue, as a tribute to an extraordinary woman.

*   *   *   *   *   *   *   *   *   *   *   *   *   *   *

Congratulations and welcome to our new officers, President-Elect Jill Mesirov, Treasurer Jenny Baglivo, and Members-at-Large Rebekka Struik and Carol Wood. Also, many thanks to outgoing officers Vivienne Mayes and Evelyn Silvia (Members-at-Large) and Treasurer Lynnell Stern. Lynnell has devoted considerable time to AWM, and we are most grateful for the expert job she has done.

*   *   *   *   *   *   *   *   *   *   *   *   *   *   *

Atlanta. After the tranquility of Salt Lake City, the Atlanta meetings seemed somewhat hectic. AWM activities were very exciting, with large audiences attending all of our events. Karen Uhlenbeck (University of Texas at Austin) presented this year's Emmy Noether Lecture, "Moment Maps in Stable Bundles: Where Analysis, Algebra, and Topology Meet." The AWM panel, "Is the Climate for Women in Mathematics Changing?," was moderated by Judith Roitman, with panelists Mary Ellen Rudin, Louise Hay, Karen Uhlenbeck, and Nancy Stanton. According to Louise Hay, the answer to the question "is a resounding — yes and no." The entire panel discussion will be written up in the next *Newsletter*.

The *Directory of Women in the Mathematical Sciences* is out, thanks to the efforts of Rebekka Struik. See below for details.

At the Executive Committee meeting, concern was expressed about the almost total absence of women speakers from the AMS Centennial activities, a subject on which I commented in my last Report. We plan to contact conference organizers earlier in the organizational process, rather than always registering protests after the list of speakers appears, and it is too late to alter the situation. It is truly unfortunate that "100 Years of American Mathematics" was not conceived from the outset as a celebration not only of the enormous success of American mathematics, but as a celebration of the mathematical achievements of women, Blacks, and other minority groups in this country, often despite great odds against their success.

The Executive Committee passed a resolution giving one hundred free memberships per year for members of Third World and Eastern bloc countries. In addition, we had committee reports from Evelyn Silvia (Committee on Relationships with Other Societies), Sally Lipsey (Math Ed), and Anita Solow (Maternity Policies), summaries of which appear in this *Newsletter*.

Our Executive Director, Lori Kenschaft, announced that she will be leaving us this summer to go to graduate school. We are now examining options for relocating the AWM office, and welcome your suggestions.

At our Business Meeting, Gudrun Kalmbach reported on recent and future activities of EWM (European Women in Mathematics), a sister organization to which we offer support and best wishes.

The Joint Committee on Women passed the following resolution: Be it resolved that the planning committee of the 75ᵗʰ anniversary of the MAA make special efforts to assure that women and minorities are represented as major speakers in the areas of mathematics research, mathematics history, and mathematics education.

On Friday evening, NAM hosted a dinner honoring Dr. Evelyn Boyd Granville and the memory of Dr. Marjorie Browne, the first Black women to receive Ph.D.'s in mathematics. Lee Lorch graciously read a statement of congratulations on behalf of AWM.

General concern was expressed in Atlanta over the fate of WAM (Women and Mathematics), which orchestrates many talks each year for high school students. The future of WAM is in question, and AWM will seek from the MAA further explanation of this unfortunate situation.

There! I told you it was hectic.

News Briefs. * Felicitations to the six women (and five men) awarded Graduate Fellowships in mathematics and computer science by the Office of Naval Research: Yvette D. Bell, Andrea Bertozzi, Clara S. Chan, Kathryn Dana Ellis, Amy F. Moorman, and Elizabeth G. Schwerer.

* I am delighted to announce that Martha K. Smith (University of Texas at Austin) is our first Book Review Editor.

* SIAM President Charles Gear has invited AWM to hold a panel discussion at SIAM's annual meeting in Minneapolis in July. Jill Mesirov is organizing a panel on women in applied mathematics. We welcome this expansion of AWM activities, and thank Dr. Gear for his expressed interest in acknowledging and encouraging women in applied mathematics.

Rhonda Hughes
Department of Mathematics
Bryn Mawr College
Bryn Mawr, PA 19010
BITNET: RHONDAJ@BRYNMAWR

HONORS AND AWARDS

Several woman have been invited to speak on the fifth day of the Sixth International Conference on Mathematical Education (ICME-6) in Budapest, July 27–August 3, 1988. The topic of that day is "Mathematics, Education and Society." Claudia Zaslavsky will be delivering an illustrated lecture with the topic "Integrating Mathematics With the Study of Cultural Traditions." Marilyn Frankenstein (University of Massachusetts – Boston) and Gloria Gilmer (Math-Tech Connexion, Milwaukee, chair of International Study Group on Ethnomathematics) will also be speaking.

Congratulations to Caroline M. Series of the University of Warwick. She has received a 1987 Junior Whitehead Prize from the London Mathematical Society for her work on dynamical systems.

Congratulations to Laura Silber, a graduate student at Boston University. She has received a Fulbright award for 1987-88 for study in West Germany.

DIRECTORY OF WOMEN IN THE MATHEMATICAL SCIENCES

The *Directory of Women in the Mathematical Sciences* contains information on over 500 women mathematicians. They are listed in alphabetical order along with biographical information (year and institution of highest degree, address of employer, mathematical interests, two publications), by mathematical interest, and by geographical location.

The *Directory* is $3 for AWM members, $5 for non-members, and $2 for students, retired, and unemployed. Write to AWM, Box 178, Wellesley College, Wellesley, MA 02181 to order your copy.

ERRATA

In the last *Newsletter* the following was omitted from the article "Joint Committee on Women in the Mathematical Sciences" on page 6: Those attending the Joint Committee meeting were Betty Lichtenberg, Chair; Carol Lacampagne, Past Chair; Marjorie Eneking; Lori Kenschaft; and Pat Kenschaft.

Also, on page 17, Margaret M. Bayer was incorrectly identified as Marjorie Bayer.

LETTER FROM THE EDITOR

I am inviting electronic submissions of messages and articles. My BITNET address is LMA24@LUCCPUA (strikingly easy to remember, wouldn't you say?). I can be reached on USENET via a University of Chicago node: if you know how to reach gargoyle, you can reach me with gargoyle!cantor!borel!alm. If you have a choice, USENET files are easier for me to transfer to my word processor.

The Kovalevskaia Fund *Newsletter* is always interesting. The current issue contains an article about the recent Central American Conference on Women in Science, Technology, and Medicine held in Managua, Nicaragua. Donors to the Fund receive the *Newsletter*. Write Dr. Ann Hibner Koblitz, Director, Kovalevskaia Fund, 6547 17th Ave. N.E., Seattle, WA 98115.

Anne Leggett
Department of Mathematical Sciences
Loyola University of Chicago
6525 North Sheridan Road
Chicago, IL 60626
BITNET: LMA24@LUCCPUA
USENET: gargoyle!cantor!borel!alm

AWM COMMITTEES

The Math Education Committee has been making excellent progress. It is the healthiest sized committee with eight active members and more who have expressed interest. They have produced one *Newsletter* article on their actions and have three more in the works.

Each of the three members of the Committee on Relations with Other Societies has been appointed monitor for one of the AMS, MAA, and ACM (the Association for Computing Machinery). The monitors have designed processes appropriate to the society they are working on. Obviously, it would be better to have more than one person involved with each of these large societies. Also, there are other societies we might monitor. This committee desperately needs more members! If you are willing to serve, please get in touch with the Chair, Evelyn Silvia, Department of Mathematics, University of California, Davis.

Also, the Speaker and Journal Committee could use more members.

The Taskforce on Maternity Leave Policies has collected information on maternity leave policies for a number of schools. One key issue is how classroom replacements for the pregnant faculty member are handled. If colleagues are covering at no pay, the new mother may feel compelled to return to the classroom almost immediately. Some schools include authorization to hire temporary faculty as part of the maternity leave policy. Says Anita Solow, Chair of the Taskforce, "One of the most striking characteristics of the letters that I received is the disparity between the official policy and the actual policy. Many personal stories involved 'luck': good planning, courses that could be team taught, helpful colleagues, etc. We need good policies that treat pregnant women fairly, not luck."

REPORT OF THE TREASURER   DECEMBER, 1987

Accounting for the period June 1, 1987 to November 30, 1987

Balance as of June 1, 1987 . . . .$47,251.31
    Total Assets, June 1, 1987 $47,363.19
    Note: The figure $47,363.19 represents $47,251.31 cash-on-hand plus 5 shares
           of Washington Water Power, valued at $111.88 as of 5/31/79.

