

Women, Work and the Academy: Executive Summaries

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Women, Work and the Academy: Strategies for Responding to Post-Civil Rights Era Gender Discrimination: Research and Intervention Strategies

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I have participated in, observed, researched, and published about gender discrimination in Canadian universities for more than two decades. Perhaps it was an inevitable offshoot of the first book I wrote with Leah Cohen in 1979, *The Secret Oppression: Sexual Harassment of Working Women*.ⁱ That was also the year I was appointed to a tenure-stream position in a very conservative and male-dominated faculty of law at the University of Western Ontario in London, Ontario. My notoriety for having co-authored the first Canadian book on what was then viewed as a controversial new topic, along with my interest in feminism and law, contributed to the creation of a very chilly climate within my own workplace. I can claim without hesitation that my experience at Western would provide an experiential base of knowledge about hostile and sexist treatment to rival many.

During the 1980s, law schools in Canada became contested sites of struggle, in which small groups of feminist law professors banded together to demand that previously patriarchal teaching and research environments make way for woman-focussed agendas. The fall-out, often designated as the “gender wars,” dislocated faculty and student relationships, wreaked havoc with the careers of some and the reputations of others, spawned several legal actions, and occasionally caught the attention of the mainstream media.ⁱⁱ Women law professors in Ontario maintained feminist community throughout most of this decade by holding twice-yearly retreats throughout the province, where support could be solicited, strategies vetted, and comradeship cemented.ⁱⁱⁱ We created “women and law” courses as beachheads in the otherwise male-stream curricula. We supported “women and the law associations” for feminist law students. We created national feminist legal institutions such as LEAF and NAWL.^{iv} Our very own *Canadian Journal of Women and the Law*, which became the first law journal in Canada to pro-actively seek feminist, lesbian-positive, and anti-racist articles, published its first volume in 1985.

Although I was thoroughly implicated in all of this feminist law school organizing, I also turned my attention outside of the faculty to the wider university. Like its law school, the Western University had a reputation for conservatism, but there were a number of committed, politically engaged feminist faculty members scattered throughout the campus. In an odd way, I think that the unsupportive environment at Western generally gave rise to a cohesive, determined, deeply-rooted community of resistance. In 1980, we set up Western’s Caucus on Women’s Issues, to serve as a voice for feminist demands. The Caucus initiated various campaigns calling for affirmative action in faculty appointments, the introduction of women’s studies curriculum, and campus safety. Its members also hosted hilariously funny dinners, at which we parodied our enemies and laughed until we wept. We publicly awarded annual medals, named after famous women from Canadian history, to the women who distinguished our community with their acts of bravery, the ones who had “taken the most cannon fodder” in the previous year. We gained strength through feminist reading groups. We created the feminist institution known as the “Wednesday lunch.” We wrote university briefs, petitioned academic administrators, and wrote countless outraged letters to the university media.

In 1986, as chair of the Caucus’s affirmative action committee, I was dismayed to discover that our university had nominated itself for a provincial employment equity award, and what was worse, received it! I resolved to do some research into the status of women at Western to balance the record of the ensuing flattering publicity. In 1988 I released what has come to be known as “the Backhouse Report,” examining the highly discriminatory history of women faculty at Western, and making a number of radical proposals for change.^v Shortly thereafter, three feminist faculty colleagues, Roma Harris, Gillian Michell, and Alison Wylie, joined with me to conduct a series of interviews with other faculty women. In 1989, our group report, which came to be known as the “Chilly Climate Report,” documented the multiple “environmental factors” that continue to impact negatively on women’s working environment across the university.^{vi} The ensuing media attention, and the viciously antagonistic response from Western’s central administrators, created a furore that refused to die down for months and turned the report into a major cause celebre. In the end, the detrimental fall-out from the report also inspired more positive actions.

Under Alison Wylie's leadership, a group of Western feminist joined together to create "The Chilly Collective" which published a full-length book detailing this history: *Breaking Anonymity: The Chilly Climate for Women Faculty*.^{vii} The Caucus obtained government funding to produce a video titled "The Chilly Climate for Women in Colleges and Universities," which has been distributed across North America, and continues to be used in classrooms and workshops even to this day.^{viii} A decade later, the York Stories Collective at York University in Toronto, cited our work at Western as one of the points of inspiration for their own volume, *York Stories: Women in Higher Education*, which brilliantly expanded the documentation of discrimination to include race, gender, class, disability, age, sexual identity, and antisemitism.^{ix} It was with the greatest of pride that I represented the Western collective at the incredibly successful York book launch, and it reminded me again of the contagiousness of women's courage.^x

In 2000, I left Western for an appointment to the faculty of law, University of Ottawa. The university has a much more progressive reputation than Western, and its law school has been administered by feminists and pro-feminists for more than a decade. Not coincidentally, Ottawa's law school emerged from its gender wars with the highest ratio of female law professors and female law students in the country. Since my appointment, I have felt freer to teach more social justice material than ever before. I have also personally been the recipient of a series of awards and honours from the university that would have been unfathomable for a feminist at Western. The environment, while by no means completely expunged of discrimination, represents a sea-change from the chilly climate of my first two decades. And as I look around, I notice that there are other faculties and universities that can also claim to have made substantial movement. A number of Canadian universities now have at least some female (and feminist) chairs, deans, provosts and even presidents. Many of us now hold positions of relative power in the academy.

And yet, looking more carefully, it seems to me that we are still far from achieving what we sought at the outset. Our universities have remained stubbornly male-centred in their core curricula, pedagogy, and administrative processes. Our female students complain of much of the same sorts of discrimination and harassment that we faced as students. Our expanding knowledge about the dangers of treating gender as an essential attribute, and the importance of incorporating the intersectionality of race, disability, class, and sexual identity, has not translated into anything like a full inclusion of more diverse faculty and students in the academy. What change we have wrought remains at the margins. Worse, we seem stalled on a plateau, even in the most hospitable institutions, with lagging spirits and lowered horizons.

What accounts for this? One might speculate about several possibilities. We have lost some of our most impressive feminist faculty to tenure-battles, voluntary resignations, early retirements and illnesses. Reflecting the women's movement more generally, we have not managed fully to renew our ranks from incoming younger generations. Some of us in positions of relative power have been forced by institutional, faculty, and student pressures to compromise. At times, it is less a problem of external pressures, and more of internal self-censorship. Many of us have laboured so long in chilly environments that we have developed what might be characterized as a "trench mentality." We can't stop thinking of ourselves as speaking from the perspective of the powerless, as perennial victims. We have difficulty recognizing how much power we actually now hold, and we neglect to exercise the options that are available. Some of us would describe ourselves as "burned out," while others, who seem to be working longer hours than ever before, would frankly admit that it is not radical feminist activism that engages the bulk of our time. To the extent that we are engaged with feminism, our projects are diffuse and our energies dispersed. If there is a unifying theme within feminism in these recent years, it appears to be critique. We complain that feminist authors do not grasp the issues properly, we fault the process and results of feminist research, we disagree with how conferences and workshops are organized, we dismember feminist organizations, we critique feminist leaders and their strategies. In addition to all of these problems, we face a cultural context of increasingly conservative politics, educational underfunding, corporatization of the academy, and the pressures of globalization.

Given all of this, what are the prospects for moving beyond the plateau? I think workshops such as these are a great place to start. I would offer the following plan as a possible departure point for engaged discussion:

1. the convening of a series of small-group regional workshops.

Essentially, we need to know who is out there - the still-militant, those whose spirits are sagging but who are still prepared to commit, and the new-comers. The objective would be to identify, and bring together, faculty members who have expertise in feminism, critical race, disability, class, and gay and lesbian issues - and an interest in the transformation of the academy. The workshops should be designed to allow participants to share and evaluate their experiences, and think creatively about the next stage.

2. the creation of informal networks.

The objective would be to keep the participants from these workshops in communication with each other, and with the participants from other workshops, to share information and collaborate on strategies. Although I would not recommend the creation of formal associations or institutions, or the expenditure of substantial resources on this.

3. the development of a clear focus.

This is an attempt to get beyond the diffusion problem. Although I suspect this will be a contentious idea, I think we need to narrow our goals into one or two manageable projects at a time. I would suggest that potential projects be judged on their creativity as well as their feasibility and the potential for maximizing change. I would also recommend that we select projects that are fun.

4. the consolidation of forces.

The objective would be to pool our strengths and resources. Once the specific projects have been identified, we need to identify who needs to be involved, what needs to be done, and what sort of timetable would work. We need to marshal our talents, energy, and relative power and privilege towards a focussed implementation.

5. evaluation.

We need a mechanism for the periodic review of the projects, strategies, and outcomes. We need to be able to identify when projects succeed, when they fail, and when they need to be redesigned mid-stream.

We also need to begin thinking about an entirely new chapter in the saga of the integration of women into the academy. In some pockets, we have now successfully recruited and retained 50% women faculty. (We have been far less successful in the recruitment and retention of visible minorities, faculty with disabilities, and out gays and lesbians. All of these areas require substantial improvement.) But where we have achieved equitable distributions, what should be our next objective? Is it sufficient to achieve the number balance alone? Or does that merely benefit the few women faculty who have achieved these prestigious positions, without altering the academic landscape more systematically?

One way of describing the options is to compare **accommodation to transformation**. Under the first model, the achievement of balanced faculty distributions is the final objective. The new faculty are required to accommodate themselves to the institution, and to succeed within the traditionally defined horizons. The second model would suggest that the equitable faculty numbers are simply the first step. The second model would require another stage as well: a deep-rooted transformation of the academy in more fundamental ways to take account of the distinctions of gender, race, disability, class, and sexual identity.

The transformation model would require us to reexamine every aspect of academic life: student body, faculty, alumni. We would need to work towards the composition of student bodies that reflected the population at large. We would need to recruit faculty who represent novel and unconventional backgrounds and talents. We would want to rethink how we define "the best" in faculty careers, so that we support and value a much wider array of characteristics and outputs. We would seek to assist our university graduates to find meaningful careers that advanced social justice interests, and to keep them integrally involved in the university.

The transformation model would also require us to reexamine our curriculum, our pedagogical methods, and our processes of evaluation. We would need to rethink our disciplinary divisions, our course offerings, and our student programming to respond more fully to the critique of patriarchy, racism, homophobia, disability privilege, and class bias. We would want to reexamine our educational methods, to ensure greater variety, and more sensitivity to equality concerns. We would need to reevaluate our

grading processes to ensure that they were less wedded to narrow hierarchical models, and more fully capable of assessing the range of talents our students bring to their university education.

The vistas for change that might be contained within a truly transformational model of university education are daunting and challenging. Although all universities have begun to move in some of these directions already, few have made holistic revisions in ways that are both truly futuristic and deeply visionary. But I would argue that without such objectives, the campaigns we are waging to recruit and retain more diversified faculties will constitute only half-remedies, and fail to produce the truly egalitarian universities that we hope to create.

ⁱ (Toronto: Macmillan of Canada, 1979). Although initially a Canadian publication, the book was later revised and republished in the United States as *Sexual Harassment on the Job* (Englewood Cliffs, NJ: Prentice-Hall, 1981).

ⁱⁱ Many would date the commencement of the “gender wars” to 1986, when the “McIntyre Memo” was leaked to the press. This was an internal faculty memo detailing the discriminatory treatment received by a junior feminist law professor, Sheila McIntyre, at Queen’s law school in Kingston, Ontario. It was subsequently circulated widely, and published in various national journals. In Toronto in 1987, York University chose an external male candidate for the position of dean at Osgoode Hall law school, over the internal female candidate. More than one hundred female law professors, lawyers, and law students filed a complaint of sex discrimination with the Ontario Human Rights Commission regarding the failure to appoint Professor Mary Jane Mossman. In 1989, Associate Dean Craig Brown at the faculty of law, University of Western Ontario, circulated a memo to the faculty on hiring policy that was supportive of two feminist colleagues who were seeking permanent appointments. The next day he was quoted in the local newspaper acknowledging and criticizing sexism within the law school. Two days later he was fired unceremoniously from his position as associate dean and removed from the appointments committee by the dean. He brought suit for wrongful dismissal, and the battle was followed fully by the media. The positions of the two Western feminist colleagues, Diana Majury and Cheryl Waldrum, were not renewed. For more details of the gender wars in Ontario law schools, see Bruce Feldthusen “The Gender Wars: ‘Where the Boys Are’” in The Chilly Collective eds. *Breaking Anonymity: The Chilly Climate for Women Faculty* (Waterloo: Wilfrid Laurier University Press, 1995) 279-313.

ⁱⁱⁱ The retreats, which attracted between 25 and 35 participants (occasionally including a few women from outside of Ontario) were housed initially at various law schools with billeting provided by the home faculty feminists. When they grew too large for this, we moved the venue to small country resorts. The first retreat was held in 1989. The last formally organized retreat took place in 1997. A small number of the participants continued to meet informally for several years after this, and the concept was reactivated in 2002, when a large retreat took place once more.

^{iv} The acronyms stand for the Women’s Legal Education and Action Fund (LEAF) - see Sherene Razack *Canadian Feminism & the Law: The Women’s LEAF & the Pursuit of Equality* (Toronto: Second Story Press, 1991) - and the National Association of Women and the Law.

^v The report was widely circulated on campus, the subject of extensive attention in the mainstream media, and the subject of several large meetings convened by Western’s Caucus on Women’s Issues. The editors at the *Canadian Journal of Women and the Law* made the courageous decision to publish the report, although it did not really fit with the journal’s mandate, and it appeared in volume 4 (1990) 36-65, thus allowing me to claim that it constituted “academic research” and should be protected under the mantle of academic freedom. It was republished as chapter 3, in The Chilly Collective eds. *Breaking Anonymity* 61-95.

^{vi} This was also later published as chapter 4 in The Chilly Collective eds. *Breaking Anonymity* 97-132.

^{vii} *Ibid.* Initial explorations into publishing at the University of Toronto Press came to naught, but Sandra Woolfrey, the director of Wilfrid Laurier University Press, courageously spear-headed the publication of these and other essays in the book, despite serious concerns of defamation lawsuits.

^{viii} The video was produced by Kem Murch Productions, London, Ontario; funded by the Ontario Ministry of Colleges and Universities and the Ontario Women's Directorate; and distributed by the Department of Equity Services, 295 Stevenson Lawson Building, University of Western Ontario, London, Ontario, Canada N6A 5B8.

^{ix} The York Stories Collective eds. *York Stories: Women in Higher Education* (Toronto: TSAR, 2000.)

^x The speech I delivered on the occasion of the book launch has been published as "Reflections on Feminist Activism Within Two Distinct Universities: Timing and Location for Transformational Activities" *Resources for Feminist Research/Documentation Sur la Recherche Feministe* 29:1/2 (2002) 117-24.

Leveling the Ivy Playing Field: A Plan for Institutional Intervention

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Earth Institute ADVANCE Program – October 14, 2004

Change is underway at Ivy League institutions. Since 1969, all of the Ivy League schools have enrolled women, and today, three have women presidents. In August 2004, MIT announced Susan Hockfield as its first women president. Despite these milestones, the leveling of the playing field seems to be occurring slowly - perhaps at glacial speeds. For example, after the release of the MIT report on the status of women faculty in science in 1999, the leadership of Harvard welcomed an initiative to hire more women scientists at the junior and senior levels (Lawler, 1999), but between 2000 and 2004, the percentage of women offered tenure slots in Harvard's Faculty of Arts and Sciences actually shrunk by half, from 37% of the total pool in 2000-01 to 16% in 2003-04 (Bhattacharjee, 2004). The atmosphere is still quite chilly in the Ivy League.

At Columbia University, a systematic study of the demographics of women through the ranks in the School of Arts and Science between 1990 and 2000 documented the lack of faculty diversity both at early and later career stages (Applegate et al., 2001). In this period, within the Natural Sciences at Columbia 32% of Ph.D. recipients were women, compared to the national average of 39%. A tremendous disparity then arises in the applicant pool for tenure track positions, with women making up only 14% of the pool over the last decade. Clearly, more needs to be done to inspire women to seek the tenured ranks.

The imbalance increases as women move through the pipeline, at the point when external hires and "targets of opportunity" are used to fill the tenured ranks. The Columbia study indicates that women that are hired at approximately the same rate as they apply (16% over the study period) and subsequently promoted to tenure at the same rate (16%). The Columbia study also found that from 1990 to 2000, 25 scientists were promoted in the tenured ranks, while 37 were hired from the outside. External hires into tenured positions are the major growth vehicle for the tenured faculty at Columbia and the Ivy League in general. Over the decade studied, only 2 women (5.5%) were hired from the outside into the tenured ranks.

There are several possible causes for the absence of women in applicant pools at Columbia. One reason for the lack of women in entry-level applicant pools is that women are leaving academia before they apply for the tenure track jobs, either for industry jobs or to raise a family. While both women and men have increasingly left academia for industry during the past thirty years, women scientists have moved into industry at a higher rate than men (Long, 2001). The overlap between the tenure clock and the biological clock has been widely documented (Cole and Zuckerman, 1987; de Wet et. al, 2002; de Wet and de Wet, 1994; Wilson, 2002). Some women simply perceive a highly competitive academic research environment to be counterproductive to raising a family.

Two possible factors seem to be contributing to the small number of women hired into the tenured ranks from outside the university: 1) women are outside or marginal to the professional networks used to recruit "rising stars," and 2) women have less geographic mobility than men. Scientists' professional networks can influence and sometimes even determine their career success. Personal contacts can control critical resources, as well as knowledge about new scientific ideas, and strategies for developing lines of research (Etzkowitz et al., 2000). In addition, women are less likely to relocate for a position, as they are disproportionately affected by the geographic constraints faced by dual-career couples (Preston, 2004; Smith and Zick, 1994). Surveys of women scientists have shown that they are more likely to be married to other scientists who are older and more established in their careers. To change the demographics in the sciences at Columbia, the under-representation of women in applicant pools *and* the lack of women hired into the tenured ranks from the outside must both be addressed.

