Association for Women in Mathematics

Volume 11, Number 1 NEWSLETTER Jan.-Feb. 1981

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CHANGING OF THE GUARD

It seems strange typing "1981" already--it's only a couple of days after Thanksgiving. But you're receiving this early in the new year, and that's why there's no President's Report. Our past president Judy Roitman is no longer in office as of your today, but our new president Bhama Srinivasan isn't in office yet on my today. Next issue, Bhama will be issuing her first President's Report. In the meanwhile, let me take this opportunity to welcome Bhama as new president and to thank Judy for the tireless effort she has put in on behalf of AWM over the last n years, including the last couple as President. Both of them are also due congratulations: Judy for earning tenure and Bhama for receiving a permanent appointment as Professor at the University of Illinois, Chicago Circle. I wish you all equally productive 1981's.

CONFERENCE ON WOMEN IN THE PROFESSIONS

A national conference on "Women in the Professions: Science, Social Science, and Engineering" will be held at Purdue University. The conference begins Friday, March 20, 1981 at 1:00 p.m. and ends Saturday, March 21 at 5:00 p.m. (The registration fee of approximately $30.00 will include dinner on Friday and breakfast and lunch on Saturday.)

The major objectives of the conference are to review the opportunities for women, assess the current status of professional women, identify factors affecting their success, and generate methods for increasing the visibility and influence of professional women. The organization of this conference comes at a time when the combination of economic pressures and social attitudes makes it important to evaluate critically the changes of the 1970's and to establish new goals for the 1980's.

This conference is the first that focuses on Women in Science, Social Science, and Engineering to be held in the Mid-West. Women who are nationally recognized for their outstanding contributions in these disciplines have been invited as speakers and workshop leaders during the Symposium. The proceedings of the conference will be published, providing a comprehensive collection of the talks and discussions to serve as a framework for future conferences.

For further information and application forms, contact: Ms. Cary Bowdich, Division of Conferences, Stewart Center, Purdue University, West Lafayette, IN 47907, (317) 749-2533.

Speakers at the Conference and their topics are: Lilli Hornig, "Professional Women in Transition"; Martha Trescott, "Women Engineers in History: Profiles in Holism and Persistence"; Naomi McAfee, "You've Come a Long Way, Baby: the Myth and the Reality"; Betty Vetter, "Changing Patterns of Recruitment and Employment"; Jewell Cobb, "Planning Strategies for Women in Scientific Professions"; Esther Hopkins, "Alternative Development of a Scientific Career"; Ruth Hubbard, "Should Professional Women be Like Professional Men?"; Anne Briscoe, "Scientific Sexism: The World of Chemistry"; Rachel Rosenfeld, "Career Mobility in Academia"; Mildred Dresselhaus, "Extra Curricular Activities of

Women Faculty in Engineering Schools"; Donna Haraway, "The Biological Enterprise"; and Nancie Gonzalez, "Professional Women in the Developing Nations, Yesterday and Today".

In addition to the talks listed above there will be panel discussions on networking, alternative life styles, sex discrimination, family planning with a demanding career, special problems of minority women, causes and cures of math anxiety, career planning, re-entry women and coping in a male-dominated culture.

NOTES

To the member who wanted information about teaching in summer math programs: I'm sorry, but I've lost your name and address. Try writing: Prof. David Kelly, School of Nat. Sci. & Math., Hampshire College, Amherst, MA 01002 (Hampshire Program) and Prof. Samuel Greitzer, Dept. of Math., Rutgers Univ., New Brunswick, NJ 08903 (Math Olympiad Training Sessions).

FYI, short information segments narrated by Hal Linden on ABC this summer, had a presentation on math and women. The main message was that women and girls ought to take more math courses so that their career choices would not be restricted. My attempt to get the text of the segment has been unsuccessful so far; if I ever get it, I will reprint it.

NSF ADVISORY COMMITTEE FOR SCIENCE EDUCATION

by Mary Gray, American University

Representing the AMS-MAA-SIAM-NCTM Joint Committee on Women, Solveig Espelie (Howard) and Mary Gray (American) made a presentation to the Advisory Committee for Science Education of the NSF at the meeting on October 9th. Their appearance resulted from earlier meetings with former NSF-director Atkinson and the advisory committee for the Mathematical Sciences Section. The subject of all these meetings, initiated by Alice Schafer (Wellesley, Simons), the chair of the Joint Committee, was to offer suggestions as to how the NSF might improve its funding for women and girls in science.

The general point made to the science education group was that women and girls continue to drop out of mathematics at every stage in larger percentages than do their male colleagues. The Foundation's programs have been rather narrowly focused and woefully underfunded. In particular, the delegation emphasized that it is not productive to fund any more studies to find out that indeed the drop-out phenomenon exists. Several action-oriented programs were suggested as possible vehicles for NSF support for women in science, but the primary message was that since what has been done has not in general proved successful, program directors and other NSF administrators should take a more flexible approach.

It should be noted that the section head for Development in Science Education remarked that a focus of his program is on how to encourage greater participation by women and minorities, but that few proposals are submitted. AWM members are urged to remedy the situation!

Some discussion centered on the Women in Science provisions of the NSF authorization bill (S.568). The House NSF authorization bill had no similar provisions but apparently the Conference Committee had come to virtually final agreement on incorporating most of the features of the Senate bill. Pre-election adjournment postponed final action until November. A detailed analysis of the bill actually approved will be presented in a subsequent issue of this newsletter, but essentially the version on which action was suspended calls for $18 million to be spent in the research as well as science education directorates on programs to encourage the participation of women in science. Grants programs for substantive research by women in mathematics and science are included. A Committee on Women and Minorities is also set up to advise the NSF Director and to monitor programs. The provisions have generally been opposed by the NSF and the science

establishment. The Joint Committee, AWM, AWC (Association for Women in Computers), AAUP, APA (American Psychological Association), AAAS, Federation of Professional Women's Organizations, AWIS and WEAL have worked closely with aides to Senator Kennedy's Subcommittee on Health and Scientific Research in developing the bill.

In general the Advisory Committee and the staff of the Science Education Directorate of the NSF seemed interested in and receptive to the ideas presented to them. The discussion was lively but not hostile. The hope is that the Advisory Committee will make some useful recommendations as to priorities to the National Science Board, a new member of which is outgoing AMS President Peter Lax (Courant Institute). Lida Barrett (Northern Illinois) is a member of the Advisory Committee on Science Education.

NSF MATHEMATICAL SCIENCES SECTION

The structure of the Mathematical Sciences Section, Division of Mathematical and Computer Sciences, from September 1980 to September 1981 is: Classical Analysis, John V. Ryff; Modern Analysis, Neal J. Rothman; Topology, Geometry and Foundations, Ralph M. Krause; Algebra and Number Theory, Alvin I. Thaler and Judith S. Sunley; Applied Mathematics, James M. Greenberg; Statistics and Probability, David S. Moore; Special Projects, Alvin I. Thaler; Head, William G. Rosen. The mailing address is: Mathematical Sciences Section, National Science Foundation, Wash., DC 20550. The telephone number for all program directors is (202) 357-9764. The telephone number for Dr. Rosen is (202) 357-7341.

RESEARCH PROGRAM ON WOMEN AND THEIR WORK

A three-year research program studying "Women and their Work: Intersections of the Marketplace and the Household," is being established by the CSEAW-Women's Center at the University of California, Berkeley, with the assistance of a grant from the Ford Foundation. The major purposes of the new program, which is built on the structure and ongoing service of the Center, are to stimulate further research on women in paid and unpaid work, and to disseminate the findings of this research.

The research program is based on the premise that it is essential to utilize the combined approaches of the humanities and the social sciences, especially as they relate to the study of women. Because women have traditionally been studied either as nurturers in the home or as workers in the marketplace, scholars have tended to stress the separation between the public and private in American life, between the workplace, which is supposedly populated by men, and the home, presumably a refuge for men maintained by women. This separation of the public from the private has affected the study of all women, but particularly of black and other ethnic minority women, who have, by necessity, been deeply involved in both the public and the private spheres. The program recognizes the need not only to study the totality of women's lives, but also to focus on the lives of those women heretofore neglected by research: minority women, heads of household, and other working-class women. Following are examples of some topical areas to be undertaken within the program: *an investigation of the impact of working women on the economic well-being of the household; *a comparison between the self-perceptions of black women as expressed in creative literature and those that emerge from social scientific research; *an analysis of sex differences in response to occupation-generated stress. The research program will support the following: *studies and research projects; *visiting fellows, lecturers, and distinguished scholars; *scholarly colloquia and conferences; *the publication of papers, monographs, and a new edition of the Directory of Feminist Research to include studies developed under the auspices of the program; *the development of special annotated bibliographies and other resource materials for

use by academic departments; *the expansion of the holdings and research referral capacity of the Women's Center Library.

For information, write: Dr. Margaret B. Wilkerson, Director; or, Ms. Gleoria Bradley-Sapp, Research Program Coordinator; CSEAW-Women's Center; Room 112, Building T-9; University of California; Berkeley, CA 94720.

MERITOCRACY AND MARGINALITY: WOMEN IN SCIENCE TODAY AND TOMORROW

by Jonathan R. Cole, Director of Center for Social Sciences and Professor of Sociology, Columbia University
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Introduction

I want to thank you for inviting me to give this talk, and for your willingness to entertain the thoughts and speculations of one who might be considered by some as an "outsider" among "insiders" (R.K. Merton, 1973).

I must confess at the outset that since I do not know whether or not to assume that you are familiar with my book Fair Science, I feel a bit like the unfortunate animal in the 14th-century fable of "Buridan's Ass" that is caught equidistant from two bales of hay, starving to death because it is unable to decide in which direction to move. Therefore, I will proceed this afternoon by reporting some material that you will find in the book, and other materials that you will not, in an attempt to address the subject of marginality and meritocracy for women in science.

It might be useful for us not only to consider the question of where women in science stand today, and what their futures look like, but also to take a glance backwards in order to gain some perspective on where we have come from. Thus, the structure of this talk: first a brief look at some historical antecedents; then a look at where we are; and then an all too brief look at some problematics, or puzzles that remain to be addressed and to be solved. In the process, I hope that we can focus on problems of marginality and meritocracy in the scientific community, and indicate not only what we have limited knowledge of, but also what we simply know little about.

Our observations about women in science, both yesterday and today, result to a notable degree from the accumulation of two basic types of knowledge: what William James (1885) distinguished as "acquaintance with" and "knowledge about." Acquaintance with knowledge "involves direct familiarity with phenomena that is expressed in depictive representation," or what Max Weber referred to as "verstehen." Knowledge about "involves more abstract formulations which do not at all 'resemble' what has been directly experienced" (R.K. Merton, 1973, p. 133). Plainly, both forms of knowledge contribute to a full understanding of social phenomena such as the place and treatment of women in science. My knowledge, which derives to a significant degree from quantitative, empirical inquiries about the place of women in science, must surely be classified more as "knowledge about" than as "acquaintance with" knowledge. With this in mind, consider several features of the attitudes toward women and their structural position in science around the turn of this century.

A Glance Backward at Marginal Women

Until the twentieth century, science was populated almost exclusively by men, and so the phrase "men of science" was almost equivalent to the non-sex-linked tag "scientists." What is remarkable is that since the turn of the century there has been relatively little change in the proportion of scientists that are female.

If there have been few women in science, there have been even fewer among the scientific elite. The rolls of National Academy of Sciences and the list of Nobel laureates register very few women. As of 1977, less than 10 of the approximately 900 members of the National Academy were women; only five of the 281 scientists who had received the Nobel Prize were women (H. Zuckerman, 1977). How can we account for these facts? Furthermore, why have there been so few women in science (Rossi, 1965)?