RECEIPTS

Dues - Individuals	$17,759.70
Families	1,447.62
Institutional	8,463.00
Pfizer Grant for AWM	1,000.00
Interest	1,638.83
Contributions	1,627.35
Advertising Fees	535.00
Registration fees for CSSP	500.00
Miscellaneous	270.20

TOTAL RECEIPTS $33,241.70

EXPENSES

Wages, FICA, HCHP (1)	$10,511.50
Newsletter (2)	3,880.21
Operating Expenses (3)	3,832.07
Kovalevsky High School Day	2,696.13
Directory of Women in Math Sciences	1,802.95
AWM National Meetings	1,198.00
Dues & Fees (4)	356.75
Massachusetts Income Tax	163.68
Miscellaneous	61.66

TOTAL EXPENSES $24,502.95

BALANCE as of November 30, 1987 . . . .$55,990.06

(1)   Full-time Executive Director.
(2)   Typing, postage and printing.
(3)   Postage, phone, supplies, duplicating.
(4)   Conference Board of the Mathematical Sciences, Massachusetts Incorporation Fee, Bulk Mail Permit.

Respectfully submitted,

Lynnell E. Stern, Treasurer of AWM
Bolt Beranek & Newman Communications Corporation

AWM EXECUTIVE COMMITTEE, 1988

President: Rhonda Hughes, Associate Professor, Department of Mathematics, Bryn Mawr College

President-Elect: Jill Mesirov, Senior Scientist, Thinking Machines Corporation

Treasurer: Jenny A. Baglivo, Associate Professor, Mathematics Department, Boston College

Members-at-Large:
Lisa R. Goldberg, Assistant Professor, Department of Mathematics, Brooklyn College

Rebecca Herb, Associate Professor, Department of Mathematics, University of Maryland

Tilla Klotz Milnor, Professor, Department of Mathematics, Rutgers University

Ruth Rebekka Struik, Professor, Mathematics Department, University of Colorado

Carol Wood, Professor, Department of Mathematics, Wesleyan University

Newsletter Editor: Anne Leggett, Associate Professor, Department of Mathematical Sciences, Loyola University of Chicago

Meetings Coordinator: Bettye Anne Case, Associate Professor, Department of Mathematics, Florida State University

Clerk: Martha Jaffe, Software Engineer, Prime Computer, Natick, Massachusetts

EWM MEETING: December 12-13, 1987, Copenhagen

by Gudrun Kalmbach, Mathematics, Universität Ulm, Ulm, West Germany and Marketa Novak, Inst. för Informationsbehandlung, Chalmers Tekn. Högskala, Göteborg, Sweden

The second meeting of the European Women in Mathematics was attended by 22 participants from nine countries. Reports were given about the situation in each country. Ragni Piene from Oslo Universitet gave an invited address on "Some differential-geometric aspects of algebraic geometry." Several committees have been formed for special issues.

A detailed report will be written by Catherine Goldstein, Dépt. de Math., Univ. de Paris XI, F-91405 ORSAY, Cedex. It will be distributed by Marion Kimberley, Goldsmiths' College, Lewisham Way, LONDON SE14 6NW, England. Marion also has a list of the national coordinators.

The next meetings are planned for Warwick, England, November/December 1988; Lisboa, Portugal, 1989 and provisionally for 1990, Roma, Italy.

This meeting was partially supported by the Danish Ministry of Education, the Danish Natural Science Research Council, the Danish Social Science Research Council, the Otto MØnsted Foundation, private donations, and the Technical University of Denmark.

A member of EWM has asked us to join in the appeal for Tatyana Velikanova of the USSR. She is a mathematician who has been an outspoken advocate of human rights since the early 1970's. She was arrested and convicted of editing *A Chronicle of Current Events*, the oldest *samizdat* publication on human rights in the USSR. Velikanova was sentenced to four years' imprisonment and five years' internal exile. Her imprisonment has been difficult.

Velikanova is now serving internal exile in a remote part of the Kazakh SSR. She is now 55 years old, and suffers from hypertension, angina, arthritis, and ischaemia. She is not due to be released until November 1988. To appeal for her early release, write to: Procurator-General of the USSR; Mr. Alexandr Mikhailovich Rekunkov; SSSR; RSFSR; 103793 Moskva; ul. Pushkinskaya, 15a; Prokuratura SSSR; Generalnomu prokuroru; Rekunkova AM.

MARGARET MUNROE'S RETIREMENT PARTY, 6/15/87: installment 2 of 2

Margaret Munroe, Ellie Palais, Madeleine Galland (Ellie's mother)

Jill Mesirov, Lynnell Stern

Vicki Rakov (Lucy's daughter), Lucy Rakov, Alexia Sontag, Alice T. Schafer

Jo Ellen Hillyer, Marjorie Reed (Margaret Munroe's daughter)

BOOK REVIEW COLUMN

by Martha K. Smith, University of Texas at Austin, Book Review Editor

This newsletter has from time to time published book reviews, mostly by our overworked editor, Anne Leggett. Beth Ruskai recently suggested that we have a regular Book Review Column. This is it. I have agreed to be column editor for at least a year. But I'm not going to do all the work by myself, either, so I'm asking for your help. Please let me know if: a) there are specific books you volunteer to review, or b) you are willing to review books from time to time (if there are specific areas that interest you, let me know), or c) there are specific books you would like to see reviewed. (If you reply to (c), I of course hope you also reply to (a) or (b). But don't let me intimidate you.)

I envisage a column flexible enough to include various types of reviews — e.g., short "I recommend" type reviews, long critical reviews, simultaneous reviews of related books, and two reviews of the same book with different reviewers presenting different views. To get things started, I've included a review of the first type below. Anne says that publishers are usually willing to send review copies. If I am ambitious enough, I will try to provide capsule reviews of some selection of books received.

Math for Girls, Diane Downie, Twila Slesnick, and Jean Kerr Stenmark, University of California, Berkeley, 1981.

This is an oldie that deserves to be better known. It grew out of a class of the same name at the Lawrence Hall of Science. The class grew out of an inquiry by sociologist Lucy Sells as to what was being done to reverse the pattern of math avoidance she had observed in women college students.

The book presents material for eight 1 1/2- to 2- hour classes. Each class consists of several activities, with at least one activity from each of four "problem-solving strands": using logic, strategies, and patterns; breaking set; creative thinking, estimating, and observing; spatial visualization.

The book is pedagogically sound and well-presented. The activities are fun. If you've ever thought about doing something in your community to encourage girls to do and like math, but hesitated because of the effort involved, take heart. This book should cut the work in half. If you're less ambitious, a single class would work well as an independent activity with Girl Scouts, Campfire Girls, Extend-a-Care, etc. If you teach math for elementary school teachers, be sure to acquaint them with *Math for Girls*. (A friend who teaches first grade reported great success with some of the activities she used in her class.) In fact, I've found some of the activities useful in teaching prospective elementary teachers, some of whom are poor in very basic math skills such as spatial visualization and ability to translate between words and pictures (e.g., the origami box on page 92 gives practice in both areas), and many of whom have a very narrow view of what mathematics is.

You probably won't find this at your local bookstore. Ordering information in my copy says to send a check or money order for $7.00, payable to Regents, University of California, to Lawrence Hall of Science, University of California, Berkeley, CA 94720, Attn: Careers.

BIBLIOGRAPHY ON WOMEN, GENDER, AND TECHNOLOGY

We are compiling an annotated bibliography on women, gender and technology to be published by Garland Publishing. So that we don't miss important works, we would like to ask you to send us information on relevant works which you have identified in your specific areas of research. We are including most of the specific technologies listed in the *Technology and Culture* Critical Bibliography and topics such as Women in Development, Utopias/Distopias, Theoretical Studies and Gender.

Please send your information to us by July 30, 1988. Thanks for your help. Write: Cynthia M. Bindocci, College of Mineral & Energy Resources, West Virginia University, P.O. Box 6070, Morgantown, WV 26506, or Kathleen H. Ochs, Humanities and Social Sciences Department, Colorado School of Mines, Golden, CO 80401.

AN INTERVIEW WITH MARGUERITE LEHR: IN MEMORIAM

by Pat Kenschaft, Montclair State College
reprinted from this *Newsletter*, Vol. 11, No. 4, pp. 4-7

Marguerite Lehr retired as professor emerita from Bryn Mawr College in 1967. She was the oldest of five children of a Baltimore grocer, the only one of the five to go to college. After graduating from Goucher College in 1919, she became Charlotte Scott's graduate reader the following fall, answering questions in class and holding office hours for Scott, who was by then completely deaf. She won a fellowship for study abroad and studied algebraic geometry at the University of Rome. In 1925 she received her Ph.D. from Bryn Mawr College, the last of Scott's students, and after that she taught there continuously except for several leaves.

She has had three research papers published and several articles about mathematics. For eight years she was an examiner for the Woodrow Wilson fellowship applicants, and she spent five weeks as a visiting MAA lecturer. She pioneered using commercial TV as a medium for teaching mathematics.

It was my privilege to visit in her living room on March 31, 1981, and record three hours of tapes for the Bryn Mawr archives. The depth of her thinking, the breadth of her knowledge, her passion, and her choice of words is too inspiring to leave to the archives, so I have chosen some of the high points to edit and share. Lehr speaks poetically with many gestures and voice inflections, so the following reflects not just her exuberant personality but also my efforts to adapt her expressions to the printed page.

— Someone asked me if I was ever sorry I had chosen mathematics. I said, "I didn't choose! Mathematics is an addiction with me!"

— Mathematics and poetry are head-tail of the same coin. Both are an attempt to discern pattern — because you refuse the idea of a chaotic universe — and to develop language which has to be metaphoric, or you'll drown in jargon.