Institutions in the Ivy League need to transform their culture from largely informal and risk-averse to one that actively encourages and recruits women for tenure-track positions. Based on the 2001

Columbia study, a group of senior scientists from the Earth Institute (EI) at Columbia University developed an intervention strategy. Funded by the National Science Foundation (NSF), the EI ADVANCE program at Columbia University was launched in 2004. The program will use the Earth Institute as a test bed for institutional change. NSF recognized the EI as a suitable test subject for ADVANCE because it is a relatively new institution, and it crosses disciplines and schools, with six academic departments, 19 research institutes, and over 600 scientists and engineers. As the ADVANCE program matures, successful strategies will then be transferred to other parts of the university.

The goals of ADVANCE at the Earth Institute are to achieve institutional change by 1) identifying methods for targeting emerging and established women leaders in the Academy 2) providing support to women scientists and engineers through demanding life transitions (e.g. elder care, adoption, birth of a child) 3) enhancing mentoring and networking opportunities for women scientists and engineers 4) increasing the transparency of promotion procedures and policies, and 5) conducting an institutional self-study that will establish a baseline for the program's evaluation, help identify targets areas that require special attention, and assess working assumptions about the work environment at Columbia upon which ADVANCE programs have been developed. These goals were developed after extensive analysis of the experiences of ADVANCE programs at other universities, including the University of Michigan and the University of Washington.

To address the absence of women in both entry-level and senior-level applicant pools, the EI ADVANCE program is forming a faculty committee to systematically evaluate the issue. Modeled after the University of Michigan's Science & Technology Recruiting to Improve Diversity and Excellent (STRIDE) Committee, the Columbia STRIDE Committee will consist of men and women who have direct influence over search committees, hiring decisions, and retention at the university. The primary incentive for this working group will be intellectual engagement, as it tackles the major gender questions facing university search committees. For example, since the ADVANCE grant was proposed, the dual-career issue has blossomed into a major stumbling block for the earth and environmental science departments at Columbia seeking to hire mid-career women faculty, with several failed efforts to recruit women for faculty positions. The STRIDE Committee will address this and other similar cases, as it works through a series of lunch meetings to identify strategies for recruiting and retaining emerging and established women leaders in the Academy.

To broaden the network of women scientists and engineers who might apply and be considered for hires into the tenured ranks, the Earth Institute ADVANCE Program will award several Marie Tharp Visiting Fellowships each year to promising women scientists. The fellowship is named after Marie Tharp, who has been called "the mother of modern ocean floor cartography." A pioneer of modern oceanography, Marie Tharp was the first to map details of the ocean floor on a global scale. She published the pivotal interpretation of mid-ocean ridges and her observations were crucial to the eventual acceptance of the theories of plate tectonics and continental drift in the Earth sciences. The purpose of the award is to provide an opportunity for women scientists outside of Columbia to conduct research at one of the units or related departments within the Earth Institute for a period of one to three months during their career-building years. Fellows will have an opportunity to work with Earth Institute research scientists, faculty, post-docs, and graduate students during their fellowship. Each Fellow will also be expected to make a scientific presentation during her residence at the Earth Institute.

While pursuing the formal goals (recruitment, retention, mentoring, transparency, and self study), the EI ADVANCE program is developing and codifying a number of implicit strategies for institutional change. First, the ADVANCE program is working to develop a coalition, secure buy-in and instill a sense of ownership of the program's activities across the institution, from the senior levels of the University administration to the level of department chairs and research institute directors. This process has involved ongoing discussions with the administration about the role of ADVANCE in the context of the university's general mission to achieve a diverse academia to educate a diverse student body. To broaden the network for scholars closely involved with the ADVANCE program, we have developed an internal advisory board of gender scholars from various departments at the University. Through this group, we are building a solid intellectual foundation for ADVANCE at Columbia, and the institutional self-

study in particular. Between the STRIDE Committee and the internal gender scholar advisory board, we are seeking to build a critical mass of internal ambassadors for change at the University.

Second, to ensure the perceived legitimacy of ADVANCE among university decision-makers, we have realized the need to regularly revisit the case for change and ensure that the data supporting our goals is accurate and as up-to-date as possible. The new Vice Provost of Diversity at Columbia is working closely with the University's Office of Planning and Institutional Research to gather and analyze current data on the diversity of the faculty. Another mechanism for data collection is the self-study, which will include both a survey and semi-structured interviews with a sample of officers of research and officers of instruction at the university.

Third, we plan to use multiple formats and mediums to communicate ADVANCE's goals. The capacity for working with different disciplines and learning styles is key to changing institutions, and it is a factor that has been critical to the success of ADVANCE programs at other universities (Sturm, 2004). In some disciplines, narratives are the most powerful communication mechanism, while in other disciplines numbers are essential to conveying the story. We will utilize both narratives and quantitative data to develop a consensus for ADVANCE. As part of this effort, we will also develop a fabric of social networks that support ADVANCE through the internal advisory committee, the STRIDE Committee, meetings with administrators, and presentations to individual departments and research institutes. At the very least, the ADVANCE program is aiming to foster an active dialogue between and among multiple constituencies. As Douglas McCracken, the former CEO of consulting powerhouse Deloitte & Touche, once noted, "the key to inciting cultural change is turning taboo subjects at work into acceptable topics of discussion," (2000). We will encourage decision-makers to articulate the level of risk and uncertainty they are willing to assume hiring prospects outside of their informal network. This process will also allow the target audience to develop their own solutions to what is clearly a complex predicament.

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Beyond the “Porous Pipeline”: Points of Leverage and Light for Women in Science

Elizabeth S. Boylan, Provost and Dean of the Faculty and Professor of Biological Sciences, Barnard College

In a review¹ of *Women in Science: Career Processes and Outcomes* by Y. Xie and K. A. Shauman (Harvard University Press, 2003), Abigail J. Stewart and Danielle LaVaque-Manty contrast the familiar “science pipeline” metaphor with its unidirectional and one-dimensional characteristics with Xie and Shauman’s “life-course perspective” for the study of gender and career trajectories in science, and applaud the advances that this analysis of multiple data sets permits. Noting also the limitations of the data available to Xie and Shauman, they look for the work to stimulate “further research applying equally careful and creative approaches to the many questions that remain.”

Creative approaches often require substituting established metaphors with new ones that generate new lines of inquiry. The “science pipeline” has been used for decades to visualize the progressive loss of potential scientists over time, with its large bore pipe open at the left of the page representing the many grade school and high school girls with interest in, and aptitude for, science connected by soldered joints to ever smaller and smaller-bore tubes across to the right hand side of the page, with the changes in pipe diameter representing the fewer and fewer women who survive in science as the levels of educational achievement increase. Even the more recent “porous pipeline” image that congers up perforations in the still rigid metal plumbing assumes a unidirectional enclosure, with inanimate walls acting as permanent, inflexible constraints.

Perhaps it is time for us to change metaphors, anticipating that they may be able to change our thinking in creative ways. To that end I offer a couple of biological metaphors for those of us who are concerned with gender equity in the academy to use to ask an “impertinent question.” I refer here to the words of mathematician, scientist, philosopher Jacob Bronowski: “That is the essence of science: ask an impertinent question and you are on your way to a pertinent answer.” Hopefully both the “impertinent question” and the “pertinent answer” can help us develop new strategies for individuals and institutions to use to improve the access, persistence and fulfillment of women in science.

I would like to credit my husband, a microbiologist, for this first example. I was querying him the night before I had to chair a session at the February 2002 conference at Barnard College associated with the release of the study “Balancing the Equation: Where Are Women and Girls in Science, Engineering and Technology” by the National Council for Research on Women. “What,” I asked as we drove home late after an evening event on campus, “do you remember about the proteins and co-factors involved in microtubule self-assembly? I want to use them to talk about the importance of single molecules of alpha- and beta-tubulin becoming dimers and acquiring the ability to self-assemble into microtubules.” “Whatever for?” he replied. I explained, “I am thinking about using them as an example of the importance of specific molecules and critical mass in the development and integrity of structures, functions and relationships -- to make the case for attention to complex variables when we think about the goal of attracting and retaining more women in science.” “Oh,” he said, “but I probably remember even less than you do since bacteria are prokaryotes, not eukaryotes, and they don’t even have microtubules. Maybe what you want to talk about is *quorum sensing*.”

“What?” I asked. “*Quorum sensing*,” he replied. “It’s the ability some bacteria have to sense their environment, to count how many other bacteria of their own type are in the area, and in response, to acquire new group properties as a function of attaining a critical mass.”

How interesting I thought. I had no idea that such supposedly primitive cells as individual bacteria had this capacity to “count” each other. So I asked, “What can they do together that they can’t do individually or when there are only a few?” He said, “Some actually emit light, and some develop increased antibiotic resistance to improve their chances of survival in unfavorable circumstances. Some even delay initiating an infection until there are enough of them to cause disease. Some pretty amazing changes in genetic activity must occur to cause these effects, and it

depends on their sensing who else is there.” So the next day, I did use quorum sensing at the NCRW conference at Barnard to ask rhetorically whether such a phenomenon was operating in the society of science.

Although I am a firm believer in Darwinian evolution and the conservation of structures and functions that are associated with adaptation and improved survival, I hesitate to force all of the properties of bacterial quorum sensing on human society. But the idea did allow me to wonder just what powers might be unleashed when women come to a certain population density – and authority – in science. What would happen, for men, women and society, if quorum sensing “worked” in the classrooms and laboratories of America’s schools, colleges and universities? Back in 2002, I left it at that. An interesting idea, a provocative image.

But then in June 2004, I heard Sheila Widnall speak at Smith College about the experience she and other MIT faculty have had as the proportion of women students has increased. She spoke proudly of the research done at MIT to use admissions criteria that were the best predictors of how women fared in MIT courses, and of the resulting improvements in the numbers of women admitted to and succeeding at MIT. She reported²:

Along the way, we identified some very important critical mass effects for women. Once the percentage of women students in a department rises above say 15%, the academic performance of the women improves. This suggests a link between acceptance and self-esteem and resulting increases in performance. These items are under our control. I am convinced that 50% of performance comes from motivation. An environment that truly welcomes women will see women excel as students and as professional engineers.

So, are women using quorum sensing capabilities without knowing it, and when they find themselves in propitious densities, turning on the functional equivalent of their light genes, their genes for antibiotic resistance? Are they succeeding because of the presence of each other? So, what if they are? Even if they are not using the mechanism that works for bacteria, what research questions would we want to pose to explore the dimensions of the “success in numbers” phenomenon that Widnall and her colleagues have observed? What other triggers of survival and success are there that we don’t know how to use?

To extend the biological reference imagery yet further and in a domain where I worked for a couple of decades, let’s consider the theories advanced for the mechanism which determines whether and where a cancer cell will grow, i.e. metastasize, after it is shed into the bloodstream from the primary tumor. While metastases from some tumor types will form beside the small blood vessels of the first organ that a tumor cell encounters, the pronounced selectivity of cells of certain tumor types for particular, distant organs is also well established. In 1889, Stephen Paget labeled this the “seed and soil” hypothesis meaning that it takes special characteristics of the tumor cell (the seed) and of the host organ (the soil) for metastases to become established and grow. Isiah Fidler³ reduces the current version of the “seed and soil” hypothesis as having two principles:

First, neoplasms are heterogeneous and consist of cells with different biologic properties; second, the outcome of cancer growth and spread depends on multiple interactions of tumor cells with host homeostatic factors.”

So, follow me one step further here: what if women and men are the “seeds” and have assorted among them various biologic properties and acquired characteristics; and what if there are host homeostatic factors (in the “soils”) that favor just some of the “seeds”? Can we prepare all the “seeds” to metastasize more efficiently even in the face of non-hospitable sites? Can we alter the “soils” that do not provide a suitable environment for all worthy, competent “seeds?”

What do women have to have to survive and thrive in science besides the grades and honors that credential them through the system? And, how does our “soil,” our different “soils” of the various disciplines, influence, even dictate, the odds of their surviving and thriving?

Let's change metaphors to address impertinent questions and get to pertinent answers. Let's move from the soldered pipelines of the past to be challenged by ideas and images which are dynamic, complex, reciprocal, interconnected, like quorum sensing capacities and "seed and soil." In so doing, let's use our imagination and powers of analysis to ask more of our institutions and our own social behaviors.

¹ - Nature 427:198-199, 2004.

² - Widnall lecture on June 3, 2004 at the international conference of presidents and academic deans on "Women's Education Worldwide 2004: The Unfinished Agenda," sponsored by Mt. Holyoke and Smith Colleges; quoted text taken from "Digits of Pi: Barriers and Enablers for Women in Engineering" at http://esd.mit.edu/headline/widnall_presentation.html.

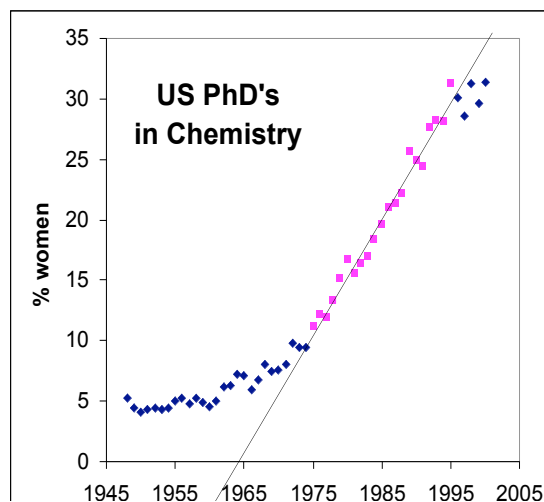
³ Isiah J. Fidler, "Angiogenic Heterogeneity: Regulation of Neoplastic Angiogenesis by the Organ Microenvironment." (Editorial) JNCI 93 (14): 1040-1041, 2001.

Some Intervention Activities in Chemistry: A Personal View

Sally Chapman, Department of Chemistry, Barnard College

The statistics for women in academic chemistry paint a mixed picture. On the positive side, women are nearing parity in the fraction of bachelor's degrees awarded. Progress has been real at the Ph.D. level as well (Fig. 1). However the near linear growth between 1975 and 1995 does not appear to be continuing; we seem to have hit a plateau at about 30%. A complicating factor is the changing composition by nationality of the pool of Ph.D. candidates at U.S. universities.

Does the increasing percentage of women chemistry graduates lead to more women in university chemistry departments? Yes and no. In the early 1970's, *Chemical and Engineering News*, the weekly magazine of the American Chemical Society (ACS), started publishing articles about women in science. Back then, the compelling story was often the significant number of top-rated departments with no women on the faculty. This is no longer the case. But there remain highly regarded departments with just one or two women in the tenure or tenure-track ranks. Departments with two or three women faculty often behave as if their "woman problem" is solved. According to the 1999 *ACS Directory of Graduate Research, (DGR)* 11.5% of faculty in Chemistry departments giving graduate degrees are women; this fell to 8.5% if only the 25 top-ranked Ph.D. granting schools were included (using 1995 National Academy of Sciences rankings for Chemistry). In the same year, looking only at the *private* universities among the top 25 Ph.D. granting chemistry departments, only 7.7% of faculty are women. On average, at top 25 departments at public institutions, 4 out of 37 faculty members are women, while at private institutions 2 out of 27.

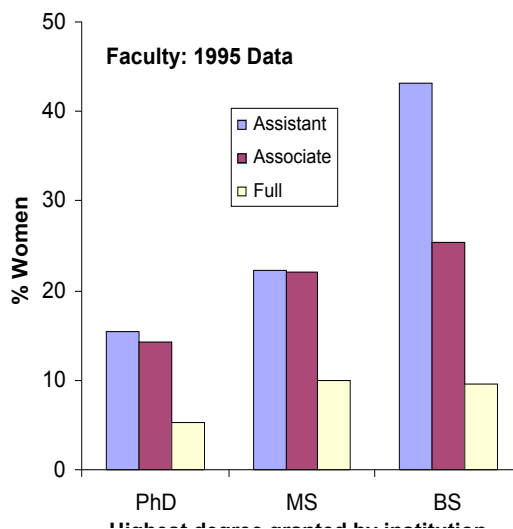


These numbers include faculty at all ranks. Not surprisingly, women are better represented at the lower ranks. According to the 1999 *DGR*, 23.2% of Assistant Professors in chemistry graduate departments were women (in the 2003 edition, the fraction is 22.8%). At the top 25 ranked schools, the fraction in 1999 was 17.5%. Some would argue that these numbers are evidence that gender equity problems have been solved: 23% (Assistant Professors) and 31% (Ph.D.'s) are not all that different, and in time these better numbers will progress naturally to the higher ranks. I don't concur: first, the difference is not insignificant: even while many chemistry departments argue that they are desperately seeking women, the hiring rate for women is 25% lower. Moreover the fall-off in the fraction of women as they ascend the ranks appears to be persistent. Another way of looking at these data is more sobering: on average in 1999, of 6.0 Assistant Professors at top-25 ranked departments, 1.0 was female. She was a very busy young woman; no wonder she was less likely to succeed.

The situation for women faculty is a bit better at four year colleges (Fig. 2; ACS data). However there too there are disturbing facts. The percentage of women in junior ranks is quite impressive, but the fall-off rate at the tenured ranks is significantly larger. Some of this difference might reflect the fact that faculty tend to remain in the Associate Professor rank longer at these schools. However I suspect that the greater attrition among women is real: some women are attracted to four-year schools believing that the pressure to publish and secure grants will be less severe, but there they encounter a different set of pressures and barriers to success.

Many of my male chemistry colleagues believe that gender inequity is a solved problem: barriers to advancement are largely gone and the numbers will simply improve by attrition. There is a wealth of data showing that this is not so; many participants at this workshop have done the significant work that supports this view. Sonnert and Holton's book (Ref 1) documents clearly the many ways that women are disadvantaged, and Valian's work (Ref. 2) describes compellingly the significant impact of accumulation of disadvantages.