While we have observed over the past 15 years marked increases in the proportion of women entering medical, law and business schools, so that they now represent roughly one-third of the population of those professional schools rather than a tenth, we have not witnessed a concomitant increase in the proportions of women in the natural sciences. To cite only a few statistics prepared by the National Research Council, in 1970 only 2.7 percent of the physics and astronomy doctorates were earned by women; by 1978 that proportion had increased to 4.9 percent--still less than one-twentieth of the total. Similarly, in 1970, 8.1 percent of the chemistry Ph.D.'s went to women; by 1978 that figure stood at 12.7 percent. More dramatic gains were made by women in both the biological and the social sciences: an increase from roughly 15 percent to 25 percent in the biological sciences; and an increase from roughly 20 to 30 percent in the social sciences, although only 12 percent of economics Ph.D.'s went to women. In short, when we examine the figures at the point of entry into the scientific community--the awarding of the Ph.D., we find that women comprise a very distinct minority of members. Furthermore, these proportions do not seem to be following the same trajectory as those in other professions.

Two basic questions follow. First, why have so few women chosen science as a career? Why has this underrepresentation persisted over time? Second, why have so few of the women who have entered science achieved notable distinction and rewards? Is this the result of gender discrimination? Or put more broadly, what are the cultural, social, psychological, and economic forces that influence the career paths of scientists, and female scientists in particular?

These are different yet plainly interrelated questions. They are important ones for us to attempt to answer, and although they are rapidly becoming old questions, we are only beginning to do the hard work necessary for discovering the answers to them. Most of my own work has dealt with the situation of women once they already have overcome the formidable obstacles to becoming scientists. I have concentrated on the "survivors," if you will. I shall spend most of my time talking about the questions of treatment of women in science, but I would also like to discuss briefly the question of why so few ever get there.

Simply put, until recently women were considered unfit for scientific work--and certainly for creative scientific work. Consider only several examples of such opinion.

Alphonse de Candolle devotes only two pages to the place of women in science in his otherwise extraordinary 1885 work Histoire des Sciences et des Savants depuis Deux Siècles. Candolle remarks that the female mind

> takes a pleasure in ideas that are readily seized by a kind of intuition: a mind to which the slow method of observation and calculation by which truth is surely arrived at are not pleasing. ... Add to this a feeble independence of opinion, a reasoning faculty less intense than in man, and finally, the horror of doubt, that is, a state of mind in which all research in the sciences of observation must begin and often end. These reasons are more than sufficient to explain the position of women in scientific pursuits (Candolle, 1885).

Candolle's ideas were not exceptional in their time. Within the scientific community in general, a significant research effort was being devoted to establishing the intellectual and psychological inferiority of the female. Extensive work was carried out on cranial volume and its relation to the lower average weight of her brain. As might be expected, evidence contrary to the "desired" outcome continually confronted these investigators. These various attempts to prove a physiological basis for the lack of female accomplishments in the arts and sciences led, of course, only to dead ends. Yet when at the turn of the century the German scholar Paul Moebius published his The Physiological Feeble-Mindedness of Women, there were fewer attacks on the conclusion than on the causal argument.

Lest I give you the false impression that my sociological brethren were immune from such sensibilities, let me assure you that our founding fathers were not. For instance, Emile Durkheim observed in Suicide:

> It is said that woman's affective faculties, being very intense, are easily employed outside the domestic circle, while her devotion is indispensible to man to help him endure life. Actually, if this is her privilege it is because

> her sensibility is rudimentary rather than highly developed. As she lives outside of community existence more than man, she is less penetrated by it; society is less necessary to her because she is less impregnated with sociability. She has few needs in this direction and satisfies them easily. With a few devotional practices and some animals to care for, the old unmarried woman's life is full (Durkheim, 1897:215-216).

Herbert Spencer, whose work had an extraordinary impact around the turn of the century, held even more dramatic biologically deterministic views. Spencer believed that women represent "a somewhat earlier arrest of individual evolutions." And finally, Auguste Comte, the putative father of sociology, worked out an elaborate rationalization of the intellectual inferiority of women, at the same time putting them on a moral pedestal in order to keep them in their place:

> Sociology will prove that the equality of the sexes, of which so much is said, is incompatible with all social existence, by showing that each sex has special and permanent functions that it must fulfill in the natural economy of the human family, and that concur in a common end by different ways, the welfare that results in being in no degree injured by the necessary subordination, since the happiness of every being depends on the wise development of its proper nature. ... The social mission of woman in the positive system follows as a natural consequence from the qualities peculiar to her nature... (Auguste Comte, 1975).

I need not review here the history of the protective legislation in the United States, since Muller v. Oregon in 1908, to see further the stilted attitudes and beliefs about the capacity of women to handle work outside of the home in general and their work in science in particular. Allow me to skip quickly to one final example of attitudes towards women in science in the early part of the century. Consider the autobiographical reflection of Otto Hahn, the renowned physicist, about his early collaborations with his long-time colleague and prominent physicist, Lise Meitner. To be sure, Hahn speaks of life in Germany, but there is ample evidence that conditions were much the same for women working in American science. He recalls the difficulties Meitner faced in pursuing her research goals:

> The beginning was difficult for her. Emil Fischer, the director of the Chemical Institute (at Berlin), did not then accept women, but he did make a concession in her favor. With the condition that she was not to enter the laboratories where male students were working, she was permitted to work with me in the wood shop. In 1907 this was a really large concession ... and in time he also developed an attitude of fatherly friendship toward Lis Meitner. But the rule that she had to stay in the wood shop (which was later extended to include another basement room) remained in force (Otto Hahn, 1966).

In short, women who entered science in the early part of this century held distinctly marginal positions--they were "marginal women" in the sense that Everett Stonequist and those that followed him applied the concept to men. As one of those followers, Robert Park, said, "the marginal man" is "one whom fate has condemned to live in two societies, and in two, not merely different, but antagonistic cultures" (Stonequist, 1937). Women who entered science were at once rejected by those in the general culture who felt that such activities were inappropriate for women to pursue and not accepted as full members of the community into which they were entering--the scientific community.

Women have, then, traditionally faced formidable barriers to becoming fully productive members of the scientific community. They have faced what Harriet Zuckerman and I have called a "triple penalty," consisting of the following components:

one, that science is culturally defined as an inappropriate career for women, that few women are recruited into science and few would seek it out;

two, that those who have surmounted the first barrier, continue to be hampered by the belief that women are less competent than men at science (Whatever the validity of this belief, it contributed to women's ambivalence towards work, and reduced motivation and commitment to scientific careers); and

three, that women had to overcome significant amounts of discrimination against members of their sex within the scientific community (H. Zuckerman and J.R. Cole, 1975).

Women who even managed to overcome the initial hurdle of cultural resistance to scientific careers for women, and who were able to make it to the starting line with Ph.D.'s in hand, were in a true sense of the term "survivors." And while I believe much has changed since the early part of this century to transform women from marginal figures in science into fuller partners with men in the scientific community, it is plain that women scientists, even today, are still "survivors." We shall return to this matter, but let me simply indicate here that the point of departure for analysis of where women stand today in science is that historically, women have been outsiders looking into the scientific community; they have been marginal figures. And once admitted through the gates into the community they were subjected to both formal and informal discriminatory behavior.

Women in Contemporary Science: Problems of Status Inequality

(This section draws heavily upon materials presented in Fair Science, New York, Free Press, 1979). For detailed analysis of the data that led to the conclusions presented here the reader is directed to the appropriate pages in the book.)

If this represents the historical frame, we may ask whether the same barriers to gender equality continue to exist. Consider the following queries:

1) How much evidence is there that gender-based discrimination exists in contemporary science?
2) Is gender discrimination, if it is found to exist, uniformly distributed throughout the scientific community?
3) Does gender discrimination obtain when we consider access to higher education; when we consider receipt of scholarships and fellowship support; when we consider initial job location and hiring practices after the Ph.D.; when we consider promotion to higher ranks and tenure; when we consider the receipt of research funds; when we consider the attraction of outstanding students and collaborators; when we consider access to outlets for scientific publication; when we consider access to masterful teachers; and finally, when we consider equal pay for equal work?

Questions about the level and intensity of gender-based discrimination in science must be viewed in the context of a substantial body of research over the last decade that has shown science to be a highly meritocratic social system (R.K. Merton, 1973; H. Zuckerman, 1970; J. Cole and S. Cole, 1973; J. Gaston, 1973; J. Gaston, 1978). There has been remarkably little evidence that has been brought forth to suggest that there is substantial bias in the meting out of rewards and recognition in science. Science seems to be fair. To be sure, science has its seamy side: its fraud, plagiarism and particularism (H. Zuckerman, 1977). But to remarkable degree, scientists who are the most productive and who are assessed by their peers to have made the most significant contributions to their fields and specialties through their research receive the lion's share of rewards. But there is a catch. These findings were based almost exclusively upon the study of male scientists--of "men of science," and particularly physics and chemistry, where large-scale, empirical inquiries using random sampling techniques rarely turned up any women in the first place.

So the question I have faced is: To what extent is the position of women in science an anomaly; to what extent are women denied access to positions and to rewards in the scientific community; to what extent are they subjected to gender discrimination?

Before reporting to you some of the fundamental results of my empirical research, I must openly acknowledge the limited state of our knowledge about the measurement or estimation of discrimination. Although each of us probably feels that we "know discrimination when we see it," "verstehen" knowledge is not the same as even rough estimation. And when we examine the literature on discrimination, whether we look at the work of economists such as Gary Becker, or sociologists such as Robin Williams or

Hubert Blalock, we see that there exist not only multiple definitions of discrimination, but more importantly, few, if any, "direct" measures of discrimination. Virtually all quantitative, empirical studies of discrimination, including my own, measure it not through direct observation or measurement, but residually. This is an important point to bear in mind, and indeed an important limitation in studies such as my own--a limitation that requires us all to be organized skeptics about our results.

Discrimination cannot be equated with inequality. There can be a great deal of inequality in an institution, as there surely is in science, without that inequality resulting from discriminatory behavior. Zero-order correlations, one-dimensional views of the world, can tell us next to nothing about the presence or absence of discrimination. In fact, they can be totally misleading. It may seem paradoxical that the presence of formal, statistical equality can itself result from discrimination. For if one individual or social group "outperforms" another, without that performance differential itself resulting from discrimination, then the absence of differences in rewards may actually signal discrimination.

Furthermore, we must not think that "naive residualism" has no practical outlet --that it is not applied in the world beyond these Ivy walls. To cite only one example of its use, the basis for establishing "prima facie" cases of discrimination in litigation under Title VII of the 1964 Civil Rights Act is just such simple inequalities. Of course, most social scientists today employ what I have called elsewhere "sophisticated residualism." They start with an inequality, perhaps income differentials between men and women, blacks and white, and so on, and they then introduce multiple variables that they believe can explain the original difference. The "left-over" difference, or the residual difference, is then taken as an estimate of "discrimination." Is this measurement procedure flawed? Yes. Are there better techniques for measuring discrimination? Apparently not, or at least none that have found even limited application.

Let me turn to results of what I have found about the position of women in contemporary science. How meritocratic is science vis à vis its female members? I wish the answers were simple, but they are not.

I studied more than 2,000 men and women scientists. They were matched initially in terms of the university from which they received their degree, their field of activity, the year that they received their degrees, and the scientific specialty in which they did their doctoral work. I traced the careers of these scientists for 12 to 20 years. I collected data as well on aspects of the scientists' social backgrounds, including their IQ's, marital and family statuses; on aspects of their career histories, such as their job changes, dates of their promotions, prestige of their affiliations, honors and awards they received, and promotion to different academic ranks; as well as on their publication histories and on the patterns of citations or references to their work by others in the scientific community. Finally, I have collected data on the "reputational standings" among a group of peers for a sample of roughly 600 men and women scientists. Standard multivariate techniques were used to analyze these data.

Let me start with the bad news that may not be news to any of you. Analysis of these data allowed me to conclude that there is evidence, today and yesterday, of significant gender-based discrimination in the promotion of female scientists to tenure and high academic rank. Even after I have taken into account many other factors, such as career interruptions and the quantity and assessed quality of research performance of the men and women, I find that women are still less likely than men to be promoted to high academic rank (J. Cole, 1979,pp. 56-58). And when they are promoted, it is not apt to happen as quickly. This finding should not be minimized. It is important because tenure and high rank not only represent security in the world of academic science, but also are requirements for full participation in the inner circles of scientific activity. Furthermore, academic rank plainly can influence income differences between men and women. In short, there is often an indirect influence of discrimination in promotion on salary differentials. Finally, high academic rank can have secondary and tertiary consequences for other forms of recognition and for the acquisition of resources necessary to carry out productive scientific work.