— The one thing I'm sure of is that pronouncement comes out of ignorance. The one thing we have to know is that knowledge is tentative.

— Even before Plato there was "high magic" and "low magic." High magic is discerning pattern. Low magic is the attempt to use accepted patterns to get an answer. In our generation we call these "pure mathematics" and "applied mathematics." Too often people search for answers before they have framed a meaningful question. That is where you must start!

— To experience reality is to discern patterns. If you have any accepted patterns (don't call them "true"), you put them to the test; that is the "low magic" stage. Maybe you get nice sentences. But maybe it blows right in your face; that's when you must admit you can't use the word "true."

— When I was still young, President Park of Bryn Mawr chose me to represent the faculty of our college at a meeting of the seven women's colleges. We met at Vassar. Vassar's president said that the young men on his faculty seemed to publish more than the women did. He added that perhaps it was because they felt the responsibility of the family. And I said innocently — I wasn't being nasty — "What do you think of the quality of the work under that motivation?"

— I went to as many of the International Congresses as I could get to. But I didn't notice if a woman were there. I went for the person I knew had done something... I thought only about the fact that I was hooked on one kind of work.

— During my first leave I attended Zariski's lectures and I thought I could generalize what he was talking about. I worked very hard, but what I got was a mess. So when the editor of the *American Journal of Mathematics* came to me and said, "Zariski says you have some work I should publish," I responded, "It's a mess; it's a bad lead." Zariski asked to see what I had done, and of course I had to give it to him. Then he said, "You didn't get what you went in after. But you proved some things. Now back off, and state what you proved. You have to publish what you have to keep other people from going down your dead end. But we don't know; maybe someone will see a fork in the road." That is very hard; if you have a feel for style, you think things should be elegant too.

Kenschaft: Did you find it painful at the time to expose those disappointing results?

Lehr: Horrible. Horrible. I hated it. But I don't say I didn't learn from just the effort to get it written.

— Once when I was walking down a corridor, I heard a colleague say to his class, "You'll never do mathematics if you can't see pictures." So I waited in the hall until the class was over and said, "What is this heresy I hear?!! Never do mathematics... ?!!" For two weeks he would try to *catch* me by asking questions he thought would force me to visualize something. Finally he said, "Okay." People use what they have... I have more or less six senses.

— I am strongly auditory. I am strongly kinesthetic. I wrap space in knots and I live in a left-helical world. (Gesturing with her arms a left helix) It is very hard for me to do that other one. (Vainly attempting a right helix) ...I live in a curved space.

— I walk up and down and talk, and when I write, the work is finished — if I pick up my reluctant pen... I came along too early... If there had been easy tape-recording and Bryn Mawr had had any money... I do think we underestimate the power of the spoken word... Mathematicians should be using TV more...

Kenschaft: But you did do a series for TV.

Lehr: Yes, fourteen weeks. And it did get response. But there hasn't been enough. We should have taped Artin...

— When Emil Artin, Emmy Noether, and John von Neumann walked and talked, work went on better for young and vigorous minds. Life isn't just writing. The new view imagines the universe as a seamless web, not those little boxes of space and time... a great cosmic dance...

— Once a woman asked me, "Are you a mathematician?" The big words, I think, belong to the big things. So I said, "No, but I spend most of my waking hours thinking about mathematics, and sometimes sleeping hours too." I didn't know Paul Levy was at my shoulder. He said in his nice French, "But you know very well what mathematics is... You do the dance called 'thinking' in front of them. And they learn. They don't all learn the same thing, but that doesn't matter." He looked puzzled, and then he exclaimed, "Ah, the little articles! All those little articles!" I had been considering leaving teaching and getting a job with a publisher, but I was so excited, I returned to Bryn Mawr.

— The first and only thing I ever failed in school was the first quarter of algebra. And I know why, now... But I could be docile and learn rules, so I passed the second quarter with a 95.

— I knew German from the time I was four; I grew up in a German church. German wasn't talked at home because my father didn't want that.

— Later I had to know French, German, and Italian, all three. You couldn't work without them. You can't wait for the translations, and you can't trust them.

— Frank Morley once presented what seemed like a very simple theorem to a group of seniors. One of the girls asked him if it had originally seemed intuitive or if that simplicity came after beating. He was absolutely delighted. And he said, "Look, child, I have eyes to see where I would like to go. I have feet to try to take me there. That is intuition and proof in mathematics, and no more. And no less! And no less!" wagging his finger at her.

— The richest experience of my life was the eight years I spent interviewing candidates for the Woodrow Wilson graduate fellowships.

— In 1967, my last year of teaching, I decided to give myself the pleasure of presenting projective spaces again. This time I did in three weeks what it used to take a semester to do!

Kenschaft: Could the students follow you?

Lehr: They followed better! They didn't have to pick their way through all those extra messes that are going to get trimmed away. You get it down to clean, clean bone. Right down...

— That same year, I was very disappointed once about how a class had gone and I must have made a noise as I walked away. A chemistry graduate student asked me if I were all right. I said, "Did I get in the way of it that time!" She said, "Maybe they don't feel that way about it." I said, "That's no excuse! How can they know the water is deep unless I take them in deep?" She was really nice and perceptive. "Now look. By the meaning of your 'best', it isn't something you can do every day." She walked to the bookstore with me so I could blow.

— Two years ago I. M. Singer was at Haverford for a few days. He announced his topic as "Applications of the Eta-invariant." It was something to do with elliptic spaces. When Singer talked, it was superb, and for 48 hours I almost think I got in there. Someone teased him as he came in, "So you jumped on the applications train too." As I left, I told him, "I have a better title for you. What you were doing was not 'applications.' It was 'apparitions.' "

— I like to put good sayings on the opposite side of one file card. Here is one. Confucius says, "The wind of anger blows out the flame of intelligence." The other side to that is, "Anger is a prerequisite to action. It steps up the adrenaline."

— I object to acting as if you can quantify creative ability... I don't care whether it is in mathematics, poetry, or whatever. Anyone who says "the greatest" this and that... it makes me chuck my lunch. It says something about the person writing, and it doesn't say anything I have to admire. ...But I do have to try to hold my tongue. You'd be surprised at some things that get called "work!"

— *Kenschaft*: Are there any guidelines for this world?

Lehr: Not guidelines, no. But there are the moments when you say "yes" before you know what you are saying yes to. Then you sweat, and that sweat makes it fun.

...There are no simple solutions... only intelligent choices. Answers! We've come far if we've framed a good question... and maybe even that will explode on you.

...I never use the word "true." Too many people act as if things were either-or, and it is almost only trivial questions that are either-or.

...For me work and worship are head-tail of a coin. They have served each other like that. The work saves me from jargon, and the worship gives me a heritage down the centuries... I think it is presumptuous when people use humankind language about God. A woman said God is "sophisticated!" People talk to you like that! It makes me want to get under a bench... In this rich dance [of reality] watch the words you give yourself. I said to a woman, "You use the word 'God,' but you puzzle me. You talk as if He needed Man's little boxes of space and time to keep track of his doings." To hear some speak you would think God began in zero A.D.! (Much laughter)

The question of what vocabulary you permit yourself is partly due to severe training in pure mathematics. Last week I heard a lecture on rather high-powered stuff, compactification and so on. It starts with something they call "one-dimensional." They used the word "curve." They stretched the word "curve." Then in the next stage when they used two of them, they called it a "surface." That's excellent use of what I call stretching a word.

...I think it's a shame to impoverish human relationships... fortunately, you don't have to... only once in a while you're plunged into... and you have to pull yourself... a dark night (she laughs)... there are enough plusses... the dark's small lamps... to light those times when you're not sure you have either the courage or desire... for life...

— (reading from a passage she wrote in the 1950's when she was paralyzed, not knowing if she would get out of bed again) I don't need a class. For me dissecting thought is fun. A class is an audience, is occasion for dissection of thought... If I have a minimum of wit, then they gain also, and, perhaps, we both gain in high degree. But this possibility would risk being invalidated by the intention that they gain. It exists only when the obstinate and persistent practice is kept up by me.

— (extemporaneously into the tape at the age of 82) True mathematicians don't need an audience. Working out the music is enough. An audience is an occasion for making music, and on that occasion it may also be an experience of delight.

NSF/CBMS REGIONAL CONFERENCE SERIES

The National Science Foundation is seeking proposals from host institutions in the U.S. for five-day regional conferences. Each conference is to feature a distinguished lecturer who will deliver 10 lectures on a subject of current research interest in the mathematical sciences. Each lecturer agrees to prepare a monograph within six months based on his or her lecture notes. It is expected that the lecturer will give two lectures per day during the five days, with the remaining time available for study, informal discussion, and exchange of ideas.

Institutions having at least some research competence in the area of its proposal are eligible and encouraged to apply. The conference should be planned for a summer week in 1989 (not earlier than May 1) or held during a recess in the succeeding academic year. The host institution is responsible for arranging conference details, hotels, and social events during the five-day conference. Participants in the conference will receive allowances for travel and subsistence under the host institution's grant from NSF.