Gender equity in chemistry departments is not just a problem for women, but for chemistry as a whole. I love chemistry, and I am genuinely fearful that too many bright young women and men considering graduate study in chemistry at U.S. universities do not see it as a welcoming field. Students today are much more sensitive to issues of climate, and they have many other options. This is why I have chosen in the last few years to become more involved with some projects designed specifically to address these issues.



The first is **COACH**: the Committee on the Advancement of Women Chemists. Geraldine Richmond, an energetic chemist from the University of Oregon, is the founder and driving force behind this organization. Starting with seed funding from the Dreyfus Foundation, in 1997 Geri convened a group of senior women academic chemists to serve on the COACH Advisory Board. The COACH Board, of which I am a member, meets twice yearly. COACH is involved in the planning and implementation of a number of programs including professional skills development workshops for faculty, research on gender issues in the chemical sciences, development of a data base of women in the chemical sciences, and coaching, mentoring and networking activities at all levels. We are currently supported with funding from NSF, NIH, and the Department of Energy.

Our most visible and extensive activity is our workshops. The Board identifies workshop topics, and, working with consultants, selects potential workshop leaders. We then test them ourselves, and have a good time doing so. Successful workshops are then offered to faculty, generally arranged to coordinate with a national meeting of ACS or AIChE. We cover the travel and housing costs for workshop participants. Initially, we limited workshops to tenured faculty. More recently, we have been offering workshops designed for Assistant Professors and for postdocs. The workshop topics are specifically tailored to the group. One very popular and successful workshop is "Coaching Strong Women in the Art of Strategic Persuasion", lead by Lee Warren (Associate Director, Derek Bok Center for Teaching and Learning, Harvard University), Nancy Houfek (Head of Voice and Speech, Institute for Advanced Theater Training, Harvard University), Barbara Butterfield (Chief Human Resource Officer for Academic and Staff Human Resources and Affirmative Action, University of Michigan) and Jane Tucker (Senior Manager, Administration Systems Management Group, Duke University). The workshop is conducted in two sessions; two groups typically switch off, morning and afternoon. In one session, Warren and Houfek work on presentation skills, while in the other Butterfield and Tucker focus on negotiation skills. A year later it is quite common for workshop participants to report specific successes which they attribute to their stronger negotiation skills. This was certainly true for the COACH board members!

Another COACH workshop is "The Chemistry of Leadership: A Women's Leadership Development Program" lead by Sandra L. Shullman (Executive Development Group, Columbus, OH). This workshop is of particular value to women undertaking leadership roles in their departments, but the lessons are also powerful for those wishing to be more effective leaders of their own research groups. Shullman has also offered the COACH Advisory Board an advanced leadership workshop on the topic "Changing Institutions from Within".

Over 200 women have participated in these workshops. The evaluations have been very strong. The success of the workshops comes from the fact that they deal with specific problems faced by women chemists in a particular stage of their careers; in addition the women participating in the workshop

become a natural mutual support network. The workshop leaders continue to work with COACH to refine the workshops and design new ones; their expertise is an essential part of the strength of COACH. Several universities have invited the workshop leaders to offer the workshops at their own institutions.

Research is part of the COACH mandate; we have been collecting data from workshop participants and from other women, through our web site. Preliminary results have been presented at professional meetings, and written results are forthcoming. Other COACH activities include working with the American Chemical Society to open up its procedures for selecting national prizes, and working to get a better representation of women on editorial boards.

More recently, I have become involved in an activity initiated by the American Chemical Society, as part of its recent PROGRESS initiative. While ACS has had an active Women Chemists Committee for more than 75 years, PROGRESS (Partnerships, Reflection, Openness, Grants, Resources, Education, Site Visits, Successes), a three-year pilot project, was just launched in 2002. The Academic Awareness/Site Visits component was funded in February 2004 as an NSF ADVANCE Leadership project; I am the principal investigator.

The project was in part inspired by earlier (and continuing) efforts of both The American Physical Society (APS)³ and of The Association for Women in Science (AWIS)⁴. Our principal activity, at least initially, is site visits to chemistry and chemical engineering departments at approximately 35 research-intensive universities. The visits are conducted by Valerie Kuck, a chemist recently retired from Lucent Technologies who has also had a distinguished career of service in ACS. Those of you who know Val know that she is a dynamic and persuasive woman. Using questionnaires and focus group interviews, we interview graduate students, postdocs, faculty, and administrators, women and men, asking a wide range of questions about what has influenced their career choices, and assessing the climate for women in their department. All groups are asked to discuss the barriers to advancement of women.

We promise complete confidentiality in the process: indeed in the reports we share with departments, we do not identify the other schools we have visited. While that this is essential for our data collection, we find it somewhat frustrating. In many instances we believe that faculty and department chairs could benefit from hearing specifically what we have learned about the climate in their department, but, given the small numbers of people we interview, we see no way of doing so without possibly compromising confidentiality.

The data, quantitative and qualitative, is being analyzed by a team of social scientists. Preliminary reports, with aggregate data, are shared with the departments we have visited. Thus far we have visited about 20 schools; the data analysis is complete for the first 13. We hope to complete the site visits during the 2004-05 academic year. Our ultimate objective is to use the results of this analysis to develop and make available a toolkit of materials and strategies for the advancement of women. Many of the recommendations in the toolkit will surely be familiar to those who pay attention to these issues; indeed the AWIS web site⁴ already offers an excellent model. Our hope is that basing these recommendations in well-documented empirical evidence using chemistry department data will make them more compelling.

In preliminary analysis of the data, we separate departments into two groups: one with four or fewer women on the faculty, the other with five or more. To date, there are nine schools in the former, four in the latter. While the data are still quite incomplete, some interesting differences do appear. Students --- graduate students and postdocs, women and men --- at the schools with more women faculty are generally more satisfied with the quality of the mentoring they receive. At these same schools, more students, both women and men, report that there are programs in place to support graduate students. Within both groups, women are much more likely than men to be aware of such programs.

When asked to describe the reasons for few tenured women faculty chemists, women are most likely to cite explicit forms of discrimination, while men attribute family priorities and lifestyle choices. 30% of male faculty (and none of the women) believe that women experience no extra barriers to promotion. At most institutions, many women faculty feel that their research is undervalued. However there were a couple of departments where the situation was strikingly different: the women know they are doing good science, and they are confident that the men know it too. If we continue to find such differences, and if we can pinpoint the factors that underlie them, our study will be a resounding success.

Our study may offer hard evidence to support trends that have been observed before, but for which much of the evidence heretofore has been anecdotal. One trend that is troubling to the future health of academic chemistry in the U.S. is the widespread opinion among students, even at the very top ranked universities, that life as a faculty member at a top-rated research university is simply unappealing: they admire their hard-working Professors, but they do not wish to emulate them. Students (men and women, but especially women) repeatedly express the belief that jobs in the chemical industry or at four-year colleges have more regular hours and are more family-friendly. Unless they have observed specific counter-examples, young women repeatedly express the opinion that a successful academic research career is incompatible with raising children. Some report that they have been told this explicitly, by male faculty. If this continues, will enough bright talented young people be attracted to careers in university chemistry departments today and in the future? There are plenty of talented international students, but what about those from the U.S.? Does this matter? If it does, what must change? We certainly won't be able to provide simple answers to such weighty questions, but we hope we can foster some serious conversation.

The ADVANCE project is reporting its results in several ways. Symposia are planned at American Chemical Society national meetings, journal articles will be prepared, and we will seek coverage in news media such as *Chemical and Engineering News*.

I see my activities in COACH and in the ADVANCE project as complementary. COACH has chosen to focus on the women themselves: providing them more powerful tools to succeed. As a small group of very busy women, we decided that this was our most effective strategy. In the ACS ADVANCE project, we are focusing on departments. As part of the ACS PROGRESS program, we are able to use some of ACS's influence. For example, the letter to department chairs requesting that we make a site visit is signed by the President of ACS. We have always been welcomed. We hope our results and recommendations will be welcomed too.

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3. <http://www.aps.org/educ/cswp/visits/index.cfm>
4. <http://www.academicclimate.org/index.asp>

Economic Explanations for the Gender Gap in Science

Donna Ginther, Department of Economics, University of Kansas

Women are increasingly represented at the Ph.D. level in academic science and across all scientific fields. Although women have increased numerically and achieved more prestigious positions in academic science, the question remains as to whether they have achieved the rewards of salary and promotion equal to those of men. Several studies have found that women in science earn less, and are less likely to be tenured than men (CAWMSET 2000, NSF 2000, AAAS 2001). Although the evidence presented is striking, the reports do little to explain what factors contribute to the observed gender differences. My research examines gender differences in the salaries and promotion of academics in science through the lens of economic theory.

Even though women earn less than men in science, one cannot conclude from the above studies that gender discrimination is the underlying cause of the gender gap. Economic theory suggests that salary differences arise from differences in preferences and productivity. Factors such as time in rank, employer characteristics, or productivity may also explain a substantial portion of the gender gap. Simply comparing salaries or promotion of male and female academic scientists without taking into consideration these factors could overstate the gender salary or promotion gaps. In addition, empirical evidence supporting discrimination must be qualified by assuming that, in the absence of discrimination, men and women would be paid or promoted the same on average. Careful examination of data is needed in order to conclude that discrimination is evident.

My research uses data from the Survey of Earned Doctorates (SED) and the Survey of Doctorate Recipients (SDR) to examine the distribution of women across scientific fields and gender differences in salary and promotion. The SED is a census of doctorates awarded in the United States each year. The SDR collects detailed information on doctorate recipients including demographic characteristics, educational background, employer characteristics, academic rank, government support, primary work activity, productivity, and salary. Academics in the life sciences, physical sciences, and engineering are included in the analysis. Although the SDR has comprehensive measures of factors that influence academic salaries and promotion, the data lack information on some quantitative measures, such as laboratory space, and extensive measures of publications.

My research finds significant gender differences in salary and promotion outcomes for academics in the sciences (Ginther 2001, 2004). Between 1973 and 2001 the average gender salary difference remained at roughly five percent for tenure-track assistant and associate professors, with more than half of that difference attributable to observable characteristics. Gender salary differences for full professors are persistently high, averaging 15 percent throughout the sample time frame, with one-third of the salary difference remaining unexplained by observable characteristics. However, gender differences in promotion to tenure are negligible—women in science are one percent less likely to be promoted than men within 10 years of achieving the doctorate.

Economic theory suggests several potential explanations for observed gender differences in career attainment and my research examines each in turn. However, when presence of children, productivity differences, and monopsony (where the university is the single purchaser of academic talent) are evaluated they are found to be inconsistent with the evidence presented in this research. The results are more consistent with the cumulative advantage and gender schema models of gender discrimination. In the cumulative advantage model, men's careers are more likely to be enhanced than women's and these advantages and disadvantages accumulate over time leading to the salary gap. In the gender schema model, women's accomplishments are downplayed relative to men's leading to lower salary increments.

So why is it that the average female academic scientist continues to fare worse than her male colleagues? Research by Ginther and Hayes (2003) shows that this is not the case for women in the humanities. At all ranks, the gender salary gap in the humanities is not significantly different from zero. It could be that women in science are required to negotiate for resources and salary more than faculty in the humanities. Recent research suggests that women are less likely to initiate negotiation than men, and when they do negotiate for salaries, they make lower salary demands (Babcock and Laschever 2003). In addition, women in science may be less likely to embrace the possibility of gender discrimination in career outcomes. Etzkowitz et. al. (1994) found in interviews of female faculty that, "Fear of stigmatization led some women. . . to deny the existence of gender related obstacles." This

contrasts sharply with the humanities, where feminism is a mainstream field of intellectual inquiry, and the concept of equal pay for equal work is sacrosanct.

Policy Implications and Future Research

As a result of these findings, colleges and universities should undertake an evaluation of the status of women in science similar to recent reviews by MIT and other elite institutions (Zernike 2001). Raising awareness among faculty and administrators is the first step towards addressing gender disparities. In addition, the National Science Foundation sponsors ADVANCE grants designed to help women scientists further their careers, to support women's leadership initiatives, and to allow for institutional transformation to make academia more hospitable for women scientists. Despite having moved from scarcity to visibility in science careers, women's salaries at the full professor rank do not reflect the same kind of progress.

This research is part of a larger project that will investigate the economic explanations for gender differences in salary, promotion, and attrition for academics in science, social science, and engineering using data from the 1973 -2001 waves of the SDR. The future studies will be based on SDR data that is merged with publication and citation information. These studies will explore whether the gender salary gap in science has converged since the mid-1990s; factors accounting for the gender promotion gap in the social sciences; and the timing and reasons for women leaving the scientific pipeline. These studies will examine economic explanations of the gender gap such as differences in preferences and productivity, market forces including monopsony and the excess supply of doctoral scientists, and discrimination.

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The NSF ADVANCE Program

Alice Hogan

The pursuit of new scientific and engineering knowledge and its use in service to society requires the talent, perspectives and insight that can only be assured by increasing diversity in the science, engineering and technological workforce. Despite advances made in the proportion of women choosing to pursue science and engineering careers, women continue to be significantly underrepresented in almost all science and engineering fields and constitute only approximately 22% of the science and engineering workforce at large. Women from minority groups underrepresented in science and engineering constitute only about 3% of the science and engineering workforce, and only 2% of science and engineering faculty in 4-year colleges and universities.

Academic institutions of higher learning play a pivotal role in preparing the science and engineering workforce of the 21st century. Faculty members and academic and administrative leadership at these institutions serve as intellectual, professional, personal and organizational role models that shape the expectations of many prospective scientists and engineers. The under-representation of senior women faculty members is likely to affect women students' critical relationships with mentors, full participation as members of research and education teams, and self-identification as potential researchers. Currently women make up less than 20% of science and engineering faculty in 4-year colleges and universities, and hold an even smaller percentage of high-ranked positions. This situation creates a minimizing effect on the number of women choosing to pursue science and engineering careers.

A number of factors have been hypothesized to account for the lower proportion of women in the senior ranks of science and engineering faculties, e.g. differential effects of conflicts between work and family demands, unequal access to resources such as space and supporting facilities, under-representation of women in important departmental decision-making processes, to name but a few. The cumulative effect of such diverse factors has been to create formidable systemic barriers to the advancement of women in academic science and engineering.

To address these and other challenges, the ADVANCE Program provides award opportunities for both individuals and organizations: Fellows Awards, Institutional Transformation Awards, and Leadership Awards. Since its inception in 2001, NSF has made 19 awards for Institutional Transformation (<http://www.nsf.gov/ADVANCE>); these awards are for five years, and are funded at approximately \$3-\$4 million each.

Where other programs have sought to 'fix' women, ADVANCE seeks to work through academic institutions to create awareness and to address structural impediments to women's success in science and engineering. While there has not been enough time to evaluate program effectiveness, several themes have emerged. One is the necessity to integrate social science into program interventions. Scientists and engineers not accustomed to looking to the social sciences for research frameworks and findings may miss important insights about stereotyping, occupational segregation, gender schemas, organizational behavior, and bias avoidance, for example, that can provide the intellectual framework for understanding the structural issues of academic science and engineering and their effect on women. Another issue the program has identified is the difficulty of evaluating these investments; institutional change, particularly, perhaps, in academic institutions is more difficult and complex than in other sectors where mandates (for example, in hiring) can create change whether or not the institutional culture has been transformed.

The importance of national leadership on these issues has been clear; by stating that the under-representation of women in academic science and engineering is an issue of concern for the national scientific enterprise, the National Science Foundation (NSF) provided a legitimizing framework within which institutions could discuss issues, assemble data, define possible solutions, and engage both faculty and institutional leadership in the process. The importance of the funding available through the

ADVANCE Program made clear the value that NSF placed on broadening participation in academic science and engineering.

Unfinished Business: Understanding and Promoting Gender and Race Equity in Higher Education

Sandra Morgen, University of Oregon

Gender and race equity are complex, related goals that remain “unfinished business” in higher education. Progress toward these goals has been uneven and nonlinear, and even the goal evokes contestation from some quarters in what has been called the “post-civil rights” era. Affirmative action as policy has endured relentless political and legal assault, and the culture, procedures and effects of affirmative action and diversity offices on campuses differ substantially. Indeed, it is common to hear colleagues on campuses across the country refer to their affirmative action offices as more about protecting the university than as engines for promoting substantive diversity and institutional transformation.

As a researcher whose expertise includes the study of organizations, and as someone who has been involved in a wide variety of efforts to promote gender and racial equality within and outside higher education, it is clear to me that much remains to be done if colleges and universities are to equally value men and women; people from different racial, ethnic and class backgrounds; and ways of knowing and producing knowledge that honor and emerge from the broader social locations that “diversity” is meant to encompass institutionally. Moreover, as the director of a women’s research center at the University of Oregon for the past fourteen years, I have had the privilege of working with many faculty, staff and students who share the vision of higher education as a site that has the potential to realize the dream of diversity, despite the many dilemmas of difference that create challenges along the way.

In this presentation I want to share some of those challenges, and a few things I have learned along the way about what it takes (or will take) to move forward toward greater equity during a period of increasingly scarce resources (especially at public institutions), political backlash, and cohort/generation change (many of those who pioneered these changes and for whom institutional transformation was a political, as well as an individual concern have already or are now retiring). Specifically I will discuss the following:

- What is the role of units such as women’s (or feminist!) research centers and institutes as part of an institutional strategy to promote greater gender (and racial) equity at a research university?
- What is the value of creating interdisciplinary and collaborative research opportunities and communities as part of a larger strategy to foster greater equity? To what extent has this helped to expand and change definitions of excellence in research? to support scholars whose research and/or teaching focuses on gender? to incubate innovative research/teaching/policy/public education connections?
- What are some of the effects of an institutional (and state) fiscal crisis on equity goals, and how can units such as a women’s research center, or a women’s and gender or ethnic program weather these challenges?