The evidence that I have collected suggests that the pattern of promotion to high

rank, in particular the evidence of discrimination against women in this form, has persisted for the past 50 years at much the same level (J. Cole, 1979, pp. 219-225). While we shall see that there is evidence of substantial progress in other areas, there has been little movement in this one. This should have the "click of reality," as one friend of mine calls it. If we simply look around us at the elite institutions in the United States, it becomes fairly clear that there is a striking paucity of women in lofty positions at the Harvards, Columbias, Yales, and Stanfords of the academic world, even when we take into account the general underrepresentation of women in science. This absence of substantial headway in the promotion of women to tenured positions at major departments of science cannot be attributed solely to their differential rate of production of science or to any demonstrable differences in aptitudes. It is at the point of promotion to tenured ranks that affirmative action pressure should be intensified.

Now for some better news. In almost all other areas of the scientific career following the Ph.D. of men and women scientists, there is little evidence of substantial formal status inequality. There simply is little evidence of gender-based discrimination in these other features of the opportunity structure of science. Consider a series of findings both from my own work and from that of other scholars of the subject.

First, let me dispel tentatively any notions that females who enter science are not as "able" as their male counterparts. Although there is a paucity of good indicators of "scientific aptitude," at least in terms of measured IQ, women in science are certainly every bit the equal of men. In fact, when I compared the IQ scores of male and female Ph.D.'s earning degrees at science departments grouped in terms of their assessed quality, women consistently had slightly higher IQ's at every level of department quality (J. Cole, 1979:159-160; L.R. Harmon, 1963).

Second, there is no evidence that women are systematically discriminated against in admission to graduate science departments. Women are admitted to science departments roughly in proportion to their applications.

Third, there is no evidence that women are systematically discriminated against in the receipt of graduate fellowships to pursue careers in science or in receipt of post-doctoral fellowships (J. Cole, 1979:74; B. Reskin, 1976). Again, data from a variety of sources suggest that they receive fellowships in rough proportion to their applications, and there is no further evidence that the average quality of the male and female applicants differ to any significant degree.

Fourth, when we examine the point of entry into the scientific community, or into the academic science labor market, there is no evidence that women are short-changed in appointments to the "distinguished," "strong," and "very good" departments of science in their fields. There simply is little statistical evidence that would suggest that appointments at the level of assistant professor are meted out on the basis of gender (J. Cole, 1979:54-55). To be sure, when we look around us we will not see anywhere nearly as many women in departments of chemistry or biology or astronomy as men, and this will be true at the assistant professor level as well as at higher ranks. But that observation does not signal discrimination, since there are far fewer women Ph.D.'s than men who are entering the academic labor market in any particular group of Ph.D.'s. I have found this pattern to hold regardless of the scientific field that I have examined--whether it be for the natural or the social sciences. Some observers might prefer to see the spectre of discrimination everywhere, but the evidence does not bear out such simple notions--at least basing such assessments on the type of materials that I have gathered.

Fifth, despite the paucity of women who have gained the most prestigious of all scientific honors, such as the Nobel Prize, the evidence suggests that, <u>on average</u>,women in the 1958 cohort are no less apt to receive honorific recognition than are their male counterparts. When we examine the probabilities that men and women scientists who entered the scientific community in 1958 have received awards for distinguished work, we find no meaningful differences in the probabilities for men and women (J. Cole, 1979: 58-62).

This finding highlights a point often disregarded in examining women's place in science. Most of us have been trained to look only at the elite of science. We pay

little attention to the rank-and-file. There are good reasons to dwell on the elite. The overwhelming majority of "important scientific discoveries" are produced by them. But if you examine the conditions and life chances confronting most scientists you find that few can expect to earn any significant honors--few women or men will gain any formal honorific recognition. This underscores the distinction between the analysis of aggregated and disaggregated units.

Let me digress here for a moment. Very different perceptions about levels of discrimination can be obtained by concentrating on different units of analysis; by the degree to which we focus on the "whole" or "the average," rather than on particular sectors of the scientific community. What might be true, on average, may not be true of course for a small fraction of the whole, such as the super-elite institutions, or the most prestigious prizes or awards. There may not be any difference in the probability of men and women obtaining initial first jobs in science at departments of prestige, but there may be very different probabilities for them at Columbia or Harvard. In fact, one of the drawbacks of larger statistical analysis of discrimination in science is that the focus is most often on larger statistical aggregates, rather than on comparisons of specific subclassifications. Thus, even when I examine departmental affiliations of differing ranks, I have grouped the departments according to either the Alan Cartter categories of "distinguished," "good," etc., or the Roose-Anderson classes that contain as many as fifteen or twenty universities, rather than focussing on the one or two cases at one end or the other of the prestige continuum.

Sixth, I have found significant differences in the average "reputational standing" of men and women in the same scientific fields (J. Cole, 1979:chapter 4). In my work, reputation is measured by the appraisals by "peers" of research contributions made by a stratified random sample of scientists who work in the same field or scientific specialty. Incidently, there is no evidence that men and women differ significantly, on average, in their assignments of women scientists, although women are somewhat more likely than men to select other women to be among the two or three most outstanding contributors to their fields over the past decade. On the basis of simple comparisons between men and women scientists, there seems to be a "cost" of being female in the process of building scientific reputations. But if we take into account the research performance of men and women scientists, in terms of both the quality and quantity of research output, the differential disappears almost completely. In short, highly prolific female scientists have similar reputational standings among their colleagues as do roughly equally prolific male scientists.

Seventh, inequalities in salaries of men and women scientists continue to exist, but recent larger-scaled studies by Centra (1974) and by Bayer and Astin (1964, 1975) among others, suggest that the earnings ratio of females to males, after taking into account a variety of explanatory factors, including research productivity, exceed .9, that is, they virtually disappear. For example, Centra's 1974 study found that male and female full professors who have been employed at universities for only 5 or 6 years have essentially identical incomes (women earn 98.5 percent as much as men); for those employed from thirteen to fourteen years, women's salaries are 95 percent of men's. Alan Bayer and Helen Astin in an earlier study (1964) found that women earned 92 percent of what men were earning. At universities, however, men and women in lower ranks earned roughly the same salaries (99 percent); within higher ranks the ratio was 91 percent. Similar results obtained when the focus shifted to colleges.

More sophisticated recent work by Bayer and Astin (1975), strongly suggests only small salary differences between men and women when we use a multivariant model to explain differences. Bayer and Astin found a -.04 partial correlation between gender and salaries after controlling for nine variables in a multiple regression equation. This could easily have been a spurious association had not Bayer and Astin teased out the influence of differences in academic rank, since there is good evidence of gender discrimination in promotion to high rank. But even without controlling for academic rank, they still found a partial correlation of -.05 between sex status and salary. In fact, female to male earnings ratios in academic science are considerably higher than in any other institutional sphere in which men and women's earnings have been compared (Lloyd and Niemi, 1979), where ratios from .6 to .8 are frequently observed even after taking into account multiple

explanatory variables.

Eighth, the social processes and background characteristics by which successful scientific careers are made and by which reputations are built are almost identical for both men and women. That is to say, the very same forces that seem to determine both positional recognition and reputational recognition for men, also determine in roughly equal weight these forms of recognition for women. For instance, the quality and quantity of research publications have roughly the same effect in influencing the recognition of women as they do for men. And for both men and women, the quality and quantity of research performance are the strongest determinants of various forms of scientific recognition.

This brings me to a ninth, and in many ways the most intriguing and puzzling result of my labors--one which continues to interest me a great deal. For every cadre of men and women scientist Ph.D.'s for whom I have collected data, there is a consistent and patterned difference in research performance. Female scientists tend not to publish as much science as males who are of equal professional age, who come from similar educational backgrounds, who are in the same fields and specialties. This result holds for every group of male and female scientists that I have studied since the turn of the century. Furthermore, these patterns of productivity differential have been observed by many other investigators as well (J. Cole, 1979; A.E. Bayer and H.S. Astin, 1968; B. Reskin, 1978; J.A. Centra, 1974; among others). It is also apparently the case that the research published by women has, on average, less impact on the development of knowledge, as gauged by the number of references or citations to their work, than does research published by men.

Research productivity in science has received generous attention. It is well known, for example, that scientific research productivity is highly skewed: about 10 to 15 percent of all scientists produce roughly 50 percent of all of the scientific literature (D. Price, 1963). Most scientists produce only three or four papers in a scientific career. In any given year, the vast majority of scientists, even those holding positions at universities, will not publish a single paper. This holds for men and women alike. The skewed distribution of research productivity also is similar for both men and women. If we examine the research patterns of the male scientists who received their Ph.D.'s in 1958, we find over a 12 year span a Gini concentration ratio of .502 for the men. When we look at the women in the same sample we find almost the identical ratio, .504. In short, among women scientists, about 15 percent produce 50 percent of the total output, or about the same proportion as obtains for men (J. Cole, 1979:63).

Most importantly, there is a moderate and consistent correlation between gender and research performance, in the neighborhood of .3, with men consistently publishing more than women. When we focus on the impact of published research, similar differences are found. Finally, when we examine these performance differentials over time, we find that differences in research productivity between men and women Ph.D.'s seem to increase over the course of the scientific career, and that the correlation between early and later career productivity is significantly higher for men than it is for women.

How can we account for these patterned differences in research performance between men and women? There have been several hypotheses, and many speculations, but few satisfying answers. Consider just several proposed explanations for the differences.

Noting these patterned differences in published productivity, it often has been asserted that the multiple role obligations of female scientists, particularly those of wife and mother, detract from the time needed to be more productive scientists. Surely the effects of marriage and families differ for men and women, even in today's world, and indeed this is a plausible hypothesis. Yet the data don't seem to support it.

My data show that not only does marriage and family life fail to impede scientific productivity of women, but it seems to be related to small increases in research performance. Women scientists who were married turned out to be significantly more prolific than those that were not; and women who were married with either one or two children were slightly more scientifically productive than women who were unmarried, and only slightly less scientifically productive than those who were married without children.

However, there is a limit to all of this. Once a woman has had three or more children there is decline in research output, but not to a point that it is significantly lower than that which is found among the unmarried women. Such results fly in the face of conventional wisdom and we should therefore approach them with caution. Of course, a fortiori, we can create plausible explanations for this outcome. Émile Durkheim might rejoice at such findings, since he would have liked us to believe that marriage and the family actually have a stabilizing, integrating, and cohesive effect on individuals. The data appear to suggest that despite the hassles and claims of marital and family obligations, they are not of a form that adversely influences research performance, at least no more so than the strains associated with being single.

The relationship between gender, marital and family life, and scientific research performance typifies many other recent findings: they are somewhat counterintuitive, they are puzzling, and since they are based upon limited data they call for important further inquiries. Consider several questions that might be put to me about these findings. Does this pattern hold for women in all age groups? When we compare the women who are married with families with those who do not have families, are we comparing the "same" women? Perhaps the women who continue to be active scientists and who are simultaneously able to manage their family lives, are quintessential "superwomen." Or perhaps they have more help in carrying out their multiple tasks. Furthermore, if we look at the career histories of these female scientists, what are the short-run vs. longer-run effects of having children on patterns of research publications? Are there temporary gaps or declines in scientific research productivity among these women while they attend to their other forms of productivity?

In brief, we simply do not yet have answers to these questions. Some observers of science believe that the gap in research productivity between men and women is itself the consequence of subtle and not so subtle discriminatory practices within science; the result of limited and impeded access to the resources that are needed to carry out scientific research, limited access to publication outlets, limited access to government and other forms of support for scientific research, limited access to the best "human capital" available within the graduate student population, and limited availability of willing colleagues with whom to collaborate; and the result of excessive non-research demands made on women faculty members in the forms of higher teaching loads, more extensive committee assignments within departments, etc. There are almost no data available to test these conjectures.

Other observers have hypothesized that the productivity differential results from the different structural positions that men and women of science occupy. Women are slightly more apt than men to be located at teaching rather than research oriented institutions. But preliminary examination of data that compare men and women at similar settings does not show more than a minor reduction in the productivity differentials.