The principal lecturer receives from the Conference Board a fee for delivering his or her lectures and a second fee upon approval by the NSF of the substantial expository monograph derived from the lectures. These monographs are published in various series by one of three organizations: the American Mathematical Society, the Society for Industrial and Applied Mathematics, or, in conjunction, the American Statistical Association and the Institute of Mathematical Statistics.

For information sheet and application guidelines, write to: Conference Board of the Mathematical Sciences, 1529 Eighteenth Street, NW, Washington, DC 20036. 202-293-1170.

Applications for 1989 conferences are due April 1, 1988.

TASK FORCE ON WOMEN, MINORITIES AND THE HANDICAPPED IN SCIENCE AND TECHNOLOGY

The Task Force on Women, Minorities and the Handicapped in Science and Technology has two remaining public hearings. They will be held on April 7, 1988, 9:30 A.M.–4:45 P.M. at Radcliffe College, Cambridge, MA and on May 4, 1988, 9:30 A.M.–4:45 P.M. at Baltimore Community College, Baltimore, MD. The exact street addresses can be found in the Federal Register approximately 30 days in advance of the hearing or may be obtained by calling the task force offices at 202-245-7477.

Persons wishing to testify should contact Sue Kemnitzer, Executive Director of the Task Force, or Mary Ann Orlando (202-245-7477 or 330 C Street, SW, Washington, DC 20201). If you can't attend a meeting, written testimony will be accepted for the record.

In November, Kemnitzer reported that relatively few women or organizations of women had made themselves heard. The Task Force needs our ideas on how the federal government can work to bring women, minorities, and the handicapped into careers in science (and retain them in these careers). If you have such ideas or know about programs that work, let the Task Force know.

AGE AND ACHIEVEMENT IN MATHEMATICS: A CASE-STUDY IN THE SOCIOLOGY OF SCIENCE

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Abstract. This paper represents a preliminary attempt to bring the field of mathematics within the scope of the sociology of science. An analysis is performed to determine whether citations are a rough measure of quality in mathematics. Citations to work published by mathematicians who have been elected to the U.S. National Academy of Science are compared with those to the work of a random sample of university-based American mathematicians. The study examines productivity and citation counts, to determine if there is a relationship between a mathematician's age and achievement, and to test the claim that younger mathematicians are more apt to do important work. Finally, this paper explores the difficulties peculiar to the sociological study of mathematics, which account for the reluctance of most sociologists of science to study this field.

In his classic work, *Little Science, Big Science*, Derek Price considered the apparent doubling of the scientific population every 10 to 15 years, and predicted that "[s]cientific doomsday is ... less than a century distant".[1] He anticipated a future growth pattern significantly different from the previous exponential expansion. In light of recent reductions in the recruitment of scientists, and of resources devoted to R & D, scholars are beginning to speculate as to what that future pattern might be, and to study possible consequences of reduced support. One concern is whether a substantial decline in scientific growth will have deleterious effects on the quality of scientific work. If so, what should policy makers, administrators, or others concerned with the future of science do about it? Stephen Cole has investigated one aspect of this problem by looking at the relationship between scientists' age and achievement — where achievement is measured both by productivity and its quality, as characterized by scientific citations.[2] Cole's study deals with whether the predicted decline in the number of *young* people who enter scientific professions will have serious ramifications for the quality of science.

Many famous scientists are responsible for promoting the view that young scientists are most productive and most likely to produce work of major significance: "Einstein once said 'A person who has not made his great contribution to science before the age of thirty will never do so.' ".[3] Einstein's hypothesis was substantiated in work by H. C. Lehman.[4] While Lehman's methodology has since been criticized as inadequate,[5] his hypothesis has nonetheless received widespread acceptance. If such statements are correct, then a decline in the number of young people who enter scientific professions may well mean a disproportionate decline in the overall quality of future scientific work. If, on the other hand, it could be demonstrated that age is only peripherally related to scientific productivity and

to the quality of scientific work (if, indeed; it is related at all), then the projected decrease in the number of young scientists would not necessarily produce any dramatic negative consequences.

To be more specific, Cole's study could have demonstrated one of three possible relationships. First, scientific performance might decrease with increasing age, as Einstein suggested. The cause of such a relationship might be either physiological or sociological: that is, if younger scientists actually produce more and better work, it might be because their mental faculties are sharper, or because of their particular position in the scientific community. Second, productivity and quality of output might increase with increasing age, suggesting that older scientists have an "edge". This could be the result of accumulated advantage gained from experience, or of the increasing ability of senior scientists to attract graduate students, funds and equipment. Finally, there might be, in fact, no relationship whatever between age and performance, and middle-aged scientists may be neither more nor less likely to produce important work than their younger or older colleagues.

In Cole's study, random samples of scientists at Ph.D.-granting institutions in the United States were selected from the five disciplines of chemistry, geology, physics, psychology and sociology. Data were collected on the quantity and quality of current scientific output, where "current output" was defined as papers published by the sample scientists between 1965 and 1969. Cole's results indicated the following about age and current productivity:

> Productivity rates rise, peaking either in the [age range of the] late 30s or 40s and then drop off. The same curvilinear relationship was observed in all five fields with the point of inflection varying slightly. In general, we can conclude that age explains little variance on productivity.[6]

Similarly, Cole used citations as a rough measure of the quality of work to demonstrate the relationship between age and quality. The results were standardized for the five fields:

> There are basically no differences in the quality of work published by scientists between the ages of 30 and 50. Scientists over the age of 50 are slightly less likely to publish high quality research.[7]

Cole concluded that a scientist's age is not significantly correlated with productivity or with quality of work published: "We can reject the commonly held belief that the creativity of scientists declines after the age of 35."[8] Hence, there would appear to be little reason to be overly concerned about the future of science. However, although the disciplines studied by Cole were meant to represent a cross-section of scientific fields, there is a major omission: mathematics. Indeed, sociologists of science have, in general, tended to ignore mathematics,[9] presumably because it appears to be different from most other sciences. This paper is a preliminary attempt to make good this deficiency. My purpose is to argue that Cole's conclusions also apply to mathematics.

The reluctance of most sociologists of science to study mathematics is not difficult to understand. Mathematicians have traditionally been characterized as unique. However, historians of mathematics (and some mathematicians) have recently set out to destroy the myth that mathematicians are a breed without parallel:

> Those who have never known a professional mathematician may be rather surprised on meeting some. Only by seeing in detail what manner of men some of the great mathematicians were and what kind of lives they lived, can we recognize the ludicrous untruth of the traditional portrait of the mathematician. ...There have been eccentrics in mathematics, of course; but the percentage is no higher than in commerce or the professions.[10]

A study of age and achievement in mathematics can serve two important purposes. First, it can test Cole's findings that age and scientific achievement are not significantly correlated. The suggestion that it is the young who are the most prolific and most qualified is made more often and more confidently about mathematics than almost any other field. Second, and perhaps more importantly, it can demonstrate that mathematics, whatever its differences from the natural sciences, does share many sociological characteristics with them. This paper uses the same methodology as that employed by Cole.

The Use of Citations as a Measure of Quality in Mathematics

The use of citations is not without inherent difficulties. To begin with, the value of citations as a measure of the quality of scientists' work is itself a controversial issue.[11] Citations can be interpreted as a measure of either quality or recognition, and although the two are not unrelated, they cannot simply be equated; in addition, citation studies which focus on age cohorts do not, in general, adequately consider the possible effects of selective mortality. In such studies the older scientists may be those who have, in their earlier years, received some reinforcement in terms of rewards and

recognition, which motivated them to continue their academic careers. Many younger people who fail to receive such reinforcement may, in time, become "drop-outs" from academic life. Hence any study which compares citation data for different age cohorts may be giving an "edge" to the older cohorts.[12]

Despite the limitations of citation studies, they do appear to provide an approximate indicator of quality of work in the sciences, however crude and biased that measure might be.[13] But it is by no means clear that citations have any validity in a study of mathematics. It may be that the most prestigious mathematicians are not, in general, the most cited ones. If this proves to be the case, then the use of citations as a measure of quality would be suspect, and the belief that mathematicians can be sociologically studied in much the same way as other scientists would be seriously undermined. Thus, it must first be demonstrated that citations can be used as a crude measure of quality in mathematics. To this end, citations to work by mathematicians who are currently members of the US National Academy of Sciences (NAS) were studied to determine if they are in general greater than citations to the work of average mathematicians. Since there is no major award (such as the Nobel Prize) given to a wide range of mathematicians,[14] which might clearly indicate the mathematical élite, honorary election to the NAS will be taken as serving the same purpose. However, use of this sample of distinguished mathematicians has an inherent difficulty: it may consist of men and women who have "passed their prime" and are no longer very productive. Since membership in the Academy is reserved for the few, highly prestigious mathematicians, one might expect that current members have already made their most significant contributions.

