



An Experiment in Institutional Transformation

THE NSF ADVANCE PROGRAM FOR WOMEN AT THE
EARTH INSTITUTE AT COLUMBIA UNIVERSITY

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Following the Civil War, women in New York City began to clamor for advanced education at Columbia University. Although the professors of the classics felt that women in the classroom were a distraction, women were welcomed into geology, physics, and chemistry classes (Rosenberg, 2004). For almost thirty years, women learned, side by side with men, in geology classes until the School of Engineering—then one of the largest schools at Columbia University—determined that it was improper for women and men to conduct fieldwork together. The School enacted a ban on women in the later 1890s, a ban enforced until the height of the Second World War. Despite this deterrent, women continued to study geology at both Columbia College and Barnard College. The first woman to receive her Ph.D. in geology from Columbia University was Lea McIlvaine Luquer, who submitted a thesis in 1894 entitled, “The optical recognition and

economic importance of the common mineral found in building stones: The relative effects of frost and the sulphate soda tests on building stones.” In 1929, Katharine Fowler was the first woman to receive her Ph.D. from Columbia University based on major geological fieldwork studying anorthosites in Laramie, Wyoming. She conducted two summers of fieldwork with only a pistol and a dog as her field assistants (Figure 1); no man would accompany her to the field. Fowler later went on to map Sierra Leone and to teach at Wellesley College.

Opportunities for women in the geosciences grew with the creation of Columbia University’s Lamont-Doherty Earth Observatory (LDEO). The Observatory was founded in 1949 on a 125-acre Hudson River estate donated by Columbia graduate Florence Corliss Lamont upon the death of her husband, Wall Street financier Thomas W. Lamont. As Maurice Ewing and his

companions turned the estate house into a geochemistry laboratory and the swimming pool into a seismic vault, a small group of women—including renowned oceanographic cartographer Marie Tharp—were finding their niche at the Observatory. Women are prominent in the early photographs, but their

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Figure 1. Katharine Fowler, the first woman to receive a Columbia University Ph.D. in geology based on major geologic fieldwork, mapping anorthosites in Laramie, Wyoming in the 1920s. The pistol was considered necessary in her fieldwork to keep the rattlesnakes under control. Image from Polk and Tiegreen (2001). Reprinted with permission by M. Polk.