In an institution such as the University of Oregon, declining state revenues have led the administration to make up for lost revenues from private donors and from faculty research activity, especially research that brings in federal and other grants and contracts with indirect costs. “Fiscal realities” have a very mixed effect on institutional equity goals. In this kind of climate there is a strong incentive to channel institutional resources to departments and faculty which have the greatest likelihood of generating “big money” from private donors, business partnerships and federal grants and contracts. Overall, at least at the University of Oregon, this has meant a reinforcement of some dimensions long recognized as aspects of a “chilly climate,” especially for faculty who are not seen as potential money makers. There are a series of subtle and not so subtle effects this has on everything from the definition of positions for searches to hiring and retention.

It is important to analyze how neoliberal values increasingly saturate colleges and universities and to explore the effects of these institutional changes on the goal of gender and racial equity. Understanding

these consequences and then working to make them visible in ways that can be tied to core aspects of the institution's mission is crucial in this period which is more than "post civil rights." It is also a period that, in some ways, is "post activist state," (at least when it comes to equality and social justice. I will conclude by talking about a few strategies we are pursuing at the Center for the Study of Women in Society to support and generate research, research opportunities, and intellectual communities that can sustain individuals and units whose work embodies and upholds core liberal (in the sense of liberal arts) values and transformative potential.

Summary of Research and Intervention Strategies

Dr. Donna J. Nelson, Department of Chemistry, University of Oklahoma

Recently (FY2001 - FY2004), we surveyed the race/ethnicity, gender, and rank of top research faculties in each of 14 science and engineering disciplines (chemistry, physics, math, chemical engineering, civil engineering, electrical engineering, mechanical engineering, computer science, political science, sociology, economics, biological sciences, and psychology). In each discipline, the departments surveyed were the "top 50", ranked by NSF according to that discipline's research expenditures. Comparing her faculty data against NSF-compiled PhD and BS attainment data for each discipline revealed that generally, the representation of females and underrepresented minorities on the faculties is much less than that in either PhD or BS attainment. These faculty data are the first obtained which are disaggregated by discipline, by race/ethnicity, by gender, and by rank. They were obtained simultaneously and by a consistent protocol and are therefore comparable across a large number of disciplines. For chemistry and chemical engineering faculties, additional data for national origin were obtained and revealed that recently, more international scientists are hired as faculty than US females and US minorities combined.

Data in Table 1 reveal a great disparity between the representations of women among BS recipients versus among faculty in the same discipline; this demonstrates that female science majors often lack sufficient female role models and mentors.

TABLE 1. Gender Distribution of BS Recipients vs. Role Models

	% Females		% Males	
	Students	Faculty	Students	Faculty
Chemistry	47.3	12.1	52.7	87.9
Math	48.2	8.3	51.8	91.7
Computer Science	27.7	10.6	72.3	89.4
Astronomy	32.7	12.6	67.3	87.4
Physics	21.4	6.6	78.6	93.4
Chemical Engineering	35.7	10.5	64.3	89.5
Civil Engineering	24.5	9.8	75.5	90.2
Electrical Engineering	13.1	6.5	86.9	93.5
Mechanical Engineering	13.9	6.7	86.1	93.3
Economics	32.3	11.5	67.7	88.5
Political Science	50.1	23.5	49.9	76.5
Sociology	70.2	35.8	29.8	64.2
Psychology	76.5	33.5	23.5	66.5
Biological Sciences	58.4	20.2	41.6	79.8

Data in Table 2 compare the representation of women among PhD recipients versus among assistant professors in the same discipline. This reveals that in most science disciplines, the pipeline is underutilized. However, there are some exceptions, with a better match between PhDs and assistant professors, in social sciences, engineering, physics, and astronomy.

Table 2 . Assistant Professors (FY2002) and PhD Attainment (1993 - 2002)* in Science and Engineering Disciplines

Discipline	White Male		Asian Male		Female		URM Male	
	Asst	PhDs	Asst	PhDs	Asst	PhDs	Asst	PhDs
Chemistry (FY2003)	65.4%	54.8%	11.5%	9.6%	21.5%	31.3%	1.6%	4.2%
Math	60.5%	58.1%	15.0%	11.3%	19.6%	27.2%	5.0%	3.3%
Computer Science	62.9%	60.6%	24.3%	15.1%	10.8%	20.5%	2.0%	3.5%
Astronomy (FY2004)	62.6%	69.8%	9.9%	6.6%	22.0%	20.6%	5.5%	2.6%
Physics	70.6%	68.9%	14.9%	13.9%	11.2%	13.3%	3.3%	3.8%
Chemical Engineering	60.7%	58.4%	16.6%	14.8%	21.4%	22.3%	1.4%	4.0%
Civil Engineering	57.9%	58.4%	11.3%	17.0%	22.3%	18.7%	8.6%	5.9%
Electrical Engineering	57.2%	59.1%	27.5%	23.9%	10.9%	11.5%	4.5%	5.5%
Mechanical Engineering	56.1%	63.4%	22.2%	21.2%	15.7%	10.4%	6.1%	5.0%
Economics	59.8%	54.9%	16.1%	9.6%	19.0%	29.3%	5.1%	6.0%
Political Science	54.2%	52.4%	4.5%	3.6%	36.5%	36.6%	4.8%	7.0%
Sociology	37.2%	31.5%	3.5%	3.0%	52.3%	58.9%	7.0%	6.5%
Psychology	46.0%	29.5%	4.6%	1.1%	45.4%	66.1%	4.0%	3.3%
Biological Sciences	55.4%	43.2%	10.7%	8.7%	30.2%	44.7%	3.7%	3.3%

Our data reveal that underrepresented groups in different science disciplines do not face the same challenges, and so the sciences should not be regarded as one group when formulating solutions. However, similarities among sciences reveal patterns, which should reduce the enormity of the problem and yet enable targeted strategies.

We share our data with anyone requesting them, such as professional societies, universities, and federal agencies. However, we have worked mostly with the US Congress and other DC organizations.

Women and Interdisciplinary Science: Promise and Peril

Stephanie Pfirman and Peter Balsam, Barnard College, Columbia University

Because women and men are different, are perceived differently, and are rewarded differently, they come to behave differently and are steered in different ways throughout their careers (e.g. Moir and Jessel, 1992; Steele, 1997; Valian, 1998). These differences between women and men might be expected to lead to differing approaches to scholarship. Socialized to be communal, build consensus, and be concerned with other's welfare, it is likely that women will appreciate research that has social value, will value applying research to improve welfare (e.g. Clough, 2004), will enjoy coming to grips with the complexity that relationships and multiple perspectives bring to problem solving, and will be interested in synthesizing and integrating information from diverse sources. Women may be drawn to interdisciplinary science, while career-oriented men, are less likely to be drawn to the unproven trajectory of interdisciplinary investigations.



Figure 1. A study by the Research Assessment Group in the United Kingdom found a small (5%) difference in the average amount of time that women and men spend on interdisciplinary research (50 vs. 45%) and but found a striking gender difference at the high end in the number of intersecting research fields. <http://www.evaluation.co.uk/library/id/gender.htm>

Here we analyze the opportunities and challenges that pursuit of interdisciplinary science pose to the advancement of women researchers. Confounding factors include the fact that many interdisciplinary fields are new, they connect science with society, and many interdisciplinary advances involve contributions from multiple participants.

Multitasking vs. Single-mindedness

When women work on a task, they tend to make more connections, while men tend to channel their attention (e.g. Moir and Jessel, 1992). Men look for the abstract and theoretical, dissociating it from distracting information, while women see a larger context and are better at understanding and predicting human action, and sensing motives and emotion. This ability to multitask and to consider other sources of information should stand women in good stead as they collaborate on work of social value.

Collaborative Scholarship and Assignment of Credit

Interdisciplinary research often involves working with others to pool intellectual resources. Collaborative projects provide women with expertise in associated disciplines, a collegial vetting and support network, a sense of community, and an opportunity to relate to others. Single authors are most likely to have their submissions rejected, while manuscripts with more than four authors are more likely to be accepted, but unfortunately, the pattern of citation rates relative to author number is almost the opposite of the pattern of acceptance rates (Tregenza, 2002). Two author papers were cited most with a linear decline in citation rate through 3, 1 and 4+ authors. Hence, although submissions with more than four authors are the most likely to be accepted, they are the least likely to be cited.

Results from psychological research on causal reasoning indicate that collaboration is likely to cause difficulties in assignment of credit. When the collaborators are well known, newcomers have to overcome the “blocking” and “overshadowing” effects of their ideas being attributed to their colleagues (De Houwer & Becker, 2002; Dickinson, 2001). Also causal attributions depend on the “relative validity”

of a predictor, which means that if researchers have a career interruption while their colleagues continue to publish, over time their colleagues will begin to get the credit for the original joint discovery.

These general cognitive operating principles are related to the fact that women's ideas are frequently attributed to their male associates in meetings and publications (e.g. Sonnert and Holten, 1995; Ward and Grant, 1996; Valian, 1998). If women try to overcome this misattribution by claiming their ideas, they may be seen as boastful and experience a negative reaction (Babcock and Laschever, 2003 citing Heatherington et al. 1992 and Miller et al., 1992).

Interdisciplinary Research and Evaluation of Innovation

Interdisciplinary research allows women to break new ground, to move into areas where others are not working. This means that women do not have to compete head on with leaders in the field, and the field does not move as quickly, so is more tolerant of interruptions. This is attractive to many women who prefer not to compete, especially against men (Babcock and Laschever, 2003), and who have more career interruptions. However, there are also costs to this research path. Research on learning and cognition indicates that the impact of information on learning and memory depends on its "news value"—how much it contradicts expectations (Dickinson, 2001). Thus we consider high impact research to that which violates our expectations. The stronger the expectation the more news in the violation. But when there is no consensus on where a field is going, there are fewer expectations about outcomes, and advances are not as easily recognized as innovative by reviewers of proposals and manuscripts.

A second aspect of interdisciplinary research that reduces the assessment of impact stems from the very nature of that activity. Much interdisciplinary work, particularly in the early stages of a new field, involves exporting ideas and methods from one discipline into addressing a problem in a second discipline. While the scholars in the second discipline may appreciate the innovation, the scholars in the first discipline will not see it as anything innovative or important. Thus at least half of the intellectual domain touched by this work will see it as derivative

Disciplinary research, with its well defined methods, language, and community, comes to a consensus about the value of a contribution -- frequently placing the highest value on research that is quantitative and/or theoretical. Because of the complexities of interdisciplinary problems, variations are more difficult to constrain and measure and research may not initially lend itself to modeling and the development of clean theories. As a result, interdisciplinary research is frequently not as quantitative or theoretical as disciplinary research. This too can be a source of a lower assessment of the impact of the work, and can present difficulties in getting it published in high quality journals, especially because many of the highly ranked journals are disciplinary. Publication rates tend to be highest in fields where there is agreement about important research questions, major theories and methods, and there are many journals (Creamer 1998).

Another factor to be considered is the lower standing of "applied" research or "problem solving" -- which is at the root of many interdisciplinary investigations. Although this is changing, within academic culture, research that is theoretical, abstract, or valuable for its own sake remains the most prestigious (Frost and Jean, 2003).

Implications

Community and Leadership

When the interdisciplinary community is not yet established, women can help to build it. With their socialization in engaging diverse perspectives and soliciting input, women can organize workshops and special sessions at professional meetings with the goal of developing strategies to take the field in new directions. Agentic people -- often men -- tend to focus on differences between things and but communal types -- often women -- tend to focus on similarities (Woike, pers.comm.), which is likely to help them in building towards consensus.

Initiation and Implementation

Departments and funding organized by discipline make interdisciplinary research more difficult to initiate and maintain. Considerable effort goes in to finding an appropriate place to submit an interdisciplinary proposal, bringing together colleagues -- often from different institutions -- and then maintaining contact during implementation, analysis and publication. Because women often don't have the professional social capital that men do (e.g. Valian, 1998; Etzkowitz et al., 2000), women face

challenges in getting members of the team to accord their joint work high priority and follow through with their contributions. This results in long start up times and delayed publications.

Interdisciplinary proposals and papers are hard to review: typically they are sent out to people with diverse backgrounds, who each come back taking strong issue with the aspect that they know most about, and wanting extensive background on aspects unfamiliar to them. This lack of consensus in reviews makes revisions challenging especially for women who tend to respond more negatively than men to criticism (e.g. Cole and Zuckerman, 1984; Roberts and Nolen-Hoeksema, 1989; 1994), and who are more likely than men to have their peers attribute their failure to lack of ability (Valian, 1998 citation of Swim and Sanna, 1996). Also, because women researchers are generally more involved than men in teaching, this detracts from their ability to implement revisions in a timely manner (as well as to conduct the research itself).

The complex combination of greater likelihood of negative reviews of interdisciplinary work, lack of social capital, and less time to devote to research, may mean that women do not resubmit proposals and ms. as frequently as men, and when they do resubmit, that it takes longer for them to do so.

Recognition as an Authority

Because women are frequently judged on process and men on product (Valian, 1998), the challenge is for women to position themselves as leaders as they build community, rather as secretaries, administrators, or simply hard working and selfless citizens. In emerging interdisciplinary fields, the peer group is often small, dispersed, and there are fewer influential colleagues – on campus or elsewhere. This means that the field is more open, with fewer steps to reach the top. But it also means that there is less of a community to recognize contributions. It is easy to characterize unfamiliar research as “niche” or even trivial. Since their authority is challenged more often than that of their male colleagues, women tend to be perfectionist in their publications, taking longer to get them into the mainstream press (e.g. Creamer, 1998; Valian, 1998; Steinpreis et al., 1999). Compounding this is the fact that responsibility for childcare and eldercare do not allow women to travel to professional meetings as easily as men. This has several effects: women are isolated from recent advances, they are not able to vet their research as completely, and as a result they do not get feedback that would give them confidence in the worth of publishing and alert them to the urgency of publication as competitors emerge (Creamer, 1998). As a result, women may delay publication until the field has caught up with them – and perhaps has actually passed them by. This is especially unfortunate, as some research shows that it takes a longer period of time and a greater number of publications for women to be recognized as meriting promotion or senior status as for their male peers (e.g. Valian, 1998). Because national standing is largely a function of recognition by colleagues external to the institution (Creamer, 1998), women should be facilitated to attend meetings and to present their research off campus.

Another factor related to the question of authority is the observation that venturing into new territories, by definition required for interdisciplinary discourse, causes high levels of anxiety and defensiveness, as people have to reveal ignorance and encounter intolerance (Armstrong 1980, Becher 1994). Presumably, these feelings would be particularly difficult for women who find their authority questioned no matter what discipline they are in, and who rely more heavily on outside cues than do men.

Promotion and Tenure

For all of the reasons outlined above, tenure, requiring departmental approval and recognition by influential colleagues, is particularly challenging for women. Many of the attributes traditionally associated with tenure are based on disciplinary research and are strikingly similar to those associated with men.

On average men are, or are thought to be ...	On average women are, or are thought to be...
Agentic (autonomous action)	Communal
Dominant	Socially sensitive
Controlling	Friendly
Independent, instrumental	Concerned about others and their welfare
Assertive	Expressive
Quantitative	Relational, qualitative
Aggressive	Nice
Tough	Emotionally supportive
Combative	Helping
Independent	Nurturant
Self-promoting, careerist	Less careerist
Risky science, mainstream/consensus science	Interdisciplinary science, "niche" science
Focused	Multitasking
Quick to publish, productive	Slow to publish
Gets ideas out	Perfectionist, complete, synthetic, cautious and careful in their method, attentive to details on the way to a conclusion
Task oriented, autocratic, directive, command-and-control leadership	Consensus oriented, democratic leadership
Enjoy competition	Enjoy competition less
Take credit for successes	Take blame for failures

Figure 2. Selected attributes pertaining to scholarship compiled from research presented in Valian, 1998; Babcock and Laschever, 2003; and other references cited here.

These stand in sharp contrast with those associated with women and with collaborative or interdisciplinary scholarship. Additionally, senior scholars are less likely to recognize the potential of a woman: women tend to be evaluated based on accomplishments, while men are evaluated based on their potential (e.g. McCracken, 2000). Senior scholars, primarily male, are also less likely to go out on a limb to promote a woman who is often not part of their professional social network (Babcock and Laschever, 2003).

Outlook

Many of the issues raised here are changing. Funding agencies are seeing the value of researching complex systems. The system is more open to leading by consensus. Negotiations are increasingly less competitive and now more often focus on finding consensus and win-win solutions (Babcock and Laschever, 2003).

However, as long as the default is departmental and disciplinary with senior ranks dominated by men, collaborative and interdisciplinary scholarship by women will be disadvantaged and will require explanations, weakening its standing.

Does this mean that junior women should be advised to shy away from collaborative, interdisciplinary, and applied research? Or are there ways to overcome these concerns and use the advantage of synthetic, communal, and socially sensitive approaches to launch women into exciting and important research directions long overlooked because of disciplinary and departmental limitations?

Research Questions

Who conducts collaborative research? A study by Long (1992) did not find major gender differences in collaboration by (1956-1963) biochemists other than the women more often collaborating with a spouse). But the UK study cited above indicated that women scientists spend more time working alone (reported by Mitchell, 1999). Perhaps women work more often alone because men are more often involved in hierarchical structures with people working below them: the greatest disparity between women and men working alone is in the physical and engineering sciences (figure 3). Perhaps women work more often alone because they are not included in the professional social networks that men are. Perhaps women prefer to have the freedom to pursue projects on their own pace and in their own direction, without having to depend on others who don't accord their work as high priority.