The productivity and citation counts for the 60 currently active mathematicians who are members of the NAS were compared to similar figures for a random sample of mathematicians on the faculty of Ph.D.-granting institutions. The universities were selected from the 1969 American Council of Education study of departmental prestige.[15] Beginning with the university ranked highest in the field of mathematics, every other university from the first 40 on the list was selected — a sample of 20 schools. Similarly, every other member of the mathematics faculty of these schools, as obtained from university catalogues, was included in the sample — a total population of 435 mathematicians. These 435 people were compared to the 60 NAS mathematicians with respect to current output and the number of citations received (both to current work and to all past work). "Current output" was defined as the total number of single-authored and coauthored works published in the period 1970-74. This information was obtained from the 1975 issue of the *Science Citation Index*.[16] For each mathematician, the number of citations to all work published in 1970-74, to work published in 1965-59, and to work published before 1965 was obtained by counting the citations listed in the 1975 *SCI*. Results for both NAS mathematicians and the sample of university mathematicians were then averaged (see Table 1).

It might appear that the NAS mathematicians are less prolific than the university sample. In 1970-74, the NAS mathematicians published less single-authored and coauthored papers than the sample population, suggesting that the quantity of work bears either no relationship or an inverse relationship to distinction in the field. Such a simple comparison is, however, misleading since the average age of the mathematicians in the university sample is 47, while that of the NAS sample is 60. Controlling for age, mathematicians aged 60 and over in the university sample produced 3.43 single-authored papers in the years 1970-74, as compared to 2.80 for the NAS mathematicians, and 3.11 for the entire sample of university mathematicians.

Despite the obvious differences noted in Table 1, these results should *not* be used to argue that NAS mathematicians are less productive than their university counterparts, for one important reason. Many mathematicians in the NAS are professors who are approaching retirement, or are in semi-retirement, while all mathematicians in the university sample are fully active. Thus it is not at all surprising that the NAS members produced somewhat less work than the university sample: it is perhaps more surprising that they produced as much as they did. In any case, the broad similarity in productivity between the élite and the average in mathematics is itself striking, and is not characteristic of the other sciences.

When we compare the number of citations to work published by NAS mathematicians with that to work by the university sample, we find a statistically significant difference. Despite the fact that NAS mathematicians produced somewhat less than their university counterparts, their work was cited, for each category indicated, more than twice as often. This suggests that citations are directly related to publicly acknowledged distinction in the field. There was an even wider divergence between the mean number of citations to pre-1965 work, but this is somewhat misleading. Since NAS members are on the average 13 years older than the average mathematician, they have published longer. But even allowing for the edge that NAS members have because of their professional age, it is clear that their

work is cited more often than the average.˙ This suggests that citations are a valid measure of the quality of mathematical work.

Table 1. A Comparison of NAS Mathematicians with a Random Sample of Mathematicians at Ph.D.-granting Institutions

Quantity	NAS	University Sample
Mean number single authored papers published 1970-74	2.80	3.12
Mean number coauthored papers published 1970-74	1.93	2.49
Total: Mean number papers published 1970-74	4.73	5.60
Quality		
Mean number citations to 1970-74 work (single & coauthored works incl.)	11.80	5.07
Mean number citations to 1965-69 work	15.17	7.24
Mean number citations to all pre-1965 work	41.92	6.48
Total: Mean number citations to all work published	68.88	18.79

Potential Difficulties Peculiar to the Sociological Study of Mathematics

This section of the paper will indicate why, despite the statistical results presented above, some scholars will still be reticent to use citations as a measure of quality in mathematics.

While the most cited mathematicians proved to be, in general, those elected to the NAS, many distinguished mathematicians are less frequently cited, if cited at all. For example, while the mean number of citations received by NAS mathematicians was 68.88, 40 of the 60 NAS members received less than that number, suggesting that a few very important mathematicians receive a disproportionately high number of citations. In short, citations may be one suitable measure of quality but, at least in mathematics, it may not be the only one — or even a necessary or sufficient one.

Skeptical assessments of the validity of citations as a measure of quality tend to occur more often in mathematics than in other sciences. There are several reasons for this. First, it is claimed that some important works in mathematics are considered really significant because they solve heretofore unresolved problems — thus eliminating controversy (and even discussion), and ultimately reducing the number of mathematicians working in that area. Some really significant work may thus be rarely cited because it becomes a kind of "terminus." Charles Fisher has studied this tendency and claims that it has historical validity:

> In 1888 David Hilbert, age 26, surprised the mathematical world by producing a proof of a general finiteness theorem. His result was spectacular, because using techniques from outside Invariant Theory he proved the theorem in the space of four quarto pages... As mentioned before, the number of research contributions which were classified as invariant-theoretic slowly declined... Many outside of Invariant Theory looked back on the work of Hilbert as having killed the subject by solving all of its problems.[17]

If Fisher's conclusions concerning Invariant Theory apply to mathematics in general, then citations may be an inadequate measure of the quality of mathematical work. It may also be that mathematical specialties are so highly differentiated, and contain so few mathematicians, that even if every paper published in a particular specialty in a given year were to cite a specific work, it would still receive a relatively small number of citations. In the absence of data on the distribution of papers by specialty, statements about the overall merits of citation analysis are not necessarily definitive. Moreover, an important work may be distinguished more by its style than by its substantive content.

Mathematicians often evaluate each others' work on the basis of its aesthetic quality or "elegance." Summarizing the results of interviews with many mathematicians, Warren Hagstrom claims: "In mathematics, the style of a proof, its 'elegance,' is often considered as important to its merit as the truth of the theorem proved."[18] Similarly, in discussing the evolution of mathematical concepts, Raymond Wilder suggests that mathematicians are often primarily motivated by aesthetic consider-ations.[19] If Hagstrom and Wilder are correct, then a mathematical work which provides a simpler, more elegant proof for an already established theory may be judged to be as "important" in the field as one which adds to or alters the theory. We can safely assume that the latter would lead to a high citation count: but since elegance does not specifically alter the store of information, the former might or might not be highly cited. If style and form are aspects of "quality" in mathematics that do not earn high citations, then citation counts would not reliably reflect mathematical achievement.

Finally, it may be that mathematics is more highly individualistic, or "anomic," than other sciences, and that this contributes to mathematical development in ways which defy traditional sociological interpretation. Hagstrom claims that mathematicians suffer from "anomie" because there are no established barriers separating specialties:

> Mathematics has come to the paradoxical situation of intense specialization without having clearly defined specialties. Many mathematicians find it difficult to identify their colleagues or themselves. The audience to which they address themselves is unknown or almost nonexistent.[20]

Anomie is defined by Hagstrom as the absence of opportunities to receive recognition.[21] His interviews indicate that mathematicians do not generally view citations as an adequate measure of recognition. Diana Crane, in an effort to test Hagstrom's claim, provides statistical evidence to show that communication lines in mathematics are not as effective as they are in other fields:

> While this area [mathematics] does not exhibit the acute social isolation that Hagstrom described, it is clear that some members were less involved in the communication network than others.[22]

Hagstrom and Crane base their view of mathematics as somewhat anomic on mathematicians' opinions of themselves. Although the internalized norm of isolation and independence may, as Crane and Hagstrom suggest, be characteristic of mathematicians, this norm may bear little if any resemblance to the *actual* relationship between mathematicians. Despite the way in which mathematicians view their own discipline, citations (as demonstrated in this study) are correlated with recognition; this suggests that anomie may not be a major factor. Hence, mathematicians may think of their field as anomic because they see themselves as independent isolates: but the statistical evidence appears to belie their claim. Similarly, historians of mathematics (and mathematicians themselves) promote the view that this field is closer to the arts than to the sciences, and hence represents a unique discipline, in which productivity and quality of work cannot be measured in any scientific sense.

> It is not surprising that many professional mathematicians consider mathematics to be an art, for certainly creative work in mathematics does share many common features with such artistic pursuits as music and painting. Moreover, the inspiration for many advances in mathematics has come from the artistic impulses of their creators.[23]

All these claims emphasize the isolation and individualism of mathematicians, and their tendency to resist norms. If it is true that mathematicians avoid aligning themselves within specific theoretical constructs, or resist being categorized into intellectual "camps," then the use of citations may prove to be an inadequate method of evaluating mathematical work.

In summary, citations may be inadequate as a measure of mathematical quality, and should be treated with some caution, pending further careful research on their validity. One can only say that, at best, citations may prove to be as good a measure of quality in mathematics as in any other scientific field; or, at worst, that citations may prove to be a less reliable measure of quality, because one or more of the factors discussed above plays a critical role.

Age and Achievement in Mathematics

I have already presented evidence that citation counts can be taken as a crude indicator of quality of work in mathematics (and hence that mathematics shares at least some of the sociological characteristics of the other sciences). I will now follow Cole's procedures, and use productivity and citation counts in the random sample of 435 mathematicians at Ph.D.-granting institutions to determine if there is a relationship between a mathematician's age and achievement.

The ages of the members of the sample had first to be determined. The dates of birth of 387 of the sample were listed in the twelfth edition of *American Men and Women of Science*, but the remaining 48 were not listed there, because they had only recently received their Ph.D. degrees. For these, the date of Ph.D. was obtained from the *Dissertation Abstracts* (1972-75), and an approximate date of birth was derived by subtracting 27 — 27 being the average age when Ph.D.'s were granted for all the others.