Still other observers of science might have us believe that the differential is a function of motivational problems that result from different reference groups. These observers argue that women who achieve Ph.D.'s in science represent more of an elite group relative to other women than do their male Ph.D. counterparts. For female scientists, who have had to overcome cultural and institutional constraints, the Ph.D. becomes an end-in-itself; for men it simply represents a union card--a temporary way station toward higher positions in the scientific community. There is limited information to test these conjectures. In short, we don't really understand the social processes at work that influence the emergence and maintenance of these patterned differences in research productivity.

Problems of Status Inequality and Citizenship

These, then, are some highlights of my empirical studies. On the basis of these data, we might conclude that status inequalities between men and women scientists have been reduced sharply over the past 50 to 75 years. Women have moved from marginal positions, which hovered at the outskirts of science, toward the inner core of the

community. In fact, there have been substantial reductions in most status inequalities, of course, with the critical exception of the area of promotion of high rank. And, I believe, the quality of experiences has improved substantially. It is in the domain of informal activities in science that the biggest gaps between men and women remain. It is in the more intangible set of experiences associated with doing science from day-to-day that women today rightly feel most excluded.

To say that women of science have now entered the central scientific community, and that they have achieved formal equality with men in terms of many measurable aspects of the reward system, does not say that the opportunity structure for men and women interested in science as teenagers is equally open. Nor does it say that the women who have chosen science have an equal chance for winding up in the "inner circles" of science, or that they will be equal participants in the "invisible colleges" of the scientific establishment. No. Resistance to full participation, to full citizenship of women in the scientific community, continues to exist. Some of the types and sources of that resistance are known, but I believe that many of the sources are little understood, if even correctly identified.

Young women interested in careers in science today continue to have more formidable high hurdles to negotiate than do young men. And women already in science continue to be faced with obstacles to full citizenship, but not as much in the formal sense of exclusion as in the informal sense of limits on the behavior that will allow them to achieve up to their capacity.

In Fair Science, I suggested that some of the incredulity about some of these findings resulted from "the haunting presence of functionally irrelevant statuses." I hypothesized that the salience of gender in contemporary society leads both men and women to construct post factum causal explanations of career decisions and formal inequalities in terms of gender. Gender is perceived as the principal reason for differences in status attainment, and other, alternative explanations are discounted. I now believe that the reasons for the incredulity go beyond this, and have to do, at least in part, with the type of knowledge that can be obtained through the use of current quantitative, social science methods.

I believe that typical quantitative methods can estimate rather well features of the formal aspects of "citizenship" in science. They allow us to estimate status inequalities in affiliations, in awards and honors received, in academic rank, etc. But these techniques, at this stage of their development, do not allow us to measure adequately other, informal aspects of "citizenship."

Until the early part of this century, the inequalities in positions held by men and women scientists were so dramatic that they resulted in status-set configurations that were almost totally dissimilar. These differences in status extended even beyond science into aspects of marriage and family life. Women scientists, for example, rarely were married, since marriage itself could have spelled the end of their careers. Men controlled all of the "means of scientific production"; they dominated almost all positions of authority and power; they completely controlled the structure of formal opportunities. A totally asymmetric relationship existed. At that point women were totally marginal figures in science.

I believe that many of those fundamental cleavages began to break down early on in the century, but sharp differences in social status remained. In most ways that status inequality could be measured, substantial gaps in position, rank, and salary persisted. Although women had moved into the community of science, they were not of that community. If there has been movement toward greater application of meritocratic principles over the past 25 to 30 years, it has taken the form of reducing the level of formal status inequality between men and women scientists.

What I do not believe has been achieved to any significant degree is the achievement of full citizenship for women in science.

When I speak of citizenship, I have in mind T.H. Marshall's concept of social citizenship. The social element in citizenship involved "the right to share to the full in the social heritage and to live the life of a civilized being according to the standards prevailing in the society." (T.H. Marshall, 1965, p. 78). Many women continue

to be excluded from the very activities of science that allow for full participation and growth, for productivity and change. These are, by-and-large, the informal activities of science: the participation in the heated discussion and debates in the laboratory; the inclusion in the inner core or the "real" invisible colleges of science; the full participation in the social networks where scientists air ideas and generate new ones. These relationships involve what Mark Granovetter (1973) has called "the strength of weak ties." These are also the close collaborative relationships that grow up over time, that help to shape scientific taste and sharpen the eye for a good research problem. Women perceive in significant numbers that they remain excluded from those activities that really define full membership in the community. I believe that there is much merit to those perceptions, although we have almost nothing more specific than anecdotal, autobiographical evidence to support them.

In fact, I believe that the differences in status and "social citizenship" explain some of the apparent clash between the knowledge generated by "verstehen" and knowledge generated by means of larger surveys. Why do the findings reported in my book often fail to elicit in many women scientists that "click of reality?" Part of this results from the limits to the two forms of knowledge. The quantitative methods that are used to measure features of scientific careers can begin to estimate the extent of status inequalities, and they can begin to account for those that do obtain. But these are differences that obtain in formal recognition. Verstehen knowledge captures aspects of citizenship that quantitative data in their current form are simply not able to measure. The value of knowledge acquired through direct experience is that it allows us to focus on particular, detailed forms of inclusion and exclusion within the scientific community. Its shortcoming is that it cannot accurately represent as can larger studies using multivariant analytic techniques the general level of status inequality that obtains in the larger social system.

In my final set of observations I would like to identify several little understood processes that must be addressed if full citizenship and indeed real meritocracy are to be achieved in science.

Looking Forward: Problems Facing Women in Science

1. Processes of self-selection and social selection.

Most of our intellectual energy in examining the position of women in science has been spent on the social processes within science that act as impediments to the career development of women. For the most part, we have looked at processes of social selection, by which institutions and organizations make selections for positions, awards, promotions, salaries, among competing candidates. And more specifically, we have attended to the question of whether these processes of social selection within the scientific community operate fairly, meritocratically, with or without discriminatory intent. We have neglected a host of extremely difficult questions about barriers that face young women who are interested in science, but who turn away from it as youngsters or as college students. We have concentrated, as I said earlier, on "survivors." In a sense, we start looking for problems at the finish line--after the race is already run. We have neglected to study the forces exogenous to science that make the low proportion of women in science virtually inevitable. We need not rejoice over science approaching its universalistic ideal when only four or five percent of the total population of physicists are women in the first place.

Perhaps the single most important question that we can ask is: What forces persist in the general culture, in the general value system of American society, in the American family, in our schools, in the presentation of professional careers by the mass media, that turn young women away from the starting line?

Young women tend to self-select themselves out of science at early ages. And we know remarkably little about the factors that lead to this decision. We know that science has not been viewed as an appropriate career for women, and that women were thought not to have the capacity to do outstanding scientific work. But we do not know much about how these values are transmitted to young women. We do not know much about the intersection between culture and social structure in processing these general beliefs and values. We

have no idea about the relative effects that parents, peers, teachers, guidance counsellors, and curricula have in turning young women away from science. Finally, we know little about the perceptions of science among boys and girls in early adolescence. As an activity, as an enterprise, does science have the same fascination for young girls it does for young boys? Does it trigger their imaginations in the same way? If this is not the case, why not? And if it is, how does this enthusiasm become dampened over time?

Let me be clear. Understanding the decision-making of teenagers may be even less tractable than understanding other decision-making processes. Occupational choice has had a long history of being a particularly thorny area of research. Even the ablest scholars have found it difficult to fathom why youngsters make the career choices that they do (D. Eiduson, 1973; R.K. Merton, et.al.,1957). Nonetheless, the problems are so significant, and the consequences so great, that a renewed effort must be mounted better to understand how our culture leads science to be viewed by our young women as an inhospitable and unattractive environment. Until we understand more fully the social conditions that lead young women to select themselves out of science, we will not have an opportunity to change these conditions. In the final analysis, opening up science to women may depend more on our getting a handle on these problems than on anything else.

2. Processes of Accumulation of Advantage and Disadvantage.

There is a tendency to view the position of women in science statically, rather than in terms of on-going social processes. In fact, there is substantial evidence that advantages and disadvantages in science cumulate over time. A social system that operates meritocratically at one point in time vis à vis a group of scientists may still discriminate against that group. Suppose the social system of science is less apt to support the education of women than men in terms of apprenticeships. If women scientists receive less support than men, it should not surprise us to find them less scientifically productive. Their futures in fact become predictable. When they come up for promotion, their publication records are carefully reviewed and found inferior to those of men with the "same" types of background, and they lose out in the academic marketplace. The self-fulfilling prophecy, which is based on the assumption that women are less motivated, less productive, and less reliable scientific risks than men, now is strikingly supported by data. Gate-keepers for resources may now present data to justify not giving equal financial support to women scientists, since they are less likely to produce significant research with the funds. And so the conditions for the self-fulfilling prophecy are reinforced. Plainly if a self-fulfilling prophecy operates at an early point in a career, a universalistic judgment later on will ultimately produce inferior status for the judged group.

Correlatively, if certain youngsters are labeled early on as potential stars, and are consequently given resources and disproportionate opportunities to study at the sides of masters, are given disproportionate opportunities to collaborate on research projects and on publications with senior scientists, it should not surprise us if later on in their careers they have more formidable research track records. They then have somewhat higher probabilities of receiving support for future research, and are apt to have received a greater proportion of honors and rewards. Of course, there is nothing wrong with such processes of accumulating advantage if initial selection is based solely on meritocratic and impartial criteria. In that event, the social system of science would be distributing resources to those who are in fact most talented and promising. However, if the initial assessment of who is apt to be a "star" is based on functionally irrelevant criteria, such as gender, then the process of accumulating advantage can begin to enhance the career possibilities of men, while diminishing the chances of women. There is relatively little information about the processes of accumulating disadvantage and how it influences the careers of women in science.

Moreover, we do not know how aspects of women's lives outside of science produce disadvantages that are felt during the course of a scientific career. Consider only one concrete example. It is apparently the case that the patterns of geographic mobility of men and women scientists differ (Marwell, et.al., 1979; Committee on Status of Women, AAS, 1979). This is especially true for married women scientists. For whatever reasons, women feel more constrained than men in shifting job locations if they are married or are part

of a dual career couple. The "Committee on the Status of Women" of the American Astronomical Society addressed this matter recently:

> In cases where a move was considered very difficult, prohibitively difficult, or of uncertain difficulty, 84% of the women listed employment of the spouse as the reason, while only 43% of the men gave this reason. ... The women respondents feel much more constrained to obtain jobs in the location where their spouses work than do the men (AAS, Committee on the Status of Women, 1979, pp. 8-9 of preprint).

It is also well known that geographic mobility tends to be associated with the building of reputations in science, with the development of important social ties, as well as with tangible rewards such as increases in salaries at one's own university or college. A time-honored way for scientists to obtain improved positions at "home" is to establish their market value "abroad." If women are less willing than men to entertain moves, and perhaps equally importantly, if they are also defined by others as less likely to be moveable because of a spouse, then a process has been set in motion that may reinforce the accumulation of disadvantage.

In sum, both the processes of social selection, including gender discrimination, and self selection can operate to compound initial small advantages or disadvantages into marked differences in status and rewards. We must begin to study the careers of scientists as a set of dynamic and interacting processes that can quickly transform equality into inequality.

3. Productivity Differences.

We have not begun to understand fully the productivity patterns of men and women. Are the differentials that have appeared in multiple studies of men and women scientists a thing of the past? What accounts for sex differences among academic scientists and scholars in published productivity? Do such differences in fact increase with age? Are younger women more like their age-mates among men in research patterns and performance than are older women? And what accounts for differences in the extent to which the works of men and women are cited in the research literature? Have the women's movement and "affirmative action" resulted in smaller sex differences in productivity among those educated after these historical changes? How, if at all, do the work habits of women differ? What factors determine whether a woman will be a prolific or a silent scientist? How do these factors differ among the several scientific disciplines? These are important questions for both the study of gender-based discrimination in science and the formulation of science policy.