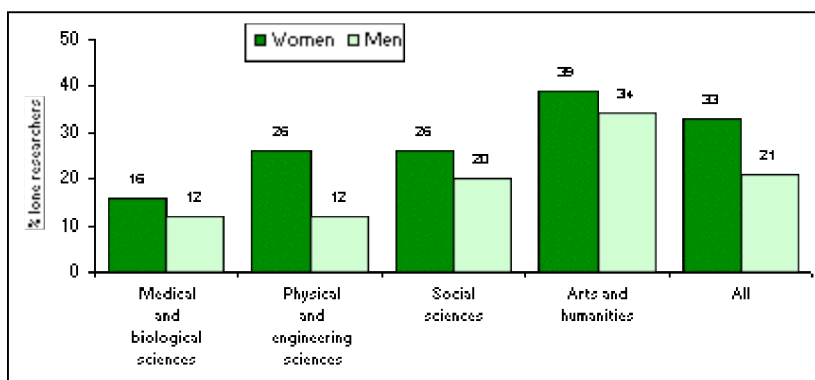


Figure 3. <http://www.evaluation.co.uk/library/id/gender.htm>

Who conducts interdisciplinary research? Gather national data and assess by gender and rank. The UK study showed that junior women are more likely to work on interdisciplinary research than their elders – with the notable exception of the physical and engineering sciences where junior women are much less likely to. Preliminary work by Rhoten also indicated that junior women in the US were less involved in interdisciplinary Biocomplexity research than their male peers (pers.comm. 2003). Use the Citation Index to analyze degree of interdisciplinarity of a selected group of women and male counterparts.

Do more women than men have cross-program appointments (as indicated by Creamer, 1998)? Are cross-program appointments advantageous (access to more resources) or disadvantageous (visibility lower in any one unit)?

Is NSF's increased emphasis on interdisciplinary research correlated with, and potentially a result of, an increase in the number of women program officers? Women PIs? Women in leadership positions at NSF? Access NSF databases.

Are interdisciplinary committees led by women more successful in producing useful products? Engaging communities? Operations? Use GAO Gallup survey of Federal Advisory Committees database.

Do women lead more interdisciplinary special sessions at professional meetings? Use AGU database.

Is there a difference between women and men in resubmitting rejected proposals? Analyze NSF and NIH databases. NSF supposedly did a study of this and did find a difference.

In publications led by women, is there a longer period of time between initial submission and final acceptance?

Do women travel to scientific meetings less frequently than men? Do women request less travel support than men in proposals to NSF, NIH, etc.? Research NSF and NIH databases.

Is there a gender difference in invitations to give presentations? Research AGU database of invited vs. contributed oral presentations, also compare those selected for oral vs. poster presentation.

Do interdisciplinary tenure cases at Columbia and other institutions fare worse than disciplinary ones? Are the outcomes moderated by gender? Data gathered for Barnard shows a tendency in that direction.

Other research indicates similarities between women and under-represented minorities, and some have asserted that minorities are also attracted by interdisciplinary research. Are they? And do they face the same issues as women?

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Title IX as a change strategy for women in science and engineering . . . and what comes next[†]

Debra R. Rolison □

What does Title IX have to do with women in science? ‡ Title IX is a mechanism that—when wielded—successfully affects change for women. Americans rightly attribute the Education Amendments of 1972, commonly called Title IX, with the spectacular increase in opportunities for female athletes in schools and colleges, but the law as originally written never mentioned athletics. It stated, “No person in the United States shall, on the basis of sex, be . . . denied the benefits of . . . any education program or activity receiving Federal financial assistance.”

In analogy with the creative legal strategy that extended Title IX to school sports and led (with time and effort) to women comprising 42% of today’s collegiate athletes, I argued in 2000 that it was time to apply Title IX as a strategy on behalf of women faculty in chemistry departments.⁽¹⁾ While that suggestion was met with near-universal horror,⁽²⁾ look at the facts. Twenty percent of the Ph.D.s in chemistry went to women in 1985, increasing to 33% by 1999. Yet the fraction of women on the tenure-track faculty of the top 50 research departments in chemistry in 2000 was only 10%, rising to 12% in 2002 and stagnating at that level in 2003 and 2004.⁽³⁾

Chemistry is not the only discipline with solid Ph.D. numbers: women earn more than 40% of the Ph.D.s in the life sciences, more than 20% of the Ph.D.s in chemical engineering, more than 20% of the Ph.D.s in mathematics. Yet applications from women for advertised faculty positions in Ph.D.-granting STEM departments rarely match the numbers of women who graduate from these departments with Ph.D.s. The now-false and tired contention that “the statistics of small populations” is the operative reason for the slow advancement of women in science, especially to positions of power and impact, has too often been used to deflect action that would transform the academic culture to one that adapts to women.^(4,5) § As Trower and Chait remind us, self-reform is not getting it done,⁽⁴⁾ and the slow pace is especially frustrating in light of the current (and historic) opportunity to change the faculty demographics as scientists and engineers hired in the boom years of the 1960s retire.

After suggesting that departments in the chemical sciences should be “Title Nined,” I then heard from women and men across all the STEM disciplines saying that they, too, experience the same problems we face in chemistry. Can one take any comfort in that universality? Hardly. Enough is enough. Nearly ten centuries of higher education should have provided ample time to diversify our

† The author’s arguments with respect to the application of Title IX on behalf of women on science faculty are presented in more extended form in Chapter 6 in *Women in the Chemical Workforce* [National Academy Press, Washington, DC, 2000, pp. 74–88], available at <<http://www.nap.edu/books/030907293X/html>> and in updated form as the Back Page feature of *APS News*, **2003**, 12 (May) available at <<http://www.aps.org/apsnews/0503/050312.cfm>>.

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‡ The term “science” will be used as shorthand throughout this discussion for the STEM disciplines of Science, Technology, Engineering, and Mathematics.

§ If the observable is not only the absence of women from the tenure-track STEM faculty in research universities, but their absence from the applicant pool for faculty openings, what is the mechanism? In Cathy Trower’s paraphrase of a 1990’s political slogan: “It’s the culture, stupid.” Academic science still echoes the standards of David Noble’s description of Western science: “a world without women,”⁽⁵⁾ one in which round-the-clock scholarship by men doing science was historically sustained by a sociological and emotional infrastructure first provided by monasteries and then by wives.

university system (and so, too, our national and federal laboratories) beyond the operative one where the de facto hiring quota in science has been 80% to 90% white men. Isn't a millennium of affirmative action for white men sufficient?

But why propose such a drastic course of action as Title IX? Because it's the LAW—as made clear by the release of the July 2004 General Accountability Office (GAO) report entitled *Gender Issues: Women's Participation in the Sciences Has Increased, but Agencies Need to Do More to Ensure Compliance with Title IX.*⁽⁶⁾ And because it works. The threat that Title IX compliance reviews could affect federal funding to universities is what has led to change, not an actual loss of funds.

Now that the GAO has reminded the Federal funding agencies that Title IX compliance audits must also be done with respect to science (and should have been ongoing for the past 30 years), it is time to contemplate what the next stage could entail—especially as any formal Federal pressure using Title IX will be slow. The strongly positive impact that Title IX has had for collegiate athletics was neither accomplished overnight nor without women fighting for their rightful place (and rightful share of the money), including a willingness to use the courts.

How does one thus reform institutions that seem mired in dysfunction? **

Firstly: Remember what psychology, sociology, and economics have taught us about how people can be influenced to change their behavior. Redirect the reward structure. The nominal demands for faculty success in STEM disciplines more and more appear to require someone who must cover the CEO, COO, CFO, CTO, CIO, and human resources functions of a small company. Our universities can never pay faculty commensurate with all those activities: It is past time to stop demanding so much of STEM faculty and return them to—and reward them for—the primary reason they are in academics: educating independent thinkers and critical scholars in pursuit of new knowledge. In my view, tenure should be abolished, with job security, and the heart of merit compensation, related to scholarly and educational contributions.

Secondly: Persuasive coercion. The possible loss of Federal R&D dollars as a consequence of Title IX compliance reviews will undoubtedly focus the attention of the powers-that-be in the existing academic culture: Administrators and those faculty most rewarded by the current system.^{††} Improving the environment in STEM institutions will require more than one solution, even if Title IX is the most implacable hammer we can take to it. A wide range of strategies to transform the culture becomes immediately more appealing—and less threatening—in the face of possible Title IX action.

Thirdly: Money. Women who chose career paths as research faculty or staff should not be faced with choosing between their career advancement and their personal life, especially whether or not to raise children. Childcare, whether provided on-site as day care or underwritten in the home or nearby community (including adult care), costs infrastructural resources and money.

Fourthly: Grass-roots activism. Change strategies can range from actions by the individual to mechanisms to extend Title-IX-like actions beyond Federal funds, for example, professional society, foundation-derived, and even intra-institutional funds and resources could be withheld from poorly diversified departments. As individuals and members of professional institutions and societies, we can remind our colleagues and students that we are life-long learners. It is time for us all (and especially our search, hiring, promotion/merit, and award committees) to learn about—and learn how to level—a psychological playing field that is skewed by unconscious biases and beliefs, which are tied to culturally

** If sweet reason, historical perspective, and moral suasion were sufficient to alter the culture of science to one that fully incorporates the talent we train, we wouldn't be holding this meeting.

†† I am not yet convinced that the most powerful administrators (at most universities) see any real need to change—there is still far too much of the attitude that one just needs to learn how the game is played in academe to do well in academe, without recognizing that the game board needs to be thrown up in the air with only certain pieces retained.

embedded gender and racial schemas.⁽⁷⁾ ‡ It would also be healthy for science in general to run the myth of pure objectivity in evaluating merit (and data) to its rightful dead-endpoint.

Finally: Market dynamics. Gratifying as it is to have seen things progress this far with respect to Title IX and STEM,^(8,9,10) §§ including the 2004 release of the GAO report on Title IX and Science, in my view the next stage may have to be more market-oriented—something with the flavor of "denial of service." I suggest we assemble a STEM data base on the nature of the graduate experience at the top 50 Research I departments, comparable to that being derived by Kuck et al. for chemistry.⁽¹¹⁾ The information should then be disaggregated faculty member by faculty member and available on the Web for consideration by the relevant consumer (i.e., the faculty at the four-year colleges and their outstanding STEM-majoring undergraduate juniors/seniors). Critical statistical factors could include the number of women in each research group (professor by professor) over the past twenty years and the fraction of those women who graduated with Ph.D.s relative to the men in the group; the number of women who went into academics (e.g., top 25 Research I departments versus any research university versus four-year colleges and universities); and the number of women who remained in STEM career paths. Important sidebar information could be "peer review" (i.e., anonymous) comments on the nature of the graduate environment in the department and the group.

With such a database, the lifeblood of the U.S. STEM university research enterprise—undergraduate juniors/seniors who choose to go on for graduate training—could make a far-more informed selection among graduate programs. There will always be students who are shopping solely for pedigree, but so many of these young people want to do cutting-edge science in an environment good for people. Such market information could rapidly skew which universities and departments and groups win the acceptance of this prize demographic. We can then see who among the lovers of the status quo in the research universities really wants to play hardball. It is time to "out" the toxic departments and research groups.

The problem is not with the women (was it ever?); it lies with a culture that is unappealing to women otherwise interested in science- and math-intensive studies, including how scientific arrogance and other solipsistic behaviors are over-rewarded by the existing culture.⁽¹²⁾ One of the greatest indictments I know of academics is the comment that has been made to me by far too many senior faculty, upper administrators, and (saddest of all) students: they thank me for my courage in making the arguments with respect to applying Title IX to science. I find that statement enormously depressing because it says all that needs to be said about how sick the university culture has become—and how far we have moved from tenure as a process that ensures academic freedom in service to innovative scholarship.

I often end my "uppity woman" lecture on these issues with a marvelous quote from the poet Adrienne Rich: "The most notable fact that culture imprints on woman is the sense of our limits. The most important thing one woman can do for another is to illuminate and expand her sense of actual possibilities."⁽¹³⁾ It is not coincidental that the world we seek to create, one in which we can do our science to the best of our abilities, will be one in which men flourish, too.

‡ One of the sanest things I have ever heard a politician say was when Congressman Vernon J. Ehlers (R-MI) opened his comments at a Capitol Hill breakfast discussing diversity in academia (on 11 October 2001) with: "Hello. My name is Vern. And I'm a recovering racist and a recovering sexist."

§§ The progress includes the U.S. Senate hearing on 3 October 2002 on "Title IX and the Sciences" ⁽²⁾ at which Senator Ron Wyden (D-OR), then chair of the Subcommittee on Space, Science, and Technology, commented for the record: "It's time Congress quantified and qualified the realities facing women in the sciences. Only then can we find fully effective solutions." This hearing led to amendments to the bill authorizing appropriations for the National Science Foundation that required the NSF to charge the National Academies of Science with examining gender differences on issues such as STEM faculty hiring, promotion, tenure, and allocation of resources including laboratory space.⁽⁸⁾ This study, which echoes the issues raised by the 1999 MIT report showing a pattern of gender discrimination among the faculty of the College of Science at MIT,⁽⁹⁾ is underway,⁽¹⁰⁾ and will provide the data to determine if such imbalances exist in our STEM departments. Title IX permits "the consideration in any hearing or proceeding under this chapter of statistical evidence tending to show that such an imbalance exists."

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Sue V. Rosser, Dean and Professor, Georgia Institute of Technology

As a scholar who has worked for a quarter of a century on theoretical and applied problems of attracting and retaining women in science and engineering, I have heard the expression of doubts and dilemmas in a variety of forms from diverse women scientists and engineers in all types of institutions. These dilemmas were reinforced by what women told me when I formerly served as Senior Program Officer for Women's Programs at the National Science Foundation (NSF) and what they tell me now in my current position as dean at a Research I institution who also serves as co-PI on an NSF ADVANCE grant for institutional transformation. The women question whether their individual choices, decisions, and will power, or institutional obstacles and barriers, prevent them from fulfilling their research potential and career goals.

In an effort to better understand the barriers and discouragements encountered by women faculty in the sciences and engineering, I undertook research comparing the experiences of Professional Opportunities for Women in Research and Education (POWRE) awardees and Clare Boothe Luce (CBL) Professorship recipients. POWRE awardees are women who received peer-reviewed funding from a focused National Science Foundation program from 1997-2000. They are primarily untenured assistant professors in tenure-track positions at research universities. The CBL Professorships were created by Clare Boothe Luce's generous bequest to The Henry Luce Foundation upon her death in 1987. CBL Professors are primarily assistant professors in their first tenure-track position at liberal arts colleges.

Because of the emergence of anecdotal reports that some women scientists actively choose to avoid research universities because of their hostile climate, it seemed important to examine the Clare Boothe Luce Professors. Data supporting these anecdotes of women's avoidance of research universities documented that women make up 40% of tenure-track science faculty in undergraduate institutions compared to less than 20% when data from four year colleges were combined with those from universities.

In order to examine this trend and to understand some of the reasons behind the data and anecdotal reports, the e-mail questionnaire responses from 389 POWRE awardees and in-depth interviews of 50 of them were extended to women scientists and engineers concentrated at small liberal arts colleges. Although the NSF POWRE awardees included individuals from all types of institutions and at varying ranks, the overwhelming majority held the rank of untenured assistant professor and came from large research institutions. The Clare Boothe Luce Professorships offered a group of women scientists and engineers concentrated at small liberal arts colleges and private institutions who, like the POWRE awardees had received an externally validated prestigious award. CBL Program Officer Jane Daniels helped obtain responses from 41 of the 46 active CBL professors and 8 of the 84 former CBL professors; 11 CBL professors were interviewed in depth. (For the complete data on this research see Rosser, 2004)

The CBL professors gave very similar responses to those of the POWRE awardees to e-mail question 1: "What are the most significant issues, challenges, and opportunities facing women scientists and engineers as they plan their careers?" 63% to 88% of the almost 450 women identified responses in the category of "balancing career and family" as the overwhelming barrier. Problems faced by women because of their low numbers and stereotypes held by others regarding gender, more overt discrimination and harassment, as well as issues faced by both men and women scientists and engineers in the current environment of tight resources, which may pose particular difficulties for women, also emerged as significant issues.

Although the responses reflected less consensus overall, the Clare Booth Luce Professors responded similarly to the POWRE awardees to e-mail question 2: "How does the laboratory climate (or its equivalent in your subdiscipline) impact upon the careers of women scientists?" Many described the impact of negative laboratory climates on the retention of women scientists and the toll these climates take on women's self-esteem. A number of both POWRE and CBL respondents noted the efforts that they make to provide a supportive atmosphere in their laboratories. Perhaps the most positive evidence to emerge came from indications of women's abilities to construct a small, empowering environment within their own labs, within a larger, hostile environment. Very exciting indications of the potential for the new ideas and approaches that women might contribute to science and engineering because of their experiences as women also emerged.

How can the dilemmas faced by academic women scientists and engineers be solved to allow more of the exciting potential for new ideas, approaches, and empowering laboratory environments? The 450 women I surveyed are highly educated and successful. They have completed Ph.D. degrees and post-doctoral experiences at the most prestigious institutions in the country. They have succeeded in obtaining a coveted tenure-track position at either a Research I institution or a highly ranked small liberal arts college. Each has competed to obtain a prestigious NSF or CBL award. Most still love their chosen field of science or engineering.

Yet, they express frustration with problems, and in some cases, almost insurmountable barriers erected by institutional and foundational policies and procedures. The interviews and responses to the e-mail questionnaires reveal that some disciplines, institutions, or individual timing of life events are better or worse than others. Encouraging mentors and role models, both male and female, do make a difference. A supportive spouse/partner is critical. But the bottom line remains the same: Most of these women struggle to have both a life and a career as a scientist or engineer.

Responses to questions 1 and 2 suggest the need for support that extends beyond the research of individual women scientists and engineers. Many of the qualitative statements of awardees particularly underline the need for institutional, systemic approaches to balance career with family, deal with problems resulting from low numbers of women in some disciplines and the stereotyping they may encounter, as well as more overt discrimination and harassment.