Table 2. Age and Mathematical Productivity 1970-74.
Mean Number of Papers Published in 1970-74
by Mathematicians of Different Ages

Ages	Mean Number Single-Authored Papers[1]	Mean Number Coauthored Papers[1]	Mean Number Total[1]	N
Under 35	3.27	1.73	5.12	101
35-39	3.97	3.36	7.33	96
40-44	3.24	2.94	6.24	67
45-49	2.37	1.13	3.49	63
50-59	2.16	3.03	5.22	73
60+	3.43	2.69	6.11	35
TOTAL	3.11	2.49	5.64	435

[1]These figures are roughly equivalent to those in Table 1. Any slight variations are a result of the fact that this table was computed to two decimal positions, whereas the previous one was computed to three decimal positions.

The mean numbers of single-authored papers and of coauthored papers were then determined for each age group. The results appear in Table 2. Note that while there are variations among age groups, there is no apparent overall relationship between age and mathematical productivity. A mathematician who is less than 35 years old, for example, has published, on the average, 5.12 papers in 1970-74, while a mathematician who is aged 60 or more has published, on the average, 6.11 papers in the same period. While there are fluctuations between these age groups, the notion that younger mathematicians are, as it were, "physiologically" more able to produce papers would appear to be in error. In general, we can state categorically that age explains very little, if anything, about productivity.

However, there may still be a relationship between age and quality of work: younger scientists may tend to produce *more important* papers. To test this, Table 3 presents information on the relationship between age and the number of citations received to work published in 1970-74. Here again, there is no apparent relationship between age and the quality of work. If anything, it seems that older mathematicians, on the average, may produce better quality work than their younger colleagues. This is not, however, the claim I wish to make since it is more probable (as Cole suggests about scientists in general) that older mathematicians have a greater degree of recognition, and hence are more likely to be cited. In short, no clear-cut relationship exists between age and productivity, or between age and quality of work. The claim that younger mathematicians (whether for physiological or sociological reasons) are more apt to create important work is, then, unsubstantiated.[24]

Citation analyses which use the mean as a basis for comparison sometimes mask skewed or disproportionate distributions. To determine if a disproportionately small number of mathematicians were responsible for inflating the mean by producing a disproportionately large number of papers, I compiled listings, by age, of the percentage of mathematicians who published more than the mean number of papers in 1970-74, and of the percentage cited more than the mean number of times for work published during this period. A skewed distribution would be reflected in a very small percentage of those publishing more than the mean. If a few, highly distinguished mathematicians have inflated the mean number of citations by producing far more than most others, this, too, would be reflected in a small percentage cited more than the mean number of times.

Table 4 provides a breakdown of these percentages. The results follow the same general pattern as that presented in Tables 2 and 3: 24.8% of mathematicians under 35 years old produced more than the mean number of papers, whereas 25.7% of mathematicians 60 years old and older produced more than the mean number of papers (a percentage difference of 0.9%, which is statistically insignificant). However, the citation results are less consistent. Only 10.9% of mathematicians under age 35 were cited more than the mean number of times, whereas 28.6% of mathematicians 60 and older were cited more than the mean: that is, 11 of 101 mathematicians under 35 were responsible for approximately half the citations of that age group, while 10 of 35 mathematicians 60 and over were responsible for half their citations. This implies that if an effort had been made in this study to eliminate or normalize disproportionately great numbers of citations to a few works (that is, citation counts that appear to be anomalous), then the citation rates for younger scientists would be somewhat less than the numbers actually obtained. Younger mathematicians, as a whole, are probably cited less frequently than the numbers in Tables 2 and 3 suggest. Thus, the belief that younger mathematicians have an "edge," a notion already deemed erroneous, is even more discredited.

Table 3. Age and Citations to Work Published 1970-74

Age	Mean Number Citations to Single-Authored and First-Authored 1970-74 Work
Under 35	2.73 (101)
35-39	3.80 (96)
40-44	5.79 (67)
45-49	3.44 (63)
50-59	5.63 (73)
60+	5.09 (35)
TOTAL	4.22 (435)

Table 4. Percent Publishing More than the Mean Number of Papers in 1970-74 by Age and Percent Cited More Than the Mean Number of Times for Work Published in 1970-74 by Age

Age	Percent Publishing More than the Mean	Percent Cited More than Mean Number of Times for Work Published 1970-74	N
Under 35	24.8 (25)	10.9 (11)	101
35-39	51.0 (49)	25.0 (24)	96
40-44	40.3 (27)	13.4 (9)	67
45-49	17.5 (11)	17.5 (11)	63
50-59	28.8 (21)	23.3 (17)	73
60+	25.7 (9)	28.6 (10)	35

Additional Findings

I have argued that, if citation counts are an adequate measure of quality, then the sociological characteristics which have been found to apply to the natural sciences in general may also apply to mathematics. I have found no clear relationship between age and achievement in mathematics — just as Stephen Cole did in five other sciences. If younger mathematicians were more able to produce significant work, they would be cited more often; they are not.

There are, however, some anomalous features which require further explanation. A closer look at Tables 2 and 3 indicates either a relatively stable, nearly linear relationship between age and achievement, or a curvilinear relationship where achievement appears to increase with age. This latter,

apparently direct relationship between age and achievement has been attributed to social factors: increasing age often results in accrued benefits such as increased recognition, funding, equipment, released time and number of graduate students — all of which give older scientists an edge in terms of productivity and citation counts. While the benefits of increased resources in general probably play a less decisive role in mathematics than in other sciences (where equipment is a more vital aspect of the research effort), the significance of other aspects of accumulated advantage may still be important.

One anomaly which has not so far been considered is that mathematicians in the 45-49 age range seem, on the average, to produce less work, and less important work, than both their younger and older colleagues. This may be a result of one of several factors. First, it may be that the sample used in this study includes unusual or extraordinary cases which tend to skew or perhaps even distort the outcome. A second possibility is that the ages between 45 and 49 may be the most likely period in a mathematician's career when an administrative or "gatekeeping" role is assumed. Zuckerman and Merton define the gatekeeping by stating that...

> Although it is often (and loosely) included under "administration," a fourth role of the scientist needs to be distinguished from the others since it is basic to the systems of evaluation and the allocation of roles and resources in science. This is the gatekeeping role. Variously distributed within the organization and institutions of science, it involves continuing or intermittent assessment of the performance of scientists at every stage of their career, from the phase of youthful novice to that of ancient veteran, and providing or denying access to opportunities.[25]

They claim that gatekeepers are among the élite in science:

> ...the gatekeeping function seems to involve a mixture of Turner's types of mobility... in which *élites or their agents* help recruit their successors fairly early.[26]

They also demonstrate that administrative responsibilities increase with increasing age, but their study does not test the extent of such responsibilities for scientists beyond the age of 50.[27] If it happens that such administrators and gatekeepers are among the élite in mathematics, and are most frequently 45-49 years old, then the decreased productivity of this age group would need no further explanation.

To test this hypothesis, career patterns of NAS mathematicians were examined, using the twelfth edition of *American Men and Women of Science*, and *Who's Who in Science*, for biographical data. The age at which these people assumed their first major administrative role was recorded. A "major administrative role" was defined as a position with a scientific agency, an executive position in a mathematical society, editorship of a mathematical journal or chairmanship of a department. Clearly these roles are not inclusive and vary in responsibility depending upon the society or institution, and the nature of tasks to be performed. It was assumed, however, that if mathematicians included such positions in their entries for *American Men and Women of Science* or *Who's Who in Science*, and specified the corresponding dates of tenure, such roles must have been important to them, either in terms of status or of achievement. In either case, the position probably required a fair share of the mathematician's time.

In the NAS sample, 58% listed a major administrative position with corresponding dates of service.[28] The average age at which the mathematicians assumed these roles was 47. For the university sample, the percent of mathematicians who held such positions was somewhat less (42%), but the average age was 48, strikingly similar to the NAS group. Since the average age at which a mathematician assumes a major administrative position falls within the 45-49 year old period in which productivity and achievement decline, it is quite possible that the two are related.

To determine precisely why mathematicians in the 45-49 age range produce less significant work, it would be necessary to select a cross-section of mathematicians and follow their careers back through time. This approach has many potential benefits. In particular, by focussing attention on the details of individual biographies, it could provide insight into factors that might tend to be neglected or obscured in a purely statistical analysis. Allison and Stewart, in their study on accumulated advantage in science, discuss this technique:

> Our central hypothesis is that the distribution of productivity among scientists becomes increasingly dispersed with the passage of time. Since persons continually enter and leave the population of scientists, the ideal method would to measure the variation in productivity for one or more cohorts at several time points during their career history.[29]

Allison and Stewart suggests that a purely statistical analysis of citation counts might tend to distort individual patterns.

In short, statistical data can be used to support the hypothesis that age and achievement are not significantly correlated, but statistical techniques of this kind are not without important limitations.

Women's Bureau, Department A, U.S. Department of Labor, 200 Constitution Ave., NW, Wash. DC, 20210. Single copies of publications available free of charge. Fact Sheets: No. 86-4, Caring for Elderly Family Members; No. 87-1, Pregnancy and Employment: Federal and State Legal Requirements. Booklet: Jobs for the Future, 76 p., 1987.