Why is knowledge about the determinants of productivity patterns among women important for science policy? Although women still represent a distinct minority among physical and natural scientists, their proportion is growing steadily. The emergence of women as a truly significant rather than as a token proportion of the community makes questions of scientific productivity differentials all the more important. If women represent an increasing portion of the entire community, and there are forces either inside or outside of science that produce a lower than expected level of research output, what will be the consequences for the growth of knowledge in these fields? It is imperative that we identify the barriers to full productivity of women so that we can eliminate them.

4. Informal Social Networks: The Strength of Weak Ties.

My work has not been finely tuned enough to identify and describe precisely the detailed patterns of social interaction and sponsorship that are an essential part of successful careers. Being part of the "proper social network," being linked to the "right" people, plainly goes some distance in determining the paths taken in scientific careers and contributes to making science fun. None of this, of course, is a substitute for talent. But given talent, it plays a significant role in launching and sustaining careers.

Consider only several questions that need to be researched. Do women have the same opportunities as men to establish "apprentice" relationships with older, eminent scientists? Whether we examine Auguste Comte's relationship with Saint-Simon; Fermi's with Corbine, Segrè's with Fermi; Otto Hahn's with Rutherford, Lise Meitner's with Otto Hahn; Mary Whiton Calkins' with William James; or the thousands of other master-apprentice relationships, we are dealing with an important mechanism of transmitting a scientific

tradition from one generation to another. Even a cursory skim of the autobiographical histories of scientists reveals poignantly how sponsorships involve jealousies, ambivalence, conflict, admiration and love; and how they are always essential in producing in young scientists a sense for a good question or a key problem, a style of doing research or theorizing, a critical stance, and a way of teaching their own future intellectual progeny.

As part of the new study of processes that sustain or set in motion an accumulation of advantage or disadvantage we must describe in detail the informal structure of activities of young men and women scientists. Are women, for example, less apt than men to spend extended amounts of time in informal scientific discourse with their teachers--and if so, why? Are they less likely to assimilate the style of scientific work which is so important to later productivity? Do science professors attempt to place women protégées in laboratories and departments where there is a significant chance for them to work on ongoing projects or programs, to develop their own ideas, and to have the facilities necessary to translate ideas into publishable papers? Perhaps even more importantly for research performance, do senior professors engage in scientific collaboration with junior female colleagues; do they ask them to join their laboratories; do they get them invited to conferences at which they describe their work to groups of scientists who have already gained some prominence and are influential in determining the next generation of esteemed and prominent scientists; do they aid in obtaining for their female students and junior colleagues invitations to publish papers in journals, in conference reports, and in proceedings from symposia? Finally, are women more apt than men to encounter difficulties in recruiting the most able graduate students to work for them, and eventually in collaborating with them?

Of course, the simple answer is that some do and some do not; but a more detailed inspection of the problem should help to establish whether for women the probabilities are lower than for men of having these informal experiences that eventually are reflected in productivity rates and higher reputational standing. More specifically, do differential probabilities exist among the most talented young male and female scientists, for whom these opportunities might actually be significant (J. Cole, 1979:130-132)?

There are no existing quantitative studies that can immediately answer these questions for us, no multiple regressions that will describe or establish the impact of these social linkages. There is work to be done here if we are to discover how the actual experiences of men and women scientists are similar and are different, and indeed whether gender is of little consequence in the development of scientific careers. It remains unclear whether or not women are less apt than men to benefit from the operation of informal networks in science. I suspect that women are relatively deprived. It is plainly an area that needs thorough investigation.

5. Measuring Discrimination.

Our attempts to measure discrimination precisely are relatively primitive. Whether we deal with impressionistic evidence provided from autobiography or with the results of larger quantitative empirical inquiries, we have at best very limited and often indirect measures of the phenomenon that we want to understand. Substantially more work must be done to discover new and improved methods of measuring discrimination.

6. Gender Discrimination in Promotion.

In the end I want to return to the beginning: the evidence that there exists significant gender discrimination in promotion. Affirmative action efforts should concentrate on this critical pressure point. Diffuse affirmative action efforts tend unnecessarily to deplete the energy that is needed to attack the major problem of discrimination in academic science. This should be the case most particularly at elite institutions of science, which have always set standards followed by others.

Concluding remarks

Let me conclude. I believe that we have made a beginning toward true meritocracy for women in science. Historical materials and contemporary studies suggest strongly that we have moved a great distance toward equality of status for men and women. Important pockets of status inequality remain. In particular, colleges and universities

have been remarkably slow to reward their female scientists with promotion to tenure and high rank. We must apply measure to change that situation. But there are two important areas where I believe change has been even slower. Within science, the failure of women to be accepted as full citizens with equal participatory rights in the informal activities of science results in their remaining in many ways second class citizens. Such forms of exclusion and discrimination are difficult to overcome; they are not easily attacked through litigation and other formal sanctions. But they must be overcome before we can say that science truly approximates a meritocratic community, where all of its citizens regardless of gender enjoy equal rights and opportunities.

And beyond these matters of attaining equality for those already in science, the larger question for tomorrow is how do we alter American culture in such a way that science will become an attractive career for bright, young, energetic women? How can we adapt the culture and its various institutions so that they will encourage women to enter science and will not derail them through sex stereotyping and self-fulfilling prophecies? If we are looking toward the horizon, if not over the rainbow, the most pressing problem is for us to be able sharply to increase the numbers of young women who enter the community in the first place. And as I have said, we are abysmally ignorant of the social and psychological processes that influence these decisions. To remain so condemns us to being concerned about the welfare of 10 or 15 percent rather than what could and should be 50 percent of the scientific community.

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OF POSSIBLE INTEREST

Stopping unwanted sexual advances at work is the subject of "How to Stop Sexual Harassment," a new booklet published for employed women. This is the first publication to offer practical strategies for dealing with a problem that is troublesome to many women at work. The 24-page booklet details women's legal rights regarding sexual harassment, and provides a series of steps for attempting to resolve the problem informally. Procedures for filing complaints and lawsuits are explained, and a special appendix gives information on legal cases. Also included are preventive strategies. The booklet is published by Facts for Women, an independent publishing house, and is being sold primarily through the mail. Single copies may be obtained by sending $3.50 ($2.95 plus $.55 postage, handling and tax charges) to Facts for Women, P.O. Box 15113-N, Seattle, WA 98115. Bulk rates available upon request.

Quest: a feminist quarterly, P.O. Box 8843, Wash., DC 20003, $9 for 4 issues.

The Women's Educational Equity Communications Network (WEECN) had been a project funded by the Women's Educational Equity Act (WEEA) Program. The WEECN contract expired on September 30, 1980. The WEEA Program may be contacted directly: WEEA Program, U.S. Department of Education, 1100 Donahoe Building, 400 Maryland Ave., SW, Wash.,DC 20202. The WEEA Program will soon award a new contract for a WEEA Information Center which will continue and expand the information referral and networking activities initiated by WEECN.

HEIGHTS, a national software services company, is not just another data processing business. It is women-owned and allows its data processors to work at home. By installing a terminal in the home, employees can work full- or part-time, supplying all the computer programming needs of HEIGHTS' clients as well as raising a family and tending to a household. For information, write: HEIGHTS, 199 Main St., Suite 210, White Plains, NY 10601 or 383 Grand Ave., Suite 8, Oakland, CA 94610.

Notable American Women: The Modern Period by Sicherman/Green; lives of 442 women. Harvard University Press, 79 Garden St., Cambridge, MA 02138, $35.00. Other titles.

TABS: Aids for Ending Sexism in School, 4 issues annually, $17.00, TABS Orders, 744 Carroll St., Brooklyn, NY 11215. Nice posters.

University of Illinois Press, Box 5081, Station A, Champaign, IL 61820. Many women's history titles.

Women's issues, Lexington Books, D.C. Heath and Company, 125 Spring St., Lexington, MA 02173.

Tapes of broadcasts on women's issues on Pacifica radio stations, Pacifica Tape Library, Department W801, 5316 Venice Blvd., Los Angeles, CA 90019.

The SWE Achievement Award, the highest honor given by the Society of Women Engineers, is given annually to a women who has made an outstanding contribution in some field of engineering. Her academic training may have been in either science or engineering, and she does not need to be a member of the Society of Women Engineers. On the other hand, she should be a person of status, and should have already progressed to a high-ranking position in her engineering career. The main criteria for selection are

based on the significance of the achievements cited on her behalf, with sustained contributions in any phase of engineering; i.e., design, production, management, education or research. In order to be eligible for the award, the nominee must be actively engaged in the engineering profession and should have one of the following qualifications: 1) an engineering degree from a recognized college or university and not less than 6 years of increasingly important engineering experience, 2) a degree in a science related to engineering from a recognized college or university, and not less than 8 years of increasingly important engineering experience, 3) not less than 11 years of increasingly important engineering experience indicating engineering competency and achievement. This year's application deadline has already passed.

Women's Studies, Princeton University Press, Box WS, Princeton, NJ 08540.

Ms. Carmen Lisboa, P.O. Box 162, Flushing, NY 11352 is a doctoral candidate at Fordham University in the Division of Administration, Policy and Urban Education. She is engaged in a study concerned with comparing determinants of demographic, socioeconomic, cultural and other characteristics among Hispanic women who left a professional graduate school while pursuing a career in science and those who completed their education. Those students in the last two years of study in the areas indicated will also be included in the present study. If you know of any women who would be interested in participating in the study (participation may be kept anonymous), please let her know.

DEADLINES: Jan. 24 for Mar.-Apr., Mar. 24 for May-June, May 23 for July-Aug.

ADDRESSES: Send all newsletter material except ads to Anne Leggett, Math. Dept., Western Illinois University, Macomb, IL 61455. Send everything else, including ads, to AWM, Women's Research Center, Room 204, Wellesley College, 828 Washington St., Wellesley, MA 02181.

JOB ADS

Institutional members of AWM receive two free ads per year. All otger 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, Huntsville. Dept. of Mathematics. Tenure earning position at Asst., Assoc. or Prof. level, 9/1/81. Rank & salary depend on credentials. Required: Ph.D. in mathematics, specialty area (s) in applied math, strong research credentials & active interest in quality teaching. Industrial and/or mathematical modeling experience preferred. Usual fringe benefits. Send application, graduate transcripts, vita & 3 letters of reference to F. L. Cook, Chmn., Dept. of Math, Univ. of AL, Huntsville, AL 35899. Screening of applicants will begin 2/1/81.

University of Alabama, Huntsville. Dept. of Mathematics. Two assistant professorships (tenure track) 9/1/81. Required: Ph.D. in math, evidence of strong potential in research & active interest in quality teaching. Teaching will involve graduate and undergraduate courses with typical load of 8 hrs. per week. Send application, graduate transcripts, vita & 3 letters of reference to F. L. Cook, Chmn., Dept. of Math, Univ. of AL, Huntsville, AL 35899. Screening will begin 2/1/81.

University of Alabama, Huntsville. Dept. of Mathematics. 2 term-appt. positions for 1, 2 or 3 years (renewable) as of 9/1/81. Length of appt., rank & salary negotiable. Master's degree in math required & terminal degree in math preferred. Usual fringe benefits. By 3/15/81 send vita, graduate transcripts and 3 letters of reference to F. L. Cook, Chmn., Dept. of Math, Univ. of AL, Huntsville, AL 35899.

University of Alabama, University. Dept. of Mathematics. Tenure-track positions, probably at Asst. Prof. level. Required: Ph.D. & demonstrated ability in research & teaching. Research interests in dept. include algebra, analysis & applications & topology. Candidates' research interests should complement those of dept. Write to C. Hobby, P. O. Box 1416, University, AL 35486.

California State University, Chico. (1) Visiting Prof/Assoc.Prof. 81-82 academic year or either semester. Teach 2 undergraduate courses/sem; give seminar series for faculty, advanced students. Prefer tenured applicants with distinguished research/ teaching record. Salary $22,620-34,476. (2) Asst. Prof/Prof. tenure-track position, Fall, 1981. Duties: teach 12 units undergraduate math, actively participate in dept. activities. Teaching, industry & research experience commensurate with desired appt. level. Ph.D. required, field open. Salary $17,964-34,476. For both positions by 3/1/81 send vitae, references & evidence of teaching excellence to Michael Dixon, Math Dept., CA State Univ., Chico, CA 95929.