The relatively new ADVANCE program (institutional transformation component) at the National Science Foundation funded nine universities beginning in 2001 and funded a similar number in 2003 to develop model policies and practices to address institutional barriers and discouragements faced by female science, technology, engineering, and mathematics faculty. As co-PI of the ADVANCE grant at Georgia Tech, my colleagues and I struggle with appropriate policy and practice recommendations.

Building upon my research on POWRE and CBL awardees, the following policy areas seem significant for institutions to address:

Moving toward balance: The issue of balance—whether pertaining to the tension between children and work, dual career academic couples, or among competing demands within the work environment—surfaces time and again as an impediment to the attraction and advancement of women.

Widening paths to success: A lack of role models, feelings of isolation, and stereotyping are all barriers caused by low numbers. Understanding specific characteristics of gender differences at each institution such as whether paths narrow in certain places (departments), at certain distances (recruitment, tenure, promotion to full professor, prestigious award, influential committees) or at specific points (salary, space graduate student assignment) provides important information for beginning to address the problems.

Improving the environment: Words describing the environment encountered by women faculty in science and engineering departments include chilly, masculine, exclusionary, elitist, and hostile. Lack of collegiality and difficulty in gaining credibility among peers exemplifies a characteristic of a negative environment identified by POWRE awardees. The results of ADVANCE will provide a variety of models for improving the environment in academic science and engineering departments and transform faculty careers to be more attractive and supportive of all men and women, particularly those from previously underrepresented populations.

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Summary of Research and Intervention Strategies

Bernice R. Sandler, Senior Scholar, Women's Research and Education Institute

My work over the last 35 years has focused primarily on pragmatic ways to improve the status of women as faculty, staff and students in colleges and universities. In my writings and in my consulting with universities and colleges I have placed special emphasis on identifying new issues and providing very specific strategies for institutions and individuals to adopt. Almost all of my writings have included such strategies. In recent years I have written short papers (usually given as handouts and eventually to be added to my web site) about subjects such as what questions can search committees be asked so that they ensure that the applicant is "good" on women's issues; how to intervene when faculty and administrators observe sexual harassment; how to warm up the chilly climate; how women faculty are treated differently by students than male faculty; how faculty can warm up the climate for students; and subtle ways in which men and women are treated differently.

Over the years I have seen probably several hundred reports by campus commissions on the status of women and have about 50 of them in my office. They represent hours and hours of work on many campuses, building on the knowledge of experienced and new faculty and administrators, men and women. Although there are differences in the areas they cover – some cover staff and students, others do not – they are nevertheless remarkably similar in the recommendations that they present. They make similar recommendations concerning tenure, hiring, recruiting, family-friendly policies, etc. Essentially, there is a basic body of existing knowledge about what needs to be done on campus to improve the status of women.

No one knows what the rate of acceptance and implementation of recommendations has been. On some campuses the recommendations were presented and never responded to. At other campuses few, or several or many were implemented.

However, even on campuses where recommendations were implemented and changes have been made the *pattern* of women's employment has remained the same as it is on virtually all campuses, and indeed as it has been for more than forty or more years: the higher the rank, the fewer the women; the higher the prestige of the field, the department or the school, the fewer the women. At virtually every university and college, women, as a group, typically earn less than their male counterparts. Even with decent policies and practices inequities in recruiting, hiring, promotion, tenure and in other areas remain. How are we to explain this? What still needs to be done?

I strongly believe that the bulk of the knowledge we need in terms of recommendations of what to do on a campus to improve the status of women is already known. There are three areas on which I am focusing: empowering women to participate in the campus political process in order to translate the many recommendation into action; providing women with individual strategies to deal with ways in which they may be treated differently; and exploring what other factors may be at work that limit women's opportunities, especially the evaluation process when women apply for positions and when they are considered for promotion and/or tenure..

1. *Empowering women to translate policies and recommendations into action.* Recommendations and policy changes do not happen because they are "right." It is helpful to be "right" but it is perhaps even more important to understand and become part of the political process that makes it possible for institutions to change for the better. What do women (and men) need to know about how institutions function? What can be done to increase the possibilities that recommendations are adopted? How does one "move" an "immovable" institution?

There are four essential elements of change (somewhat oversimplified):

- Increase awareness of the problem (no one turns over in bed if they are comfortable; the task here is to make the powerful people somewhat uncomfortable so that they recognize the need for change).

- Provide proposed solutions. (We already have most of these solutions on hand.)
- Press for adoption. Who is the person or persons who make the necessary decisions to adopt a new policy. What kinds of influence are they subject to? What is the decision-making process? How can we intervene in this?
- Monitor the implementation of the solution to see if it works, are there unintended consequences, what fine-tuning is needed, etc.

The question, in part, is how do we educate women about the political process so that they can have a greater impact on campus policy and programs? How do we strengthen the political participation of women on campus? (Because much campus change emanates from committees, I have written one paper on "Empowering yourself as a committee member" which includes strategies that help get recommendations from committees adopted.)

2. Providing women with individual strategies to respond to the ways in which they may be treated differently. Women are typically treated differently in many subtle and sometimes overt ways although they may not always recognize that they have been treated differently (one paper I wrote identifies about 50 ways in which women are treated differently). What does a woman do if she make suggestions at faculty meetings and someone else gets the credit for her suggestions? What can she do if her male colleagues have lunch with each other but never with her? What should she do if she raises her hand at meetings but is rarely called upon? How can she react if someone tells a sexist joke or makes a sexist remark? How should she respond if a colleague or administrator engages in sexually harassing behavior?

Several of the papers I have written provide a wide array of strategies which women can use to respond to differential treatment.

Although true institutional change consists of policy and programmatic change and implementation, individual women nevertheless need to be able to identify ways in which they are being treated differently and how to respond.

3. What other factors may limit women's opportunities? The increasing interest in how policies and practices affect women faculty as members of families is one much-needed approach. Certainly to the extent that women's careers are affected by their family role, this new focus can be of much help. Some of my work in the past has focused on family issues and how policies and practices affect family members. One of my fantasies was to take 1-3 institutions and examine every policy and practice for its impact on all family members, whether they be parents, adult children of older parents, siblings, etc. Indeed, everyone on a campus is a member of a family and family life is affected by all kinds of policies. For example, even something as innocuous as a college calendar can cause difficulties for families if spring break for the institution is different from spring break in the local school system.

There is one major area which I believe has been largely overlooked in the exploration of factors which might account for the slow progress of women on campus and elsewhere. That is the general devaluation of women in our society and the way in which devaluation affects women on campus.

There have been numerous research studies which a set of something, such as pictures of works of art or a set of articles are given to two groups to rate. Each article, for example, has either a male or female name attached to it and the gender of the author is switched for each group. What is consistent about this line of studies is that when an article has a male name attached to it, it gets a higher rating from women *and* men, than when the same article has a female name attached to it.

Even more telling are several studies by Rhea Steinpreiss, at the University of Wisconsin at Milwaukee. In one study she sent identical vitae to faculty members in psychology departments. Half the time the name of the vita was "Brian Miller" and half the time the name was "Karen Miler." Participants were asked if they would hire the applicant, tenure the applicant and what starting salary they would offer. Male and female faculty were very similar in how they ranked the applicant. Brian Miller was more likely to be "hired" than "Karen." From this and other research it is not unreasonable to conclude that although most men and women may hold egalitarian beliefs, those beliefs do not guarantee that they will be able to

impartially evaluate others, and that women as likely to show gender bias in evaluation as are men. For example, participants who received Karen's vita in the study were four times as likely to write "cautionary" comments in the margins of their questionnaire, (such as "I would need to see evidence that she had gotten these grants and publications on her own") than those who received "Brian's" vita.

One can see the devaluation of women, in an incident reported to me by a member of a promotion and tenure committee. A man's committee experience was described as follows:

He has served on two departmental committees and on *even* one institution-wide committee.

Later in the day, a woman's committee experience was described this way:

She has served on two departmental committees but on *only* one institution-wide committee.

I strongly believe that many of the ways in which women are treated differently occur because of devaluation. Women receive less eye contact; are called by name less often; receive less praise, less criticism and less feedback; are less likely to receive mentoring and encouragement; are more likely to be asked factual question while men are more likely to be asked open-ended "thinking" questions, etc. , because they are devaluated by everyone else. Women and men, working in the same department, even at the same job, have very different experiences.

I have in recent years been focusing on how women are evaluated by their peers, supervisors, and recruiting and promotion and tenure committees. I have also served as an expert witness in tenure cases (as well as in sexual harassment cases) which have given me a comprehensive view of how the process often works to women's disadvantage, and how women are often treated differently in the evaluation process than their male colleagues.

How to make men and women aware of how the devaluation of women affects their own behavior and how they evaluate women candidates for hiring, promotion and tenure is a major task which had not been addressed by any of the campus studies that I have seen. Search committees as well as Promotion and Tenure Committees need specific information and strategies to minimize devaluation. If we are to help women succeed and survive in academe we will need to deal directly with the problem of devaluation.

Kimberlee A. Shauman, Department of Sociology, University of California Davis

*My primary research in the area of gender equity is a collaborative project with Yu Xie (University of Michigan, Professor of Sociology) that examines gender stratification in science and engineering occupations. This project concluded with the publication of our book, *Women in Science: Career Processes and Outcomes* (Harvard University Press) in the fall of 2003. More recently, I have begun a collaborative data collection effort with Debbie Niemeier (University of California, Davis, Professor of Civil Engineering Professor) aimed at describing the representation of men and women among department chairs across all academic disciplines and sex differences in the experience of that administrative position. I briefly describe these research projects below.*

Women in Science: Career Processes and Outcomes

In this book we present the first systematic examination of gender differences in the science and engineering career trajectory throughout the life course: from middle school through the career years. Adopting a life course perspective to the analysis of a career trajectory, we explore both the early life course processes of selection into and out of the science educational track, as well as the stratifying influences that operate after entry into the science labor market. With detailed statistical analyses of data drawn from seventeen nationally representative datasets, this book provides a systematic and updated account of where and why women fall behind men in the preparation for and development of scientific careers.

We begin with an assessment of the extent of gender differences in mathematics and science achievements in middle and high school and their impact on gender differences in subsequent participation in science education. We then examine sex differences in postsecondary educational paths leading to a bachelor's degree in science or engineering and the subsequent career paths that follow degree attainment. In the second part of the book, we focus on sex differences in the labor force experiences of practicing scientists. We first provide an overview of sex differences in labor force outcomes such as employment, earnings, and promotion before delving into detailed analyses of three specific topics where consequential gender differences are evident: geographic mobility, research productivity, and the experience of immigrant scientists in the U.S. labor market.

Throughout the book, we attempt to analyze the science/engineering career trajectory in its entirety. Our analyses focus on specifying the causal influences of prior experiences on later career outcomes and the interactions of the multiple domains of an individual's life such as career and the family. We accomplish this by relying on extensive statistical analysis of longitudinal data and, in places where true longitudinal data are lacking, "synthetic" cohorts constructed through piecing together information from various data sources pertaining to different periods of the life course.

Our empirical results do not support many popular explanations for the underrepresentation of women in science, such as those that attribute the relatively low participation of women in science education to gender differences in achievement and coursework and the low supply of women in the science and engineering labor force to lack of persistence in the relevant college majors. Instead, we find that the causes are complex and vary across educational and career stages. Most notably, our findings suggest that gender inequality in family roles remains a significant roadblock to women's further progress in science and engineering careers, as marriage and parenthood continue to benefit men but disadvantage women. The book is an important contribution to the women in science literature and to the more general literature on gender stratification in education and the labor force.

Notable findings from the book:

- Gender differences in math achievement favor boys, but the magnitude of the differences has declined significantly over time; even at their greatest level, gender differences are not large (Chapter 2, pp.37-38). However, girls are significantly less likely than boys to be among the highest achievers on standardized math and science tests (Chapter 2, p.39).

- Gender differences in the likelihood that a high school senior expects to major in science or engineering in college cannot be attributed to gender differences in math course participation or achievement (Chapter 3, pp.71-72).
- Entering a science/engineering major during college after expecting to pursue a non-science/engineering major is the most common route to a science/engineering baccalaureate among women (Chapter 4, p.83). Also, after the transition from high school to college, young women are as likely as young men to persist to degree attainment in a science/engineering major (Chapter 4, p. 86).
- Gender differences in career paths following the completion of a bachelor's degree or a master's degree in science/engineering are relatively small (Chapter 5, pp.113-114; Chapter 6, p.125).
- Among recipients of a bachelor's or a master's degree in science/engineering, married women with children have low rates of participation in the labor force or graduate education (Chapter 5, pp.111-113; Chapter 6, p.122).
- There is a clear and persistent pattern in which marriage and parenthood exacerbate gender differences in outcomes such as employment, earnings, and promotion. Gender differences among unmarried scientists are either small or nonexistent, but married women experience large disadvantages relative to men, especially if they have children (Chapter 7, pp.143-146).
- Parenthood limits women scientists' migration significantly more than that of men scientists. We show indirectly that the greater geographic mobility among men is probably due to their wives' lesser labor force commitment and greater investment in childcare, especially when the children are young. Women scientists' geographic mobility is restricted significantly when their children are young, a period that is likely to coincide with the formative years of their careers (Chapter 8, pp. 170-172).
- Gender differences in publication productivity among academic scientists has declined significantly over the past decades (Chapter 9, pg. 176), and such differences are due to gender differences in personal background characteristics, structural positions, and facilitating resources (Chapter 9, pp.182-183).
- Immigration works to increase women's representation in the biological, mathematical, and physical sciences (Chapter 10, pg.197). Immigrant women scientists, however, appear to face more impediments to success than do native-born women. In particular, gender differences in rates of promotion are much greater among immigrant scientists than among those who are native-born. Immigrant women are promoted at a rate that is less than a third as high as the rate for immigrant men (Chapter 10, pg. 199).

Stepping up the Academic Ladder: Examining the Progress of Women as Department Chairs

This project is the first systematic effort to collect data about the characteristics of the job of department chair and the scholars who assume that responsibility. The lack of data on the representation of women among department chairs, the correlates of their attainment of that position and their experiences in fulfilling such a leadership role represents a significant gap in our knowledge about gender equity in academia. Experience as a department chair is widely seen as a prerequisite for other positions of leadership and often provides the successful chair with a prominent voice whose influence long outlasts the tenure as chair. Sex differences in access to such leadership positions may handicap the ability of individual women scholars to assume and/or to successfully execute higher-level administrative positions and, therefore, the pursuit of gender equity in the academy more generally.

A two year (2002-2004) grant from the National Science Foundation ADVANCE Leadership Program supported the administration of a survey of department chairs at universities classified as Research I (R1) institutions by the Carnegie Foundation and/or belonging to the American Association of Universities (AAU). The survey collected information about the institutional process by which a department chair is appointed, the responsibilities of the chair, personal feelings about preparedness for the position and success in the role, and background information about education, career achievements and demographic information. The survey was fielded to department chairs in science and engineering departments during the 2002-2003 academic year and to chairs of non-science departments during the 2003-2004 academic

year. The complete database includes information from over 2,600 department chairs. Preliminary analyses of the survey data are currently under way. These data will support a series of articles that (1) examine the representation of women and racial/ethnic minorities among departmental chairs across both science and non-science disciplines, (2) describe the structural correlates of differential access to such positions, and (3) describe differences in the experiences of those who serve as department chairs.

Preliminary findings:

- In 2002 , women held 2 percent (15 out of 754) of the department chair or head positions in R1 and AAU university engineering departments.
- In 2002 , women held 4.6 percent (26 out of 566) of the department chair or head positions in R1 and AAU university math and physical science departments.

Executive Summary

Gerhard Sonnert

My primary interest has been in research rather than intervention, and, in terms of career stages, I have looked at postdoctoral and later phases as well as at the college level. (My focus has been on the sciences, not on all fields of higher education). The Project Access Study, which I conducted with Gerald Holton, examined gender differences in the careers former postdoctoral fellows who had received a fellowship from the National Science Foundation (NSF) or the National Research Council (NRC). Currently, I am collaborating with Mary Frank Fox of Georgia Tech in a study of programs for women undergraduates in the sciences.

I. Thinking about science careers

Here are some ways I have found useful in thinking about science careers and about gender differences in career outcomes.

1. Robert Merton's concept of the accumulation of advantages and disadvantages over the course of a science career provides valuable insights. It also holds a lesson for potential interventions: It appears unlikely that a "magic bullet" could be found that solves all problems of women in science entirely. Rather, small effects and micro-inequities are important, as they can add up.
2. Cole and Singer's kick-reaction model shows a concrete mechanism of how the accumulation process might work. According to this model, a science career consists of a sequence of positive or negative kicks and of advantageous or disadvantageous reactions. Feedback loops represent the accumulation of advantages and disadvantages; that is, positive kicks increase the possibility of future positive kicks, and so on. Thus, if women, as a group, have an even slightly lower probability of positive kicks (or higher probability of negative ones) or a slightly lower probability of advantageous reactions (or higher probability of negative ones), the average career paths will diverge considerably in the long run.
3. The kick-reaction model also makes it possible to represent a useful distinction between two major sources of gender-specific differences in the characteristics and outcomes of science careers. One possible source is a gender bias in the opportunity structure. We have called this the deficit model—in it, women's access to opportunities is restricted; women are treated differently and therefore have collectively worse career outcomes. In the difference model, women act differently (and various sources of such a difference have been hypothesized in the literature). The kick-reaction model elucidates how the deficit model (influencing kicks) and the difference model (influencing reactions) can work in concert.
4. The accumulation processes may differ in different career stages. For instance, one might ask whether women scientists who did well at earlier career stages pass a threshold beyond which they proceed on equal footing, collectively, with comparable men, or whether they hit a glass ceiling that makes it harder for them than for their male counterparts to reach the top of their profession.