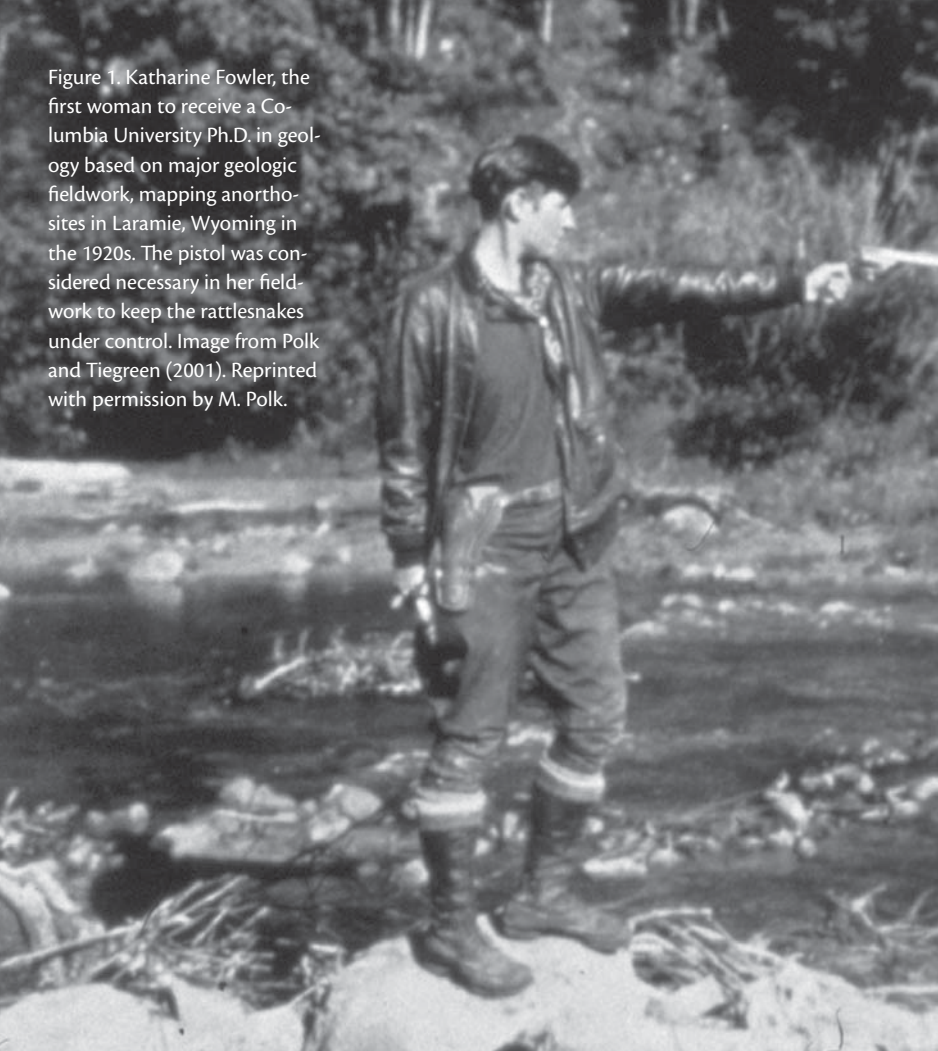


Figure 2. Ellen Herron securing the heat-flow probe on the deck of the R/V *Eltanin* during a cruise from New Zealand to Chile in 1965. This was the first Lamont cruise to permit women scientists. Image courtesy of Ellen Herron.



BOX 1. THE HISTORY OF WOMEN IN THE GEOSCIENCES AT COLUMBIA UNIVERSITY

- 1890s: Columbia School of Engineering bans women due to concerns about women working in the field
- 1894: Lea McIlvaine Luquer becomes the first woman to receive her Ph.D. in geology from Columbia University
- 1929: Katharine Fowler is the first woman to receive her Ph.D. in geology from Columbia University based on major geological fieldwork
- 1948: Lamont-Doherty Earth Observatory is founded
- 1965: Women first permitted on a Lamont cruise
- 1975: Ellen Herron becomes the first woman chief scientist on a Lamont ship
- 2000: The on-site childcare facility at Lamont opens its doors
- 2001: Lamont-Doherty Earth Observatory bestows the Heritage Award on oceanographic cartographer Marie Tharp, just a few weeks before her 81st birthday
- 2004: The Earth Institute at Columbia University (of which Lamont is a part) is awarded the National Science Foundation ADVANCE grant for institutional transformation

roles at the Observatory were limited to that of illustrators, human computers, and telephone operators. Renee Brilliant, a persistent young geologist, worked for several years testing pressure cases for cameras and installing land-based seismometers with Doc Ewing's wife Midge while the ship shot explosives offshore. Eventually frustrated with limitations on fieldwork and comments like, "women cannot wear pants in the field," Brilliant decided to pursue a different career path becoming a successful pediatrician in Rockland County.

Women were permitted on a Lamont cruise for the first time in 1965. Jessica Donahue and Ellen Herron, both married graduate students, sailed on the 60-day cruise on the *Eltanin* from Auckland, New Zealand to Valparaiso, Chile. An injury to one of the shipboard technicians allowed Herron to become the heat-flow technician, acquiring soldering skills and other practical training (Figure 2). Upon her return from the *Eltanin*, Herron would later write one of the early papers on mid-ocean ridge segmentation, re-

ceive her Ph.D., and eventually become the Observatory's only woman assistant director. In 1975, Herron returned to sea aboard the *Robert D. Conrad* research vessel, this time as the first woman chief

the graduate population. Since the early 1970s, the percentage of women post-doctoral scientists has grown from 0 to 38 percent, associate research scientists from 18 percent to 29 percent, and the

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By the late 1970s, the incoming graduate student population was consistently 40 percent women. By the mid 1980s, the institution was making great progress toward matriculating more women, with graduating classes of 30 percent women. Today the average population of graduating Ph.D.s is closer to 40 percent women. In the past 25 years, 96 women have graduated from Columbia with Ph.D.s in geology and geophysics (Figure 3). Box 1 provides a timeline of historical events of women in the geosciences at Columbia University.

This growth has not been limited to

tenured staff from 3 percent to 13 percent (Figure 4). While the Lamont research population has remained relatively constant over this same time period, the percentage of women has more than doubled from 10 to 22 percent.

LDEO has undergone significant change in other ways related to the presence of women. During the past thirty years, the institution has made maternity leave available to both research and teaching scientists, established an on-site daycare facility, and enacted a stop-the-clock policy that accommodates tenure-track women with children. Although the camaraderie among women graduate