California State University, Fullerton. Dept. of Mathematics. Tenure-track and/or lecturer positions for applied mathematicians. Ph.D. required. Prefer applicants with outstanding teaching qualifications, research experience in modern applied areas such as modeling, combinatorics, numerical analysis, applied statistics or optimization. Rank & salary determined by experience & qualifications of appointee. By 2/16/81 send vita to Chair, Selection Committee, Dept. of Math, CA State University, Fullerton, CA 92634.

California State University, Long Beach. Dept. of Mathematics. Several lectureships (2 year appt., non tenure track) available Fall, 1981. Required: Ph.D., excellence in teaching & potential for research. Salary $17,964 to 21,600/academic year. By 2/15/81 send resume, 3 references & transcripts to Dr. Gittleman, Chair, CA State Univ., Dept. of Math, 1250 Bellflower Blvd., Long Beach, CA 90840.

Loyola Marymount University. Dept. of Mathematics. Tenure-track position Fall, 1981. Prefer applicants with demonstrated training and/or experience in computational or applied mathematics. Please send resume & 3 letters of recommendation to Prof. Michael Grady, Math Dept., Loyola Marymount Univ., Loyola Blvd at West 80th St., Los Angeles,CA 90045.

Occidental College. Dept. of Mathematics. Asst. Professor. Required: Ph.D. or Ph.D. pending with field of specialization open but with interest in some aspect of applied mathematics. Entry level applicants preferred, but others may be considered. Salary $16,000-19,000. By 2/15/81 send resumes & 3 letters of reference to T. N. Robertson, Chair, Dept. of Math, Occidental College, Los Angeles, CA 90041.

San Diego State University. Dept. of Mathematical Sciences. (1) Assoc. Professorship in Computer Science (tenurable) for Fall, 1981. Salary $22,620 to 27,575. Required: Ph.D. in Math or Comp. Sci., research background, good teaching references & 5 or more years of university level teaching experience. Consulting or industrial experience preferred. Duties: teaching undergraduate & graduate courses, directing graduate projects at Master's Degree level & conducting own research. (2) Position in Comp. Sci. (tenurable) for Fall, 1981. Rank: Open. Salary (depending on rank): from $19,692 to $31,476. Required: Ph.D. by time of appt., research background & good teaching references. Duties: teaching graduate & undergraduate courses in computer software & theory, directing research at Master's Degree level & conducting own research. By Jan. 31, 1981 (for both positions) send vitae & names of 3 references to Comp. Science Search Committee, Dept. of Math Sciences, San Diego State University, San Diego, CA 92182.

San Diego State University. Dept. of Mathematical Sciences. Post Doctoral Lectureship for Sept., 1981. Prefer candidate who has recently completed doctorate in pure or applied mathematics. Duties include moderate teaching, so classroom experience would be helpful. 2 year appt. Salary: $17,694 to 21,600. Send vitae & names of 3 references to Post Doctoral Search Committee, Dept. of Math Sciences, San Diego State Univ., San Diego, CA 92182. Closing date: 2/15/81.

San Diego State University. Dept. of Mathematical Sciences. Tenurable position in applied mathematics for Fall, 1981. Rank: Open Salary: $17,692-34,476. Required: Ph.D. in math or related area with strong Master's in math or equivalent by time of employment; experience in math modelling in applied field, a commitment to quality teaching; will be asked to expand existing applied program & interact with industry. By 1/31/81 send vitae & 3 references to Applied Math Search Committee, Dept. of Math Sciences, San Diego State Univ., San Diego, CA 92182.

San Francisco State University. Dept. of Mathematics. Asst. Professorship tenure-track starting Feb. or Sept., 1981. Required: Ph.D. & demonstrated competence in teaching & research. Will aid development of applied mathematics curriculum, research program & facilities in liaison with industrial & research organizations & other science faculty, especially applications of modeling, statistical methods, operations research & computing. Teaching load 12 hrs/wk. Salary $17,964-21,600. Send vita, bibliography & names of references to J. T. Smith, Math Dept., San Francisco State University, 1600 Holloway Ave., San Francisco, CA 94132.

San Francisco State University. Dept. of Mathematics. Tenure-track faculty positions & visiting appts. spring or fall, 1981. Desired: strong interest in teaching & research. Will aid in continuing development of BS & MS Computer Sci. degree programs. Specializations in software engineering, language design, operating systems & performance evaluation will be given preference for 2 of positions. Rank & salary depend on qualifications & experience. Send resumes & inquiries to J. T. Smith, Math Dept., San Francisco State Univ., 1600 Holloway Ave., San Francisco, CA 94132.

San Jose State University. Dept. of Mathematics & Computer Science. Six openings for Asst. Prof. (Assoc. Prof. in exceptional case). Required: Ph.D. with competence in comp. sci., numerical analysis, statistics, applied math, logic or differential geometry. Candidates must have high ability & interest in undergraduate teaching & be able to take active role in dept. affairs. Current salary $17,964-21,600. Teach 12 hrs/sem. By 2/20/81 send vitae & 3 letters of reference to Dr. John Mitchem, Chair, Dept. of Math, San Jose State University, San Jose, CA 95192.

University of California, Davis. Division of Statistics. Tenure-track Asst. Professorship, Fall, 1981. Duties: teaching, research & campus-wide consulting. Area of specialization open. Required: strong interest in both theoretical & applied statistics. By 2/15/81 send resume & 4 letters of reference to J. R. Blum, Division of Statistics, University of CA, Davis, Davis, CA 95616.

University of California, Davis. Dept. of Mathematics. S. E. Warschawski Asst. Professorship is special 2-year position. Nine mo. salary, $22,900. Recent or expected Ph.D. by 9/1981. Selection based on demonstrated research achievement. By 1/16/81 send vita & have 3 letters of reference , vita & publications sent to Chairperson, Dept. of Math, Univ. of CA, San Diego, La Jolla, CA 92093.

University of San Diego. Mathematics Dept. One definite and second probable opening, Asst. Prof. level, tenure track positions, fall, 1981. Teaching duties 12 hours per semester. Most teaching is in service courses for business. Computer background desirable, but not essential. By 2/20/81 send vita & 3 letters of reference to Dr. Jack W. Pope, Chmn., Dept. of Math, Univ. of San Diego, Alcala Park, San Diego, CA 92110.

University of Connecticut. Dept. of Mathematics will hold a Special Year in Applied Mathematics during 1981/82. Numerical analysis will have significant representation. Applications from junior & senior research mathematicians are invited. One or two junior or senior tenure track positions in Applied Mathematics available. By 2/1/81 send vitae & references to Jeffery L. Tollefson, Head, Dept. of Math, Univ. of CT, Storrs, CT 06268.

University of Connecticut. Dept. of Mathematics. 2 positions. Visiting Asst. & Assoc. Prof. or Prof. Salary negotiable. Teach graduate & undergraduate courses & do research. Required: Ph.D., strong background in applied mathematics preferably in area of numerical analysis such as finite elements, spline & polynomial approximation, numerical solutions to differential & partial differential equations. Ability to interact with members of dept. & to contribute to Special Year in Applied Mathematics. Reply to Jeffrey L. Tollefson at U-9, Univ. of Conn., Storrs, CT 06268.

University of Connecticut. Dept. of Mathematics. Asst./Assoc. Professorship. Salary negotiable. Duties: teaching at graduate & undergraduate levels; assist departmental research effort; assist graduate students with dissertaions. Required: Ph.D. in math. Research interests should relate to those of department. By 2/1/81 send vitae & references to Jeffery L. Tollefson, Head, Dept. of Math, U of CT, Storrs, CT 06268.

Wesleyan University. Dept. of Mathematics. Tenure-track Assistant Professorship in combinatorial/discrete mathematics or another area of applicable mathematics. Will sometimes teach computer-related courses and introductory programming. Send vita and 3 letters of recommendation to: Search Committee, Department of Math, Wesleyan University, Middletown, CT 06457.

Northeastern Illinois University. Math Department. 3 tenure track positions at Asst. or Assoc. Prof. level 9/1981. Ph.D. in Statistics desirable with ability to teach undergraduate and graduate level statistics courses. Strong background in mathematical & statistical computing & also in operations research/applied mathematics. Salary commensurate with experience. Interviewers will be available at AMS meeting in San Francisco, CA in Jan., 1981. Send vita, transcripts & 3 letters of recommendation to Tony Patricelli, Chmn., Dept. of Math, Northeastern IL Univ., 5500 N. St. Louis Ave., Chicago, IL 60625.

Northern Illinois University. Dept. of Mathematical Sciences.

1. Assoc. or full professorship, Fall, 1981. Preferred field: Numerical Analysis, Optimization or similar computational mathematics. Ph.D. required & also proven record of research & commitment to teaching.
2. Asst. professorship (anticipated) tenure track, Fall, 1981. Ph.D. & proven commitment to research & teaching required. Strong candidates in all areas of statistics are urged to apply, but will consider applicants with expertise in Time Series Analysis or Multivariate Analysis.
3. Asst. professorship tenure track, Fall, 1981. Preferred field: Numerical Analysis, Optimization or similar computational mathematics. Ph.D. & strong record of research & commitment to teaching required.

Northern Illinois University (con'd)

4. Three-year assistant professorship, Fall, 1981. Ph.D. & proven research ability & commitment to teaching required. Specialization in Algebraic Topology, Probability, or Functional Analysis preferred for 3 of these position, but candidates in all branches of math or math education are urged to apply. Preference will be given to candidates whose research complements that of current faculty.
5. Visiting Positions for academic year 1981/82. Ph.D. & proven record of research & commitment to teaching is required. Preference will be given to candidates whose research complements that of current faculty.
Applications for position No. 2 above are due 2/28/81. All others are due 1/31/81. Send application including vitae & names of 3 references to D. B. McAlister, Chmn., Dept. of Mathematical Sciences, Northern Illinois Univ., DeKalb, IL 60115.

University of Illinois-Urbana. Dept. of Mathematics. One or more Asst. Professorships (tenure track) although in exceptional case tenured Assoc. Professor level may be possible. One or more visiting positions at any level. Required: Ph.D. & evidence of scholarly ability. Salary for Asst. Prof. is from $19,000 upward & of a visiting lecturer $17,500. Duties: teaching & maintaining vigorous research program. By 1/19/81 send vita, transcripts & 3 references to Prof. H. Halberstam, Dept. of Math, Univ. of IL, Urbana, IL 61801.

Indiana University. Dept. of Mathematics. Possibly 3 regular or visiting appts. at Asst. Prof. level & 1 appt. at Assoc. Prof. level as of 8/1981. Exeeptional research promise & excellence in teaching required. Send resume & 3 letters of recommendation to M. S. Baouendi, Head, Dept. of Math, Purdue Univ., West Lafayette, IN 47907.

University of Iowa. Dept. of Mathematics. Anticipated visiting positions. Required: effective teaching experience & research potential & achievements; ability to relate to instructional needs of dept. & interact with faculty at research level. By 3/1/81 send vita & 3 letters of recommendation to Robert H. Oehmke, Dept. of Math, Univ. of Iowa, Iowa City, IA 52242.

University of Iowa. Dept. of Mathematics. Anticipated tenure track positions at junior level. Required: effective teaching & research achievements & potential; ability to relate to instructional needs of dept. and interact with faculty at research level. By 3/1/81 send vita & 3 letters of recommendation to Robert H. Oehmke, Dept. of Math, Univ. of Iowa, Iowa City, IA 52242.

Kansas State University. Dept. of Statistics. (1) Asst./Assoc. Prof.; Ph.D. in Statistics. Teach Theory & Probability Courses & consult with researchers. Publishable research expected. 9 mos. position. (2) Asst. Prof., 9 mos.; Ph.D. in Statistics. Teach service courses, both graduate & undergraduate. Research will not be discouraged. By 1/31/81 send resume & names of 3 references to Dr. Arthur D. Dayton, Head & Director, Dept. of Statistics, Kansas St. Univ., Manhattan, KS 66506.