II. Postdoctoral fellowship and beyond

Our evidence from Project Access mostly supported the glass ceiling hypothesis, especially in fields outside biology. It is therefore advisable for policy interventions to address the "top end" of later career stages.

We also found that the connections between marital and parental statuses and career outcomes are much more complex than often imagined. These statuses present not only restrictions for women scientists (as commonly understood), but also opportunities.

III. Undergraduates

The proportion of women among majors and bachelor recipients in biology, the physical sciences, and engineering was positively correlated with the proportion of women among the faculty. This is consistent with the notion that the presence of women faculty boosts the participation of women students in the sciences

A small but pervasive gap was found in cumulative GPA: Women students tended to have higher GPA scores than did men students. One of the causes for that gap may lie in differences in self-selection. Women students might embark on careers in male-dominated fields, such as the sciences, only if they consider themselves particularly well-prepared or talented. In addition, they might take their studies more seriously and work harder. Again, the size of this gap was found to be correlated with the proportion of women among the faculty. The women students' GPA advantage was smaller when more women faculty members were present. The gap might be interpreted as a sign that women students feel as if they are "swimming upstream" when they participate a field that is non-traditional for women. A strong representation of women on the faculty may make the field look more like a "normal" field for women, which may affect women's self-selection and attitudes.

Both these results underline how different career stages are interconnected.

It is also my preliminary impression from this ongoing study that residential programs and living and learning communities of women students work are beneficial.

IV. Final thought

In policy discussions, one sometimes hears alternative goals being set up: "Changing women to fit science, or science to fit women." This may not be an alternative, as the two processes work at different time scales. There is near-universal consensus that discriminations of the deficit-model type should be eradicated, but it is a more controversial question to what extent difference-model type elements should be accommodated through structural changes. Furthermore, we found a high degree of naiveté about the dynamics of science career in the Project Access study. A good understanding of the currently effective dynamics is necessary for making informed choices.

What We Can Learn from Computer Science's Differences from other Sciences

Ellen Spertus, Mills College

Like many fields with "science" in their name, computer science isn't really a science. In many ways, it has more in common with engineering. Both qualitatively and quantitatively, it is different from any other science or engineering field. In most of the disciplines discussed at the workshop, the percentage of female students has been increasing, while the percentage of female faculty has not. In computer science, the reverse is true. This paper reviews the data and suggests some possible theories.

Decline of women earning bachelor's degrees

As Figure 1 shows, the percentage of bachelor's degrees in computer science going to women has been consistently lower than in other scientific fields and higher than in engineering [NSF 2004]. The peak occurred in 1984, when 37% of computer science bachelor's degrees went to women. While other fields of science and engineering have increased or at least maintained their female bachelor's degree production since 1984, computer science showed a marked decline. In 2000 (the most recent year for which data is available), 28% of bachelor's degrees in computer science went to women, a decline of nearly one-third from the 1984 peak. Women's underrepresentation is even greater at top engineering schools, such as MIT, where computer science had the smallest proportion of women for any undergraduate program, including those in engineering [MIT 1995].

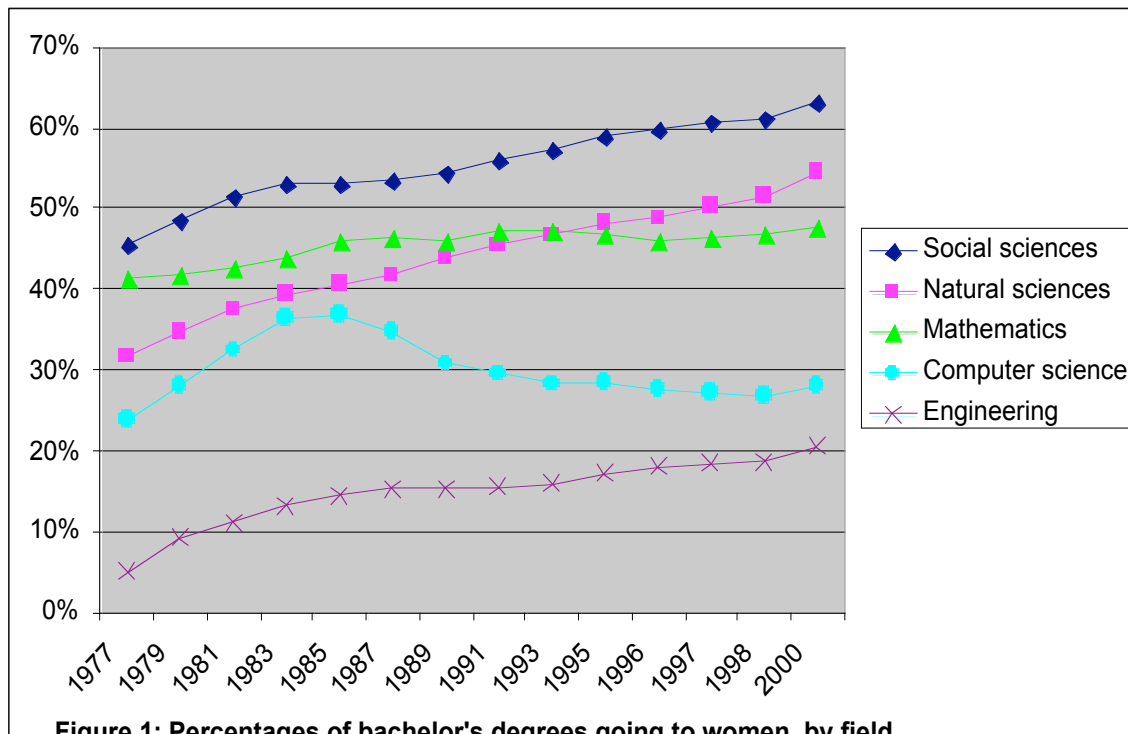


Figure 1: Percentages of bachelor's degrees going to women, by field

There are many theories as to why women's participation in computer science has declined since 1984 [Gürer & Camp 2002]. One theory is the rise of the personal computer. Before 1980, few people had access to computers at home or in K-12 schools. Thus, young men and women were equally inexperienced with computers when they entered college. Since 1980, computers have become common in (some) schools and homes, where they are disproportionately used by boys,

giving them an advantage in introductory college computer science courses [Gürer & Camp 2002, Margolis & Fisher 2001].

Another factor is “The College of Engineering effect”, in which the percentage of female students decreased as computer science departments were moved from science to engineering divisions [Camp 1997], consistent with Figure 1 above. Similarly, in the public’s mind, computer science, more than any other academic discipline, became associated with antisocial male misfits [Gürer & Camp 2002, Margolis & Fisher 2001].

Increase in female PhDs and faculty

Just as the “pipeline” metaphor does not describe women’s participation in the other sciences (with increasing degrees failing to lead to increasing faculty), it fails in computer science, although in a happier way. While women’s undergraduate enrollment has decreased or stagnated, the percentage of women earning PhDs and joining the faculties of research universities has increased.

Figure 2 [CRA 2005] shows the percentage of computer science degrees awarded to women at the bachelor’s, master’s, and PhD levels. For decades, the higher the degree, the fewer women; however, since 1997, a greater proportion of master’s degrees than bachelor’s degrees were awarded to women. Observe too that PhD representation has been rising consistently, if unevenly, over time.

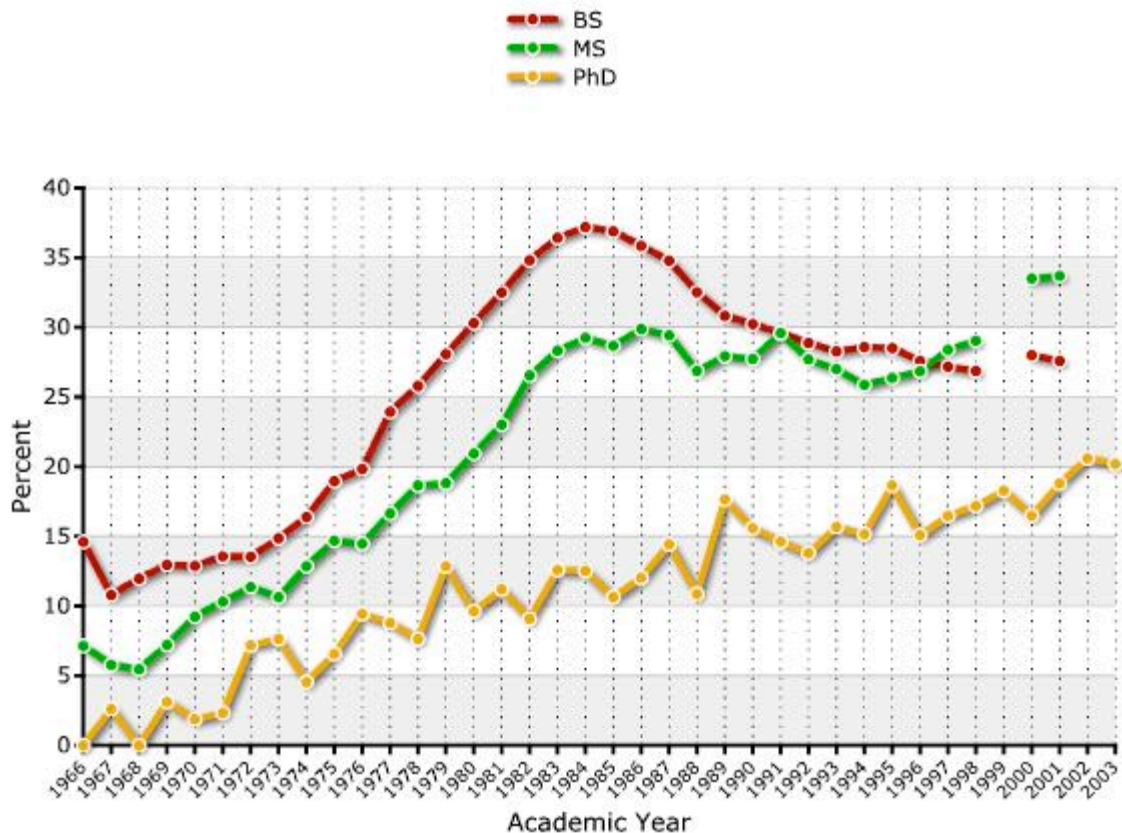


Figure 3: Proportion of computer science degrees granted to women.
Reprinted with permission [CRA 2005].

Figure 3 shows the increase in tenured and tenure-track faculty in PhD-granting computer science and computer engineering departments in the United States and Canada.

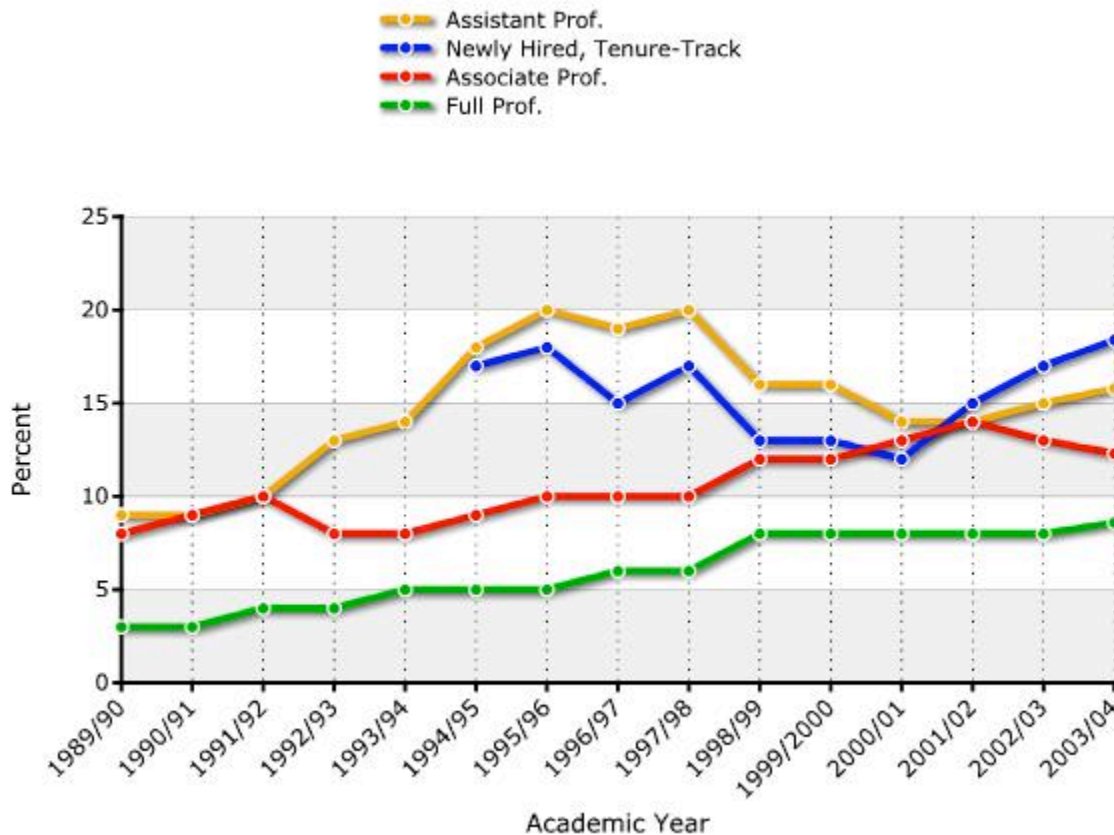


Figure 3: Percentage of computer science and computer engineering faculty who are female. Reprinted with permission [CRA 2004].

Why did women make gains at the faculty levels after and while losing ground at the undergraduate levels? In the following section, I offer some preliminary speculations.

The “Tech Boom” hypothesis

There was a peak in PhD (Figure 2) and faculty (Figure 3) representation during the mid-nineties, when the Internet boom took place, during which some graduate students and faculty temporarily or permanently left academia for industry. Perhaps male computer scientists were more likely than their female peers to seek greener pastures. On a personal note, I completed my dissertation on Internet search during this period. I saw many of my male peers work at or found start-ups, either instead of or while completing graduate school. (I did not have enough female peers to be able to comment on them.) When I looked for a faculty position in 1997, there were many more jobs available than people to fill them, both because departments were growing and because existing and potential faculty were choosing industry instead.

The improved academic environment hypothesis

During the same period that female undergraduate enrollment was increasing, female computer scientists and their male allies were aggressive in improving the environment for female graduate students and faculty. The watershed event occurred in the early 1980s, when female MIT graduate students and research staff got together, shared their experiences, and wrote a highly influential report, entitled “Barriers to Equality in Academia: Women in Computer Science at MIT” [MIT 1983], which is still being discussed more than twenty years later (see, for example, <http://www.cs.washington.edu/homes/lazowska/mit/>). On another personal note, this report,

shown to me when I started doing computer science research at MIT, was a major factor in improving my view of women as computer scientists, as it demonstrated that their unequal representation did not arise on a level playing field, as I had presumed.

Another watershed event was Anita Borg's founding of the "Systers" email list [Systers 1993]. It began in the women's bathroom of an operating-systems conference in 1987 where the few female attendees met and recognized the benefits of forming an online community, and now has more than 2000 members. Otherwise isolated women could get practical information, such as how to manage a "two-body" job search (in which a woman and her partner were both seeking academic jobs) or issues in the timing of motherhood. I found Systers valuable not just for practical information (such as what to wear when presenting a paper at my first conference, a topic on which my otherwise excellent male advisor was useless), but for changing my perception of female computer scientists (and myself) from anomalous freak to abundant community. It also greatly influenced a report I wrote, entitled "Why Are There So Few Female Computer Scientists" [Spertus 1991].

Another major player has been The Computing Research Association (<http://www.cra.org>) and its Committee on the Status of Women in Computing Research (<http://www.cra.org/Activities/craw/index.php>), which have led many excellent programs, such as the Distributed Mentor Program, which provides undergraduate women with summer research opportunities helpful for preparing themselves for graduate school, and offers highly effective career workshops to graduate students and faculty. (The Computing Research Association is the source for much of the data [CRA 2004, CRA 2005] and one of the papers [Borg 1993] I cite.)

Conclusions

Just as increasing female undergraduate degree production in other fields does not guarantee increases in the professoriate, declining undergraduate enrollment does not preclude growth at the PhD and faculty levels. While computer science continues to struggle with its failure at attracting and retaining undergraduate women, its successes at later stages should be understood and replicated in other scientific and engineering fields where possible.

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The Power of Ideas: Feminist Theory and Social Science Research as Resources for Transforming the Academic Science Work Environment

Abigail J. Stewart, University of Michigan

For many years researchers and administrators who care about the situation of women and science have regularly bemoaned the “chilly climate” for faculty and students. This concern has grown more intense as observers have noted that over the past thirty years, when other fields have seen dramatic change in the demographics, many fields in science and engineering have hardly changed at all, particularly in faculty composition. At the University of Michigan we have drawn ideas from interdisciplinary women’s studies and from social science research to develop interventions that seem to be allowing us to make some headway on this problem.

Funded by the NSF ADVANCE Institutional Transformation program, a committee of distinguished scientists and engineers on the faculty of the University of Michigan has studied the social science literature on cognitive bias in evaluation of performance, and has been talking with their science faculty colleagues about it. This committee (on Science and Technology Recruiting to Increase Diversity and Excellence, or STRIDE) is particularly concerned about the impact that gender schemas and unconscious biases have on judgments of job candidates and of women’s performance as scholars, teachers and community members. They have selected social science articles for their colleagues to read, and have developed a recruitment handbook, a fact sheet about retention, and three different kinds of presentations—two in a lecture format and one in a longer workshop format. They work together in interdisciplinary teams to present these research findings, along with the information that conscious awareness and a variety of very specific practices can minimize the likelihood of biased judgments. Even after only two years, twice as many offers as before are being made to women in science and engineering fields, and twice as many women are accepting positions! This year, because of the prior success, STRIDE has been asked by three deans (of Medicine, Engineering and Literature, Science and the Arts) to offer workshops for those faculty chairing faculty search committees, in an effort to create a cadre of senior faculty well-versed in fair and effective recruitment and retention strategies, and able to represent the rationales for those strategies to their colleagues.