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San Francisco State University. Dept of Math, 1600 Holloway Ave, San Francisco, CA 94132. Tenure track Asst Prof position in Mathematical Statistics to begin Fall 1988. Required: PhD, demonstrated competence in teaching and research, US citizen or permanent resident. Teaching load equiv. to 12 hrs/wk. Anticipated salary $27,588-$38,136. Closing date: 3/15/88. Send vita, grad transcripts, and 3 letters of recommendation to Newman Fisher, Chair.

Santa Clara University. Dept of Math, Santa Clara, CA 95053. G.L. Alexanderson, Chair. Tenure track Asst/Assoc Prof position to begin 9/88. PhD required. Specialization open, probability and statistics preferred. Dept emphasizes excellent teaching and continuing research commitment. Undergrad teaching only, 7 courses per yr on quarter calendar. SCU is a Jesuit institution.

University of Delaware. Dept of Computer & Information Sciences, Newark, DE 19716. Possible tenure track and visiting positions to begin 9/1/88. Strong applicants in all areas encouraged; preference for research experience in symbolic mathematical computation, parallel processing, AI, networking, graphics, programming languages, and software engineering. Required: PhD or equivalent, excellence in research and teaching. Salary and rank commensurate with qualifications and experience. Facilities: IBM 3081D, CDC Cyber 174, Vax 8600 (Unix), Pyramid 98xe (Unix), more than 75 microcomputers (IBM PC-XT's, AT's, and Macintosh's), Symbolics Lisp machines, Micro-Vax II, SUN-3's, VAX-8500, three VAX-780's, access to ARPAnet, CSNet, and BITNET. Send vita and names of 3 references to Claudio Gutierrez. Positions open until filled.

DePaul University. Dept of Math, 2323 N Seminary, Chicago, IL 60614. Tenure track Asst Prof position to begin 9/88. Required: PhD in math or statistics, potential for continuing math research, strong commitment to and evidence of good teaching. Teaching load 9 quarter courses/yr, reduction to 7 typical with evidence of sustained research. Summer teaching often available. Send vita and 3-4 letters of recommendation, at least 1 addressing teaching, to Hiring Comm.

Loyola University of Chicago. Dept of Math Sci, Chicago, IL 60626. At least one tenure track and several 1 yr positions anticipated to begin 8/88. Required: PhD, an active research program in any area, commitment to quality teaching; preference to interest in CS and/or statistics programs. Visitors interested in working with faculty may apply for at least one of the temporary positions. Interviews begin in Jan. and continue until positions filled. Send detailed vita and 3 letters of recommendation to R.J. Lucas.

Southern Illinois University at Carbondale. Dept of Math, Carbondale, IL 62901. Temporary lecturer positions anticipated to begin 8/16/88. Required: MS in math or admission to candidacy, PhD preferred; evidence of excellence in teaching; for foreign applicants, evidence of ability to speak English effectively. Preference to research interests compatible with those of faculty. Duties: 12 hrs undergrad math teaching per semester. Closing date 5/1/88, or positions filled. Send applications, incl. transcripts, to Temporary Positions, c/o Ronald Kirk, Chair.

University of Iowa. Dept of CS, Iowa City, IA 52242. Jr or sr tenure track positions. Required: PhD in CS or closely related field, strong research commitment, interest in both grad and undergrad teaching. Visiting positions may also be open. All areas welcome, but especially Software Engineering, Parallel and Distributed Systems, and AI. Dept has active programs in software engineering of embedded and real-time systems, parallel systems, languages, vision and robotics systems, and systems models, with affiliations to industry. 18 faculty offer MS, PhD, and undergrad major. Own well-equipped research laboratory has two f-t staff. Dept actively encourages applications from women & minorities, is dedicated to goal of diversity. Applications from couples considered. Send resume, names of 3 references, and copies of recent publications or technical reports to Chair of the Faculty Recruiting Comm.

Fort Hays State University. Dept of Math, 600 Park Street, Hays, KS 67601. Tenure track Asst Prof position to begin 8/88. Duties: teaching approx 12 hrs/semester undergrad & grad math/CS, incl. at least one freshman level course, usual participation in dept and university affairs. Required: PhD in math science or math ed with strong math component, commitment to superior teaching of undergrad math. Send vita and 3 letters of reference, incl. evaluations of teaching, to Ron Sandstrom, Search Comm Chair. Review begins 3/31/88, applications accepted until position filled.

University of New Orleans. Dept of Math, New Orleans, LA 70148. Tenure track Asst Prof position expected to begin 8/88. Required: PhD, strong commitment to research and teaching. All fields considered. Teaching load and salary competitive. Send resume and 3 letters of reference to Hiring Comm. Deadline: 2/1/88, or until position filled.

University of New Orleans. Dept of Math, New Orleans, LA 70148. Instructor to begin 8/15/88. Duties: teach courses from developmental through sophomore level. Required: MS in math, some teaching experience preferred. Teaching load: 12 semester hours. Anticipated salary $17,500/9 mo.; additional compensation possible through teaching overload and/or summers. Send vita, grad transcripts, and have at least 3 letters of recommendation sent to C.F. Blakemore, Chair.

Goucher College. Dept of Math & CS, Towson, MD 21204. At least two 1 yr leave replacements to begin Fall 1988. Good chance of at least one position becoming tenure track. Ranks & salaries open. Teaching load: 9-10 hrs/wk. Required: PhD in math or CS with strong commitment to teaching. Ability to teach CS courses desired. Send vita and 3 letters of recommendation to Bernadette R. Tutinas, Chair.

Wellesley College. Dept of Math, Wellesley, MA 02181. Temporary or visiting position for 88-89 or 88-90. Required: PhD in math, excellence in and commitment to math research and undergrad teaching in a liberal arts environment. Send vita and at least 3 letters of recommendation that address both teaching and research. Women and minority candidates encouraged.

Wheaton College. Dept of Math, Norton, MA 02766. 2 yr tenure track Asst Prof position to begin 9/88. Required: PhD in math science, commitment to quality teaching, active scholarly activity. Analysis, CS preferred. Wheaton is a private liberal arts college of 1100 students in a small town between Providence, RI and Boston. Send letter of application, transcript, and 3 letters of recommendation to Rochelle Leibowitz, Chair.

Alma College. Dept of Math & CS, Alma, MI 48801. Tenure track Asst Prof position to begin Fall 1988. Alma is a selective liberal arts institution. Duties: CS instruction, participation in developing an interdisciplinary Cognitive Science program, supervising undergrad research. Required: MS in CS; terminal degree, Cognitive Science or constituent field; experience in LISP. Facilities: clustered VAXes, microcomputers, Ethernet; LISP, Prolog, and common languages. Send application letter, resume, transcripts, reference letters to Jean Simutis, Acting Chair. Deadline: 3/5/88, or position filled.

Ferris State University. Dept of Math, Big Rapids, MI 49307. Tenure track position. Required: masters in math or math ed, strong course work in math, demonstrated excellence in college teaching. PhD in math or math ed desired. Duties: teaching at most levels of math, advising students in science-oriented curricula. Opportunity for development of special interests in applied math, math ed, CS, or pre-college math. Send resume, transcripts, and 3 letters of reference to Robert Kosanovich.

Michigan State University. Dept of Stat & Prob, East Lansing, MI 48824-1027. Tenure track Asst or Assoc Prof position to begin Fall 1988. Full Prof may be offered subject to funding. Required: PhD in stat or prob and strong commitment to excellence in research and teaching, strong research for candidates above Asst Prof. Send resume and 3 letters of recommendation to Search Comm.

Northern Michigan University. Dept of Math & CS, Marquette, MI. 49855. Two tenure track positions in computing. Required: PhD in CS or PhD in math with significant experience in CS. All fields considered, dept interests incl. heuristic search, AI, graphics, and mathematical software. NMU is primarily an undergrad institution, and commitment to teaching is an essential expectation. Research and professional activity are both encouraged and supported. Send transcripts, 3 letters of recommendation, and resume to Terrance L. Seethoff.

Western Michigan University. Dept of Math & Statistics, Kalamazoo, MI 49008, 616-383-6165. Tenure track Asst Prof position in math ed to begin 8/29/88. Required: PhD in math ed, substantial background (masters level) in math, elementary or seconday level teaching experience. Duties: teaching undergrad and grad math ed courses, undergrad math courses (occasionally), research, advising, and curriculum development. Strong teaching and research both required for eventual tenure. Send vita, transcripts, and 3 letters of recommendation to Joseph Buckley, Chair.

Wayne State University. Dept of Math, Detroit, MI 48202. Two tenure track positions, incl. one in statistics. Also possible visiting positions. Required: PhD in math sci, established record of original research activity. Send letter, vita, and 3 letters of recommendation to Bertram M. Schreiber, Chair.