University of Louisville. Dept. of Applied Mathematics & Computer Science. Two full-time tenure track positions: (1) Asst. Prof. & (2) Instructor/Asst. Prof. Asst. Professorship requires Ph.D. in Comp. Sci. or Comp. Engineering. Instructor/Asst. Professorship requires Master's degree in Comp. Sci. or in engineering with strength in Comp. Sci. for Instructorship & Ph.D. in Comp. Sci. or comp. engineering for Asst. Professorship. Candidates should have teaching & research interests in software and/or hardware. By 2/26/81 send resumes & applications to Dr. Arthur M. Riehl, Chmn., Dept. of Applied Math & Comp. Sci., Speed Scientific School of Engineering, Univ. of Louisville, Louisville, KY 40292.

University of Louisville. Dept. of Mathematics. Asst. Professorship, tenure track, Fall, 1981. Ph.D. in math with an active research program. Required: Graduate training in geometry courses and broad undergraduate teaching interests. Continued research necessary for tenure. Normal teaching load 9 hrs/semester. Send vita, graduate transcripts & names of 3 references to Search Committee, Dept. of Math, Univ. of Louisville, Louisville, KY 40292 by 2/16/81.

Bates College. Dept. of Mathematics. Two tenure track at Instructor or Asst. Professor level starting 9/1981. Two one-year temporary appts. at Instructor or Asst. Prof. level starting 9/1981. For all positions applicants should have completed all requirements for Ph.D. Please send resume, list of publications, transcript & at least 3 letters of recommendation to David C. Haines, Chair, Dept. of Math, Bates College, Lewiston, ME 04240.

Goucher College. Dept. of Mathematics. 2 or 3 tenure track positions Fall, 1981. Asst. Prof. level. Teach undergraduates. One position in Computer Science, others in math with preference for analysis. Please send vitae & 3 letters of recommendation to Prof. Elaine Koppelman, Goucher College, Towson, MD 21204.

University of Maryland. Dept. of Mathematics. Anticipate positions at all ranks in math and statistics beginning Aug., 1981. Outstanding research credentials required. Vita, brief description of current research & 3 letters of recommendation should be sent to W. E. Kirwan, Chmn., Math Dept., Univ. of Maryland, College Park, MD 20742 by 1/30/81 to guarantee full consideration.

College of the Holy Cross. Dept. of Mathematics. Two tenure track positions for Fall, 1981; one for applied mathematician in numerical analysis, optimization, operations research, etc.; no specific area required for other. One of 2 positions will require knowledge of use of computer in research & teaching. Teaching load is 3 courses per semester. Salary competitive. Excellent fringe benefits. Send resume & 3 letters of recommendation to Melvin C. Tews, Chmn., Dept. of Math, Holy Cross College, Worcester, MA 01610.

Smith College. Dept. of Mathematics. Two-year position at asst. professor level, starting Sept. 1981, subject to budgetary approval. (Current minimum salary: $17,500). We are looking for a statistician who is interested in teaching probability, statistics, and mathematics in a liberal arts college. Evidence of dedication to teaching and significant scholarship is required. Send resume & 3 letters of recommendation by Feb. 1, 1981 to Marjorie Senechal, Chair, Dept. of Math, Smith College, Northampton, MA 01063.

Albion College. Dept. of Mathematics. New tenure track position in computer science 8/81. Rank & salary depend on qualifications. Ph.D. preferred with firm background in math. Duties: 3 courses per sem., direction of student research & student advising after first year; normal departmental & collegiate activities. Resources include a Burroughs B6803, a microcomputer laboratory & several Apple II's. By 1/15/81 contact John A. Wenzel, Albion College, Albion, MI 49224.

Michigan State University. Dept. of Mathematics. Two postdoctoral fellowships in mathematics. Appt. for 1 year with possibility of additional year subject to availability of funds. Duties: teach one course each term & spend rest of time on research. These fellowships are normally offered to persons who have had their doctorate less than 2 years. By 1/15/81 send applications to Dept. of Math, Michigan State Univ., East Lansing, MI 48824.

Michigan State University. Dept. of Mathematics. Several Asst. Professorships (full-time tenure track) as of 9/1/81. Ph.D. in math with interest in research & teaching. By 1/15/81 send resume & have 3 letters of recommendation sent to Prof. J. E. Adney, Chmn., Dept. of Math, Michigan St. Univ., East Lansing, MI 48824.

Michigan Technological University. Dept. of Mathematical & Computer Sciences. Limited term instructorship for which M.S. is required. Tenure track positions for which Ph.D. is required. Need people in numerical analysis, statistics, applicable math, other areas of mathematics & computer science. Candidates for tenure track positions should show evidence of strong research potential & teaching ability. Write Dr. William P. Francis, Acting Head, Dept. of Math & Comp. Sci., Michigan Technological University, Houghton, MI 49931.

Oakland University. Dept. of Mathematical Sciences. One or two tenure track Asst. Professorships as of 8/15/81. Ph.D. required with strong potential for research. Well qualified persons in any of mathematical sciences are needed, especially those in statistics or operations research. Two course teaching load. Salary $17,000 for 8 mo. academic year. Send resume, graduate transcript & 2 letters of reference to George F. Feeman, Chair, Dept. of Math Sciences, Oakland Univ., Rochester, MI 48063.

Wayne State University. Dept. of Mathematics. Several tenure track positions starting Fall, 1981. Required: Ph.D., excellence in teaching & research. Salary & rank negotiable. Send vita & have 3 letters of reference sent to B. J. Eisenstadt, Chmn., Dept. of Math, Wayne State Univ., Detroit, MI 48202.

Western Michigan University. Computer Science Dept. Tenure track position Fall, 1981. Duties: teaching, research & program development. Teaching load: 9 hr/wk. Research interests include informa. systems, AI & computer graphics, among others. Rank: Asst. Prof. or higher. Ph.D. in comp. sci. or related field required. Instructorship requiring Master's degree may also be available. Send inquiries & resumes to Dr. Kenneth Williams, Chair, Comp. Sci. Dept., Kalamazoo, MI 49008.

University of Michigan. Dept. of Mathematics. Expect to have positions at or near tenure level in following areas: Actuarial science, number theory, numerical analysis, applied mathematics, & differential geometry. Fall, 1981. Salary & rank depend on qualifications. By 2/1/81 contact Allen L. Shields, Acting Chmn., Dept. of Math, Univ. of Michigan, Ann Arbor, MI 48109.

University of Michigan. Dept. of Mathematics. Expect to have at least 2 T. H. Hildebrandt Research Asst. Professorships. Fall, 1981. 3 yr. appt. Reduced teaching load. Prefer persons having Ph.D. less than 2 years. By early Jan. please contact Allen L. Shields, Acting Chmn., Dept. of Math, Univ. of Michigan, Ann Arbor, MI 48109.

Carleton College. Dept. of Mathematics. Seeking holder of Ph.D. interested in undergraduate teaching & who has some experience in computer science and/or statistics. Appt. 9/1/81 for 2 years with possibility of renewal. By 2/15/81 apply to Frank L. Wolf, Dept. of Math, Carleton College, Northfield, MN 55057.

College of St. Catherine. Dept. of Mathematics. Asst. Professorship starting 9/1981 with possible renewal depending on enrollment. Excellence in teaching & interest in some area of applied math & some computer science competence desirable. Ph.D. required. Normal teaching load: 3 courses per semester. By 2/15/81 send resume & 3 letters of recommendation to P. Tomsich, Chmn., Dept. of Math, College of St. Catherine, St. Paul, MN 55105.

Moorhead State University. Dept. of Mathematics. Instructor or Asst. Prof. Duties: teach undergraduate courses in math, advise students and do university & departmental committee work; teaching load, 12 hrs. per quarter. Required: Ph.D. or pending Ph.D. Prefer applicants who are qualified through course work or experience to teach applied math courses, but mathematicians in all fields will be considered. Send completed Moorhead St. Univ. application, transcripts & 3 to 5 references to Milton Legg, Chmn., Dept. of Math, Moorhead St. Univ., Moorhead, MN 56560.

University of Minnesota, Minneapolis. School of Mathematics. (1) Several visiting positions from instructor to full professor available for periods of 1/4 to 2 years Fall, 1981. Strong research & teaching abilities required. Prefer applicants whose research interests are compatible with those of School. Salary competitive. (2) Several junior & senior positions available. Outstanding research & teaching abilities required. Prefer individuals able to interact with mathematicians in other fields. Applicants' demonstrated knowledge of applications for their research desirable. Salary competitive. Current teaching load five 1-quarter courses per academic year. For all positions send vitae & 3 letters of recommendation by 2/2/81 to Prof. Willard Miller, Jr., Head, School of Mathematics (127 VH) 206 Church St., S.E., Univ. of MN, Minneapolis,MN 55455.

University of Missouri, Rolla. Dept. of Mathematics. Asst. Professor (tenure track) teaching & research position. Submit vita & 3 letters of reference to Glen Haddock, Chmn., Dept. of Mathematics, Univ. of Missouri, Rolla, MO 65401.

University of Nebraska, Lincoln. Dept. of Mathematics & Statistics. Asst./Assoc. Professorship tenure track in applied mathematics starting 8/17/81. Two course teaching load. Required: Ph.D., strong interest in research & demonstrated excellence in teaching. By 2/15/81 send vita & 3 letters of recommendation to Jerald Dauer, Chairperson of Search Committee, Dept. of Math & Statistics, Univ. of Nebraska, Lincoln, NE 68588.

Dartmouth College. Dept. of Mathematics. Two John Wesley Young instructorships. Two year, non renewable, postdoctoral appts. for Ph.D.'s with strong interests in research & teaching. Teaching duties 6 hrs/wk. Academic year stipend of $16,000 is supplemented by a resident research fellowship of $2500. Write to Donald L. Kreider, Chmn., Dept. of Math, Dartmouth College, Bradley Hall, Hanover, N.H. 03755.

Dartmouth College. Asst. Professor, Computer Science. Initial 3-year appt. Possibility of reappointment & eventual tenure. Qualifications include demonstrated research in comp. sci. & ability & interest in teaching undergraduate courses in comp. sci. & math. Ph.D. required. Write to Donald L. Kreider, Chmn., Dept. of Math, Dartmouth College, Bradley Hall, Hanover, N.H. 03755. (Atten: Recruiting)

Dartmouth College.Asst.Professorship, Algebra, tenure track. Qualifications include demonstrated research ability in core algebra (including algebraic number theory & algebraic geometry) & strong interest in undergraduate teaching. Ph.D. required. Write to Donald L. Dreider, Chmn., Dept. of Math, Dartmouth College, Bradley Hall, Hanover, N.H. 03755, by 2/1/81. (Atten: Recruiting)

Trenton State College. Dept. of Mathematical Sciences. (1) Computer Science position to teach at undergraduate & graduate levels. Require Masters in Comp. Sci. with willingness to pursue doctoral program. Prefer Ph.D. candidates in comp. sci. (2) Math position to teach upper level comp. sci. courses or upper level applied statistics courses and lower level math courses. Ph.D. in math or statistics required; background in scientific computing desirable. Rank & salary dependent on background & qualifications. By 2/15/81 send resume to Dr. Michael Iannone, Dept. of Math Sciences, Trenton State College, Trenton, N. J. 08625.

Adelphi University. Dept. of Math & Comp. Science. Tenure track asst. professorship in comp. sci., Sept., 1981. Ph.D. required. Duties include teaching & curriculum development of upper-division & graduate courses in comp. sci. Research interests in some theoretical area of comp. sci. preferred. By 3/15/81 send resumes to Prof. D. Hammer, Chmn., Dept. of Math & Comp. Sci., Adelphi Univ., Garden City, L. I., N. Y. 11530.

Cornell University. Dept. of Mathematics. H. C. Wang Instructorship (Research) for 3 years. During first year appointee will teach 2 courses in first semester & one in second; thereafter, 2 courses per semester. Instructorship is nonrenewable after 3 years. 1980/81 salary $18,100. Send applications & letters of reference to Prof. S. Lichtenbaum, Chmn., Dept. of Math, Cornell Univ., Ithaca, N. Y. 14853.