In another effort at Michigan, an interactive theater troupe (the CRLT Players) performs brief sketches depicting gendered interaction dynamics and gender stereotypes that can influence faculty meeting discussions of candidates, mentoring of women junior faculty by senior faculty (particularly men), and discussions of candidates by tenure committees. In post-sketch interactions with the troupe, actors remain “in role” and explore with faculty audiences the motivations and reactions of the various characters. In depicting their characters the actors draw not only on the social science literature, but on the research into Michigan’s climate conducted at the outset of the ADVANCE project. Many faculty have reported that they do notice connections between what they see in the sketches and what they see in their departments, and that they also pay attention to new things after the performances. CRLT Players attempt to encourage faculty audiences not only to develop new insights into what may sometimes happen in their departments, but also to develop new strategies for interacting with their colleagues.

Institution-level efforts at “consciousness-raising” advanced last year through the establishment of three high level committees, named by the President and Provost and chaired by three deans, to review institutional policies and practices around three large topics (recruitment and retention, evaluation, and family-related policies and career tracks). After a year’s deliberation, reports were issued from each committee, reviewed by the Provost’s council of deans, and implementation processes were initiated, tailored to the level of institutional policy implicated (college or university), and the type of remedy sought. This effort reflects the project’s recognition that a “system” perspective on the academy requires both institutionalization beyond science, and specific institutionalization via key academic practices.

Finally, the development of a positive “collective identity” among the women scientists and engineers has been deliberately encouraged and facilitated. In the long run, this group’s resistance to their own stigmatization and marginalization will be best ensured by their own commitment and activism on their own behalf. Social movement and social identity literatures provide useful insight into both the processes of transformation of stigmatized identities, and political mobilization.

Throughout our efforts we have drawn—more and less consciously and deliberately on the intellectual resources of interdisciplinary women’s studies, feminist theory and social science. We believe

we have learned that one important obstacle to transformation of the science climate has been a dearth of conceptual tools for understanding the self-perpetuating and systemic causes of its chilliness to women and other underrepresented groups. Fortunately those tools are close at hand!

Research description

Susan Sturm

October 27, 2004

Growing numbers of universities in the United States have undertaken gender and racial equity initiatives to achieve more inclusive institutions. They have formed gender commissions, undertaken data-driven inquiries, created processes for institutional analysis and ongoing deliberation, and implemented reforms as a result. These initiatives have been fostered by the actions of mediating institutions, such as the National Science Foundation and private foundations, research oriented non-governmental organizations, and professional and student associations. Universities have themselves formed informal associations to support and promulgate their efforts. They have used the internet and other forms of communication to share their work and learn from other institutions. Repeat players, both individual and institutional, are playing an important intermediary role across institutional domains as well. This work has sometimes been encouraged by the specter of coercive state power, such as through private litigation or regulatory agencies' investigation of university practices. My research documents and analyzes these simultaneous and, to some extent, linked developments to understand their implications as an approach to norm development, public problem-solving, and institutional transformation.

The Michigan and MIT gender equity initiatives are not a one shot gender equity program by a single institution. There is evidence that change is happening, at least to some extent, at an institutional and cultural level. Moreover, these initiatives are nested in an ongoing, multi-institutional practice arena involving other universities, mediating institutions, activists, and regulatory bodies. It offers the theory-in-practice of deliberative public problem solving driven by a combination of self-analysis, mobilization, cross-contextual comparison and institutional redesign.

This constellation of interventions offers a concrete example of the dynamics and mechanism that drive these new governance processes. First, the initiative institutionalizes accountable self-study that is generating information that otherwise would not be revealed about problems. Identification and disclosure of institutional problems proceeds in the face of strong incentives, some of them introduced by legality concerns, to avoid the problem. It occurs in no small part because of thorough-going participation in producing understanding of the problems by those affected and some of those responsible.

Second, the conceptual, structural, and strategic framework connects gender equity concerns with a range of related and underlying problems and values. Concerns about science are driving the initiative, without displacing the salience of gender. The problem definition and scope of the regime constructs and is in turn constructed by who is at the table, and is itself subject to scrutiny. Thus, the initial conceptual frame shapes and delimits who participates and how problems are defined, and the problems created by these conceptual boundaries are themselves questioned along the way.

Third, the initiative creates of new institutional spaces that are linked to and transformative of ongoing governance structures and processes. It fosters the development of mediating actors who enable translation, learning, and benchmarking across practice domains. It also creates experimental spaces that link governance systems, projects, and even regimes. These institutional spaces lie at the intersection of multiple governance and regulatory processes.

Fourth, the architecture of the initiative is itself creating spaces for mobilization of advocacy, leadership, and knowledge. It is also changing the context for the development, exercise, and redefinition of leadership. In so doing, the project acknowledges leadership as a significant

factor. But it avoids the tendency to treat leadership and mobilization as exogenous variables and instead treats them as crucial components of the implicit regulatory theory.

Fifth, the initiative grapples with the mechanisms that enable or prevent cross-institutional learning to occur. It builds on pre-existing institutional and interpersonal relationships and networks. It also develops and empowers mediating actors who are creating a context for universities to look to each other both for ideas and strategies as well as a benchmarks and incentives for change. This includes an explicit focus on developing and continually revising a common metric that permits comparison and learning. In this process, the participants are confronting the profound difficulties and challenges even as they move forward in that endeavor. They are doing so with an explicit focus on sharing learning and data.

Sixth, the gender equity project is incomplete and uneven in its implementation and scope, even as it shows signs of penetrating the fabric of the institution and its organizational field. This provides a concrete domain in which to develop criteria for evaluating when change is symbolic and when it is substantive, both within a particular institutional setting and across institutional settings.

Finally, law and rights continue to operate in contradictory ways: as a normative catalyst and floor and as an obstacle or ceiling. The gender equity initiatives operate on a separate track from affirmative action programs. Lawyers are not driving the momentum and are most often not at the table. Affirmative action and human resources professionals tend to play a marginal role or to be completely uninvolved. At the same time, for some types of problems and some actors, law is playing a catalyst role as well as one of institutionalizing new understandings that have sedimented through the process of inquiry.

At this stage, we have identified five analytical categories that seem to us to capture major mechanisms contributing to the formation of a gender equity regime: (1) functionally integrating gender equity and core institutional practice through embedded independence and accountable governance; (2) developing and legitimating mediating actors; (3) building in architecture for sustaining mobilization and leadership; (4) connecting knowledge and action, generating usable knowledge; and (5) linking domains of practice: horizontally, vertically, and across regulatory systems.

About the Participants

Constance Backhouse, B.A.(Man.), LL.B. (Osg. Hall), LL.M. (Harvard), LL.D. (honoris causa, Law Society of Upper Canada), F.R.S.C., holds the positions of Distinguished University Professor and University Research Chair at the University of Ottawa. She was one of the co-authors of *Breaking Anonymity: The Chilly Climate for Women Faculty* (Waterloo: Wilfrid Laurier University Press, 1995). Her *Challenging Times: The Women's Movement in Canada and the United States* (Montreal & Kingston: McGill-Queen's University Press, 1992), co-edited with David H. Flaherty, was named the "Outstanding Book on the Subject of Human Rights in the United States" by the Gustavus Myers Center. She is the co-author with Leah Cohen of *Sexual Harassment on the Job* (Englewood Cliffs, NJ: Prentice-Hall, 1981) and *The Secret Oppression: Sexual Harassment of Working Women* (Toronto: Macmillan of Canada, 1979).

Dr. **Robin E. Bell** is the Director of the ADVANCE program at the Earth Institute at Columbia University. Funded by the National Science Foundation, the ADVANCE program seeks to increase the recruitment, retention, and advancement of women scientists and engineers at Columbia through institutional transformation. Dr. Bell is also a Doherty Senior Research Scientist at Columbia University's Lamont-Doherty Earth Observatory, where she directs major research programs on the Hudson River and Antarctica. She has studied the mechanisms of ice sheet collapse and the chilly environments beneath the Antarctic ice sheet, including Lake Vostok. She has also led seven major aero-geophysical expeditions to Antarctica. After receiving her undergraduate degree from Middlebury College in Vermont, she built a 24-foot dory, which she sailed and rowed down the Hudson River past Lamont and Columbia on to Woods Hole where she worked for several years. Returning to the Hudson River Valley, she received her doctorate in marine geophysics from Columbia University. Presently, she is chair of the National Academy of Sciences Polar Research Board and Vice Chair of the International Planning Group for the International Polar Year.

Elizabeth S. Boylan is Provost and Dean of the Faculty, and Professor of the biological sciences at Barnard College. A developmental biologist and cancer researcher, Provost Boylan earned a Ph.D. in zoology from Cornell University and a bachelor's degree in biological sciences from Wellesley College. She came to Barnard from Queens College/CUNY in 1995 where she had been associate provost for academic planning and programs. While at Queens, she was involved in a University-wide program reform in science, engineering, technology and mathematics, and in secondary education. At Barnard she led the first systematic review of the College's general education requirements since the early 1980's, resulting in the implementation of new curricular requirements in 2000, and she has coordinated the planning and implementation of a number of major building projects, including renovation of the science facilities in Milbank and Altschul Hall. Provost Boylan was a moderator for the inaugural meeting of the Women's Investigator's Network of the New York Academy of Science, and serves on the University Relations Committee of the President's Council of Cornell Women which advises the Cornell administration on its policies regarding faculty and staff recruitment and advancement.

Sally Chapman attended Smith College in Northampton, Massachusetts, where she received her A.B., summa cum laude, in 1968. Her Ph.D. in physical chemistry was awarded in 1973 by Yale University. She did postdoctoral research at the University of California at Irvine, working with Prof. Don L. Bunker, and at U. C. Berkeley, with Prof. William H. Miller. She joined the faculty at Barnard College in 1975. Prof. Chapman's research in computational physical chemistry is in the area of molecular reaction dynamics. Prof. Chapman has spent sabbaticals at the Joint Institute for Laboratory Astrophysics in Boulder, where she had a Research Fellowship for Teachers, at Oxford where she worked with Prof. Mark Child, and at the University at Perugia, Italy. Her research has been funded by the Alfred P. Sloan Foundation, Research Corporation, the Petroleum Research Fund, and the National Science Foundation. Prof. Chapman was a member of the Advisory Committee for the Chemistry Division of the National Science Foundation from 1986 to 1989. She was a member of the American Chemical Society's Committee on

Professional Training from 1990 to 2001, and served as its Chair from 1995 to 1997. She was on the Advisory Board of the Petroleum Research Fund from 1990-1996, and was its Chair from 1997 to 2002. She is a member of the advisory board of COACH, the Committee on the Advancement of Women Chemists. Working with the ACS, she is the principal investigator in an NSF ADVANCE site visits project.

Donna Ginther is an Associate Professor of Economics at the University of Kansas. Prior to joining the University of Kansas faculty, she was a research economist and associate policy adviser in the regional group of the Research Department of the Federal Reserve Bank of Atlanta and held academic appointments at Washington University and Southern Methodist University. Her major field of study is gender differences in employment outcomes in academic labor markets. In 2004 Ginther received a grant from the National Science Foundation to continue this research. A native of Wisconsin, Dr. Ginther received her doctorate in economics in 1995, master's degree in economics in 1991, and bachelor of arts in economics in 1987, all from the University of Wisconsin-Madison. Dr. Ginther has published numerous articles and working papers on gender differences in academia.

Alice Hogan is Program Director for ADVANCE at the National Science Foundation. ADVANCE is designed to address the underrepresentation of women in academic science and engineering, particularly at the senior ranks. Ms. Hogan has worked with ADVANCE since its inception, first as Chair of the committee at NSF charged with design of the ADVANCE Program and then as Program Director. Prior to work with the ADVANCE Program, she was a senior program manager with NSF's Division of International Programs with responsibility for bilateral science and engineering grant programs with countries in the Asia Pacific region. She worked at the White House Office of Science and Technology Policy on a detail from the Foundation, and was responsible for coordinating science and technology efforts under Vice Presidential Commissions with Egypt and Ukraine, and for advising on science and technology programs with China and with the OECD. Prior to joining NSF in 1986, she worked in the National Oceanic and Atmospheric Administration in a variety of professional positions involving international operations, policy and research, including the development of the first cooperative projects between NOAA and China in 1979. Ms. Hogan is a Fellow in the Women and Public Policy Program at Harvard's Kennedy School of Government. She holds degrees from Cornell University and the University of Michigan.

Sandra Morgen is Director of the Center for the Study of Women in Society and Professor of Anthropology at the University of Oregon. Her most recent books include *Into Our Own Hands: The Women's Health Movement in the U.S., 1969-1990* (Rutgers 2002) and an edited book (with Frances Fox Piven, Joan Acker and Margaret Hallock), *Work, Welfare and Politics* (University of Oregon, 2002). Given her theoretical interest and expertise in understanding women's relationship to the State, her work to promote women's research and research on women and on the intersection of gender, race, and class is informed by her scholarship, as well as by her long years of experience working for institutional changes in higher education.

Dr. **Donna Nelson**, is an Associate Professor of Chemistry at the University of Oklahoma. She took her BS in Chemistry at the University of Oklahoma and her Ph.D in Chemistry at the University of Texas at Austin. She did her postdoctorate at Purdue University with Herbert C. Brown during 1980 - 1983 and joined the University of Oklahoma in 1983. She was a Faculty Fellow in the OU Provost's Office 1989 - 1990. She has been recognized for her work, most recently via a Sigma Xi Faculty Research Award (2001), a Ford Foundation Fellowship (2003), a Guggenheim Award (2003), and a National Organization for Women "Woman of Courage" Award (2004). For more information, visit her website.

Professor **Stephanie Pfirman** chairs the Department of Environmental Science at Barnard College, co-chairs the Education Subcommittee of the Earth Institute at Columbia University, and is one of the co-PIs of the ADVANCE grant to the Earth Institute. Current research interests include environmental aspects of sea ice in the Arctic and interdisciplinary scholarship by women.

As the first chair of the National Science Foundation's Advisory Committee for Environmental Research and Education, Pfirman oversaw analysis of a 10 year outlook for environmental research and education at NSF. Pfirman also chaired NSF's Office Advisory Committee to the Office of Polar Programs. Prior to joining Barnard, Pfirman was senior scientist at Environmental Defense and co-developer of the award-winning traveling exhibition "Global Warming: Understanding the Forecast" developed jointly with the American Museum of Natural History. Pfirman received her Ph.D. from the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program in Oceanography and Oceanographic Engineering, Department of Marine Geology and Geophysics, and a BA from Colgate University's Geology Department.

Deborah Rolison received a B.S. in Chemistry from Florida Atlantic University in 1975 and a Ph.D. in Chemistry from the University of North Carolina at Chapel Hill in 1980 under the direction of Royce W. Murray. Dr. Rolison joined the Naval Research Laboratory as a research chemist in 1980 and currently heads the Advanced Electrochemical Materials section. She is also an Adjunct Full Professor of Chemistry at the University of Utah. Her research at the NRL focuses on multifunctional nanoarchitectures, with emphasis on new nanostructured materials for catalytic chemistries, energy storage and conversion, biomolecular composites, porous magnets, and sensors. She is the principal inventor of composite aerogels; electrified microheterogeneous catalysis; a process to electrodesulfurize carbons and coals under mild conditions; and 3-D nanowired mesoporous architectures.

Sue Rosser received her Ph.D. in Zoology from the University of Wisconsin-Madison in 1973. Since July 1999, she has served as Dean of Ivan Allen College, the liberal arts college at Georgia Institute of Technology, where she is also Professor of History, Technology, and Society. From 1995-1999, she was Director for the Center for Women's Studies and Gender Research and Professor of Anthropology at the University of Florida-Gainesville. In 1995, she was Senior Program Officer for Women's Programs at the National Science Foundation. From 1986 to 1995 she served as Director of Women's Studies at the University of South Carolina, where she also was a Professor of Family and Preventive Medicine in the Medical School. She has edited collections and written approximately 100 journal articles on the theoretical and applied problems of women, science, and technology and women's health and authored nine books.

Bernice R. Sandler, Senior Scholar at the Women's Research and Education Institute has published more than one hundred reports about women on campus, including the first reports on the chilly climate for women faculty, how men and women are treated differently in the classroom, campus sexual harassment, gang rape, and campus peer harassment. She is well-known for her expertise on programs, policies, practices and strategies and has given over 2500 presentations. In the 1970's she filed charges of sex discrimination against more than 250 institutions. The *New York Times* dubbed her "the godmother of Title IX" for her work in the development and passage of Title IX.

Kimberlee A. Shauman is an Assistant Professor of Sociology at the University of California, Davis. Her main areas of interest are social stratification, family and kinship, demography, sociology of education, and quantitative methodology. Her research focuses on gender differences in career development and outcomes with particular attention to the causal effects of family characteristics. She has recently published a book, *Women in Science: Career Processes and Outcomes* (co-authored with Yu Xie), that examines the underrepresentation of women in science from a life course perspective. She is currently studying the sex differences in the career causes and consequences of family migration and gender differences in the leadership of academic departments at research universities in the U.S. (with Deb Niemeier).

Gerhard Sonnert is a research associate in the Department of Physics at Harvard University. He received master's and doctorate degrees in Sociology from the University of Erlangen, Germany, and a Master's in Public Administration from Harvard University. One of his major research interests there has been the impact of gender on science careers. That research has resulted in

two books (both authored with the assistance of Gerald Holton): *Who Succeeds in Science? The Gender Dimension and Gender Differences in Science Careers: The Project Access Study*. He currently works with Professor Mary Frank Fox of the Georgia Institute of Technology on a nationwide study of programs designed to support women undergraduates in the sciences and engineering.

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