University of Minnesota, Morris. Div. of Science & Math, Morris, MN 56267. Tenure track Asst Prof position in CS to begin 9/16/88. Required: PhD or ABD (hired at instructor rank) in CS or PhD/ABD in closely related area with 30 semester credits in CS; strong interest in teaching and research. Teaching load: 2 courses/quarter. Salary negotiable. UMM is a publicly supported residential liberal arts college. Send resume, transcript, and 3 letters of reference by 4/15/88 to James Olson, Chair. UMM specifically invites and encourages applications from women and minorities.

University of Minnesota, Minneapolis. Institute of Technology, 105 Walter Library, 117 Pleasant St SE, Minneapolis, MN 55455. New position of Associate Dean for Faculty Development and Special Programs. Individual will have tenured faculty appointment in one of the academic depts, will devote approx. 2/3 time to associate dean position, 1/3 to teaching and research. Institute of Technology (IT) is the University's 2nd largest college, comprises engineering, physical science, CS, math, architecture, and landscape architecture. Responsibilities: activities and policies that promote professional opportunities for faculty, oversight of IT administration of University policies for academic & civil service employment, development and administration of special faculty and staff development programs, development of programs to increase participation of women in science and engineering and to increase recruitment and retention of women faculty and students, serve as senior EEO, be informed about all aspects of IT's activities. Required: PhD, minimum 5 yrs university experience, be qualified to hold a tenured faculty position in one of IT's depts. Send applications and nominations, postmarked by 4/4/88, to Priscilla Grew, Chair, Associate Dean Search Comm, IT Dean's Office. Applications from women and minorities specifically invited & encouraged.

University of Minnesota, Morris. Div. of Science & Math, Morris, MN 56267. Instructors in CS to begin 9/16/88. Required: MS with at least 30 grad semester credits in CS, PhD hired as Asst Prof; strong interest in teaching and research. Teaching load: 8-10 credit hrs/quarter. Salary negotiable. UMM is a publicly supported residential liberal arts college. Send resume, transcript, and 3 letters of reference by 4/15/88 to James Olson, Chair. UMM specifically invites and encourages applications from women and minorities.

Lindenwood College. Dept of Math, St Charles, MO 63301. Tenure track Asst Prof position to begin 8/88. Required: PhD in math, strong commitment to liberal arts education. Duties: teaching a wide range of undergrad courses, ability to teach in CS program desirable. Lindenwood is a small private liberal arts college. Send applications, resumes, transcriptes, and 3 letters of recommendation to Daniel Keck, Dean of Faculty, by April 1.

Glassboro State College. Dept of Math, Glassboro, NJ 08028. Tenure track Asst Prof position. Duties: teaching advanced undergrad math courses, particularly geometry and applied math. Required: PhD, evidence of excellent undergrad teaching.

Kean College of New Jersey. Dept of Math & CS, Morris Ave, Union, NJ 07083. Tenure track Asst Prof position to begin 9/1/88. Required: ABD (but PhD in pure or applied math and teaching experience strongly preferred), strong commitment to excellence in teaching, active interest in scholarly pursuits. Duties: teach introductory and advanced mathematics courses, participation in dept and university affairs. Send resume and grad & undrgrad transcripts to Dorothy Goldberg, Chairperson by 3/25/88.

Cornell University. Dept of Math, White Hall, Ithaca, NY 14853-7901. Keith Dennis, Chair. Six visiting teaching leave replacement positions in math in small liberal arts colleges for academic yr 1988-89. Salary: $15,000 plus fringes. Duties: teach 2 identical freshman calculus courses. Time to attend courses and seminars for credit without cost. Summer stipend for up to 10 weeks available before or after the academic yr for an approved course of study or research at Cornell. By 4/30/88, send 2 teaching references, vita, and letter from deans and/or chairs showing how such a visit would benefit your home institution. Sponsored by The Pew Charitable Trusts.

Hamilton College. Dept of Math & CS, Clinton, NY 13323. Temporary 1 or 2 yr leave replacement position. Duties: teaching 6 courses/yr at small, highly selective, 4-yr liberal arts college. Excellence in teaching required. Send vita and 3 letters of recommendation, at least 1 about teaching, to Larry Knop, Chair. Women and minorities encouraged to apply.

Lehman College. Dept of Math & CS, Bronx, NY 10468. Tenure track positions anticipated in math and CS. Required: PhD, strong commitment to teaching, demonstrated outstanding research potential. Rank and salary commensurate with qualifications. Send resume and names of 3 references to Robert Feinerman, Chair.

Marymount College. Dept of Math & CS, Tarrytown, NY 10591-3796. Tenure track specialist in remedial math to begin 9/88 (subject to budget approval). Duties: 9 hrs teaching through calculus each semester and supervision of developmental program. Required: PhD, or near completion. Send grad transcript and 3 reference letters to Doris Appleby, Chair, by 3/1/88.

Rensselaer Polytechnic Institute. Dept Math Sci, Troy, NY 12180. J.G. Ecker, Chair. Seek extremely high quality applicants for several tenure track positions at all levels in Applied Math, incl Mathematical Programming, to begin 9/88 or earlier. PhD & very strong research potential required for jr appts; demonstrated outstanding record for sr appts. Also anticipate 2-3 Visiting and Postdoctoral appts at all levels.

SUNY Stony Brook. Dept of Applied Math & Statistics, Stony Brook, NY 11794-1401. Seek distinguished scholar to lead dept's further development. Selected individual will be expected to expand and enrich the mathematical sciences on campus in cooperation with the chairs of the Depts of Math and CS and other mathematically oriented units. Significant resources are available to assist the new chair. Applications accepted until 4/15/88 or until position filled. Send nominations, applications, and supporting materials, incl. names of referees, to Benjamin Walcott, Associate Provost.

Vassar College. Dept of Math. Poughkeepsie, NY 12601. Visiting position for 1988-89, 1 semester or 1 yr, subject to administrative approval. Rank and salary commensurate with qualifications. Faculty maintains high standards of teaching as well as active research programs in combinatorics, differential eqs, logic, and algebraic topology. All specialties welcome. Send vita and letters of recommendation to John McCleary, Chair.

Kent State University. Dept Math Sci, Kent, OH 44242. Tenure track CS positions at all levels to begin Fall 1988. Required: PhD or comparable degree in CS or a closely related area earned or expected by 9/88. Salary competitive and negotiable. Dept awards BS, MS, and PhD, has active research program in CS and scientific computing. Facilities: VAX 11/780 (under Berkeley UNIX), VAX 11/750 (UNIX), STARAN-E SIMD Parallel Processor, 4 HP 9000/320 graphics workstations, Symbolics 3600 and 3640 LISP machines, Tektronix 4404 AI workstations, variety of micro-computers and peripherals; connected by Ethernet local area network, access to CSNET; IBM 3081D on BITNET and other processors; convenient access to Ohio Cray Supercomputer. Send resume and have 3 letters of recommendation sent to O.P. Stackelberg, Chair.

University of Cincinnati. Dept Math Sci, Cincinnati, OH 45221-0025. Asst Prof positions anticipated pending budget approval. In addition to the Otto Szasz Visiting Professorship, 1-2 more visiting positions. Charles Phelps Taft Postdoctoral Fellowship, filled by college-wide competition, also available. Send applications incl. 3 letters of reference to C.W. Groetsch.

Oregon State University. Dept of Science, Math, and CS Education, Corvallis, OR 97331. 9 month tenure track Asst Prof position in math ed to begin 9/15/88. Duties: teach grad & undergrad courses in math and CS education, supervise student teachers, supervise and participate in research in math and CS education, serve on doctoral and masters degree committees, teach doctoral research seminar. Required: PhD in Math Ed, secondary school teaching experience, demonstrated competence in math ed research, strong background in basic math, background in CS ed, experience in supervision of math teachers, mathematics teaching methods, and curriculum development. Salary $25,000. Send letter of application, vita, and names and addresses of 3 references to Thomas P. Evans, Chair. OSU has a policy to be responsible to the needs of dual-career couples.

La Salle University. Dept Math Sci, Philadelphia, PA 19141. Position to begin 9/88. Required: PhD in math. Preferred: background in CS, some interest in research. Salary competitive. Send resume and letters of recommendation to Samuel Wiley.

University of Texas at Austin. Dept of Math, Austin, TX 78712. A number of positions to begin Fall 1988: Instructor (customarily new PhD) and Asst Prof (customarily at least 2 yrs beyond PhD). Strong research credentials required. Send vita, detailed summary of research interests, and at least 3 letters of recommendation to Recruiting Comm ASAP.

College of William and Mary in Virginia. Dept of Math, Williamsburg, VA 23185. One or more tenure track positions anticipated, Asst Prof or above, to begin 8/16/88. Required: PhD in math, capability for strong sustained research, commitment to effective teaching. Encouraged: research interests in Matrix Analysis or a related area. Send letter, vita, and names of at least 3 references to Chair, Math Search Comm. Screening begins 2/15/88, applications accepted until position(s) filled.

ASSOCIATION FOR WOMEN IN MATHEMATICS
Box 178 Wellesley College, Wellesley, MA 02181
617-235-0320 x. 2643

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Association for Women in Mathematics
Box 178 Wellesley College
Wellesley, MA   02181

March-April 1988

Marie A. Vitulli
Univ of Oregon
Dept of Math
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