Rensselaer Polytechnic Institute. Dept. of Mathematical Sciences. Anticipate tenure track openings at all levels Sept., 1981. Ph.D. & strong research potential in applied mathematics required for junior level appts. & demonstrated outstanding record in applied mathematics for senior level appts. Teaching 6 to 7 hrs/wk per semester. Also anticipate 2 or 3 visiting appts., all levels. Contact Richard C. DiPrima, Chmn., Dept. of Math Sciences, R. P. I., Troy, N. Y. 12181.

SUNY, Buffalo. Statistics Dept. Asst. Professor starting 9/1/81. Desire Ph.D. with potential for creative research, commitment to teaching & interest in applications. Preferred: Experimental Design, Statistical Inference, Statistical Computing. By 2/1/81 send CV & 4 letters of evaluation to Willard H. Clatworthy, Dept. of Stat., SUNY, Buffalo, 4230 Ridge Lea Rd., Amherst, N.Y. 14226.

SUNY, Buffalo. Dept. of Mathematics. At least one Asst. Professorship for 2 year term beginning 9/1/81. Salary copetitive. Priority will be given to applicants in algebraic & differential topology & applied mathematics including combinatorics. Want applicants with high research potential & strong commitment to teaching. By 1/15/81 send vita & have 4 letters of recommendation sent to Dr. Zbigniew Zielezny, Chmn., Search Committee, Dept. of Math, SUNY, Buffalo, 106 Diefendorf Hall, Buffalo, N. Y. 14214.

SUNY, Buffalo. Dept. of Mathematics. Geo. William Hill/Emmy Noether Research Instructorship for 81/82. (2 yr. appt.) Applicants should be recent or prospective Ph.D.'s whose degrees will be completed by 9/1/81. 12 mo. stipend is $19,000 plus generous staff benefits. Teaching load will total 2 one-semester courses during 12 mo. period. Upon expiration of 2 yr. appt. person will be considered for 2 yr. appt. as asst. prof. Please send post high school record/and sketch of past & projected research activity. Application forms available on request. Have 4 mathematicians send letters of recommendations to Dr. Z. Zielezny, Chmn., Search Committee, Dept. of Math, SUNY, Buffalo, 106 Diefendorf Hall, Buffalo, N.Y. 14214. Deadline: 1/15/81.

SUNY, Stony Brook. Dept. of Applied Math & Statistics. One year visiting positions & 3 year asst. professorships (tenure track) in: (1) statistics - applied or theoretical (some participation in applied research projects necessary; (2) operations research - applied interests, especially energy modeling preferred; and (3) numerical analysis - any subspecialty. High research potential essential. Starting Fall, 1981. Write Professor A. Tucker, Dept. of Applied Math & Statistics, SUNY, Stony Brook, N.Y. 11794.

Syracuse University. Dept. of Mathematics. Several tenure track positions are available in the Asst. and Assoc. Prof. level. One position is in Numerical Analysis; the others are open to any field. Research potential is of primary importance; compatibility with research activity in our dept. is also important. There also may be one or more temporary one year positions open to applicants in any field. Ph.D. is required for all positions. Teaching load is 2 courses per semester. Applications must include a detailed vita, 3 letters of reference, and for new Ph.D.s a transcript. Tenure track applications are due 1/30/81; all others are due 3/30/81. Contact Jack E. Graver, Chairman of Math, Syracuse Univ., Syracuse, N.Y. 13210.

Union College. Dept. of Mathematics. Several 2 year asst. professorships & one tenure track position. Salary competitive, full range of fringe benefits, 9 hour teaching load. Contact William Fairchild, Chairman, Dept. of Math, Union College, Schenectady, N. Y. 12308.

University of Rochester. Dept. of Statistics. Asst. Professorship (4 years) for 1981/82. Required: strong research potential in some area of statistics or related fields and teaching competence in statistical methodology. Possibility for joint appointments. Contact W. J. Hall, Chmn., Dept. of Statistics, Univ. of Rochester, Rochester, N.Y. 14627.

Vassar College. Dept. of Mathematics. Three year Asst. Professorship, 1981-82. Ph.D. in math required. Interest in computer science and/or applications desirable. Send resume to David Merriell, Chmn., Dept. of Math, Vassar College, Poughkeepsie,N.Y.12601.

College of Wooster. Dept. of Mathematics. Person to teach elem. & advanced undergrad. courses in math. Required: excellence in teaching, Ph.D. received or imminent. Teaching load: 2 courses per quarter. Start 9/81. Excellent fringe benefits. By 2/1/81 send applications to J. W. Warner, Chair, Dept. of Math, College of Wooster, Wooster, OH 44691.

Reed College. Dept. of Mathematics. Opening for one year (possibly one additional year) to teach undergraduate mathematics starting late Aug., 1981. About 11 class hours per week. Doctorate desirable. Salary approx. $17,000 plus fringe benefits. Non tenure track, replacing faculty on leave. By 2/15/81 send applications to H. E. Chrestenson, Chmn., Dept. of Math, Reed College, Portland, OR 97202.

Bucknell University. Dept. of Mathematics. One position (potentially tenurable) may open 9/1981. Required: Ph.D. (or nearly so) & strong commitment to teaching & research. Experience desired, but not vital. Applications from mathematicians & statisticians are solicited. By 1/15/81 send curriculum vitae, graduate transcript & 3 letters of recommendation to David S. Ray, Head, Dept. of Math, Bucknell Univ.,Lewisburg,PA 17837.

Community College of Philadelphia. Dept. of Mathematics. 3 full time positions for Fall, 1981 requiring either Master's in Math and Master's in Math Education with teaching experience in developmental/remedial mathematics preferably at community college level, or (2) Master's in Math and a Doctorate in Math Education with teaching experience in developmental/remedial mathematics, preferably at community college level. By 3/1/81 send resume, transcripts etc. to W. A. Clee, Dept. Head of Math, Community College of Philadelphia, 34 S. 11th St., Philadelphia, PA 19107.

Pennsylvania State University, Capitol Campus. Dept. of Mathematics. Tenure track position at Asst. of Assoc. Prof. level, March or Sept., 1981. Required: Ph.D.(or near) in Math, Stat., Comp. Sci., Operations Res. or related field, & strong commitment to teaching & research. Rank & salary based on qualifications & experience. Will teach in both undergraduate and graduate programs. By 2/1/81 send vita & supporting materials to Dr. Theodore L. Gross, Provost/Dean, Box X, PA St. Univ., Capitol Campus, Middletown, PA 17057.

University of Pennsylvania. Dept. of Mathematics El. Several tenure positions for academic year 1981-1982 or 1982-1983. Preference for one of these may be given to candidates in general area of Algebra. Candidates in all areas should apply. Write to Professor Stephen S. Shatz, Chmn., Personnel Committee, Dept. of Math (El), University of Pennsylvania, Philadelphia, PA 19104.

University of Pennsylvania. Dept. of Mathematics El. Limited number of positions for academic year 1981-1982. Effective date of appointment 7/1/81. By 1/1/81 send resume & 3 letters of reference describing both research & teaching ability to Prof. Stephen S. Shatz, Chmn., Personnel Committee, Dept. of Math (El) University of PA, Philadelphia, PA 19104.

College of Charleston. Dept. of Mathematics. (1) Four Asst./Assoc. Professorships 8/81. Will teach math courses, direct undergraduate independent study & have option of teaching computer science courses. Standard teaching load 12 hrs/wk. Required: Ph.D., strong commitment to undergraduate teaching & serious research. 3 positions (asst. level) are in area of math or statistics, but preference will be given to individuals with training in pure & applied mathematics. One position (assoc. level) will depend on candidate's previous experience. Minimum nine month salary is $18,500.
(2) Possible Visiting Position. One year appt., 8/81. Teaching in undergraduate mathematics program. (12 hrs/wk). While primary duties will be related to teaching, candidates with research specialty the same as a current member of faculty will be given some preference. Candidates for all positions should send 3 letters of recommendation and a resume to W. Hugh Haynsworth, Dept. Chair, Dept. of Math, College of Charleston, Charleston, S. C. 29401.

University of Tennessee. Mathematics Dept. Tenure track Asst. Professorship Sept., 1981. Required: strong research & teaching qualifications. Expect to hire from 2 of following fields: algebra, applied mathematics, mathematical ecology, modern analysis, ordinary differential equations, probability theory. Contact John S. Bradley, Acting Head, Math, Dept., Univ. of Tennessee, Knoxville, TN 37916.

Vanderbilt University. Dept. of Mathematics. (1) Tenured position. Impressive research accomplishments & evidence of effective teaching required. Should have specialization in some area of classical analysis or applied mathematics. (2) Asst. Professorship. Initial 3 year appt. (renewable, tenure track). Outstanding research potential & evidence of effective teaching required. Should have specialization in some area of applied or applicable mathematics. Have vita & at least 4 letters of recommendation (3 letters for 2nd position) sent to Professor R. R. Goldberg, Chmn., Dept. of Math, Vanderbilt Univ., Nashville, TN 37235.

Southern Methodist University. Dept. of Mathematics. Several positions available Fall,1981. Prefer candidates with proven outstanding research ability or potential & commitment to quality teaching. Salary & rank are negotiable. Send resume & names of 3 references to G. W. Reddien, Chmn., Dept. of Math, Southern Methodist Univ., Dallas, TX 75275.

Texas Woman's University. Dept. of Mathematics & Physics. Chairman of Dept., Sept. 1, 1981. Earned doctorate in mathematics, physics or computer science essential. Good degree of competence in at least 2 of these areas expected. Required: teaching & research experience, publications & high degree of professional awareness. Administrative experience desirable, but not essential. Salary competitive. Send resume & names & addresses of 3 references to Dr. R. E. Collier, Chmn., Search Committee, Box 22675 TWU Station, Denton, TX 76204.

University of Texas at Austin. Dept. of Mathematics. One or two tenure track Asst. Professorships & two or three terminal instructorships (each instructorship lasting 2 or 3 years), starting Fall, 1981. For information contact Peter John, Chmn., Recruiting Committee, Dept. of Math, Univ. of Texas, Austin, TX 78712.

University of Utah. Dept. of Mathematics. (1) Three or four Instructorships (for 3 years), Persons of any age receiving Ph.D. in 1980 or 1981 are eligible. Ability & potential in teaching & research required. Salary: $18,000. Teaching duties: 2 courses thru academic year. (2) One visiting position for 1 year or less. Selective criteria will be teaching ability & potential research contribution. (3) One or two Asst. Professorships with particular interest in Probability, Statistical, and Applied Mathematics, but other areas will be considered. By 3/1/81 send vita, bibliography & references to Ms. Sylvia Morris, Committee on Staffing, Dept. of Math, Univ. of Utah, Salt Lake City, Utah 84112.

James Madison University. Dept. of Mathematics & Computer Science. Asst. Professorship, tenure track, Fall, 1981. Ph.D. in statistics, probability or related area. Background & interests must be compatible with curricular needs of dept. Strong commitment to teaching & research. By 1/20/81 send vitae, transcripts & have 3 letters of recommendation sent to Dr. Diane Spresser, Head, Dept. of Math & Comp. Sci., James Madison University, Harrison, VA 22807.

University of Virginia. Dept. of Mathematics. Two Assistant Professorships (one in probability), visiting positions. Research instructorship, (two year term reduced teaching load $17,600, any area). Interested in applicants who have received Ph.D.s recently or those expecting Ph.D.'s in near future. Contact Loren D. Pitt, Chmn., Dept. of Math, University of VA, c/o New Cabell Hall, Charlottesville, VA 22903.

University of Wisconsin, Eau Claire. Dept. of Mathematics. Adjunct Asst. Prof. (or higher). Duties: teach undergraduate (and possibly graduate) courses. Course load is 12 semester credit hours. Preferred: Doctorate & applicants with training & experience in mathematical modeling or applications. 1 or 2 year appt. beginning 8/24/81 with possibility of contract renewal. Salary depends on training & experience. By 1/31/81 send application, vita, transcripts of graduate & undergraduate work, & at least 3 letters of recommendation to Dr. Marshall E. Wick, Chmn., Dept. of Math, Univ. of Wisconsin, Eau Claire, Eau Claire, WI 54701.

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January - February, 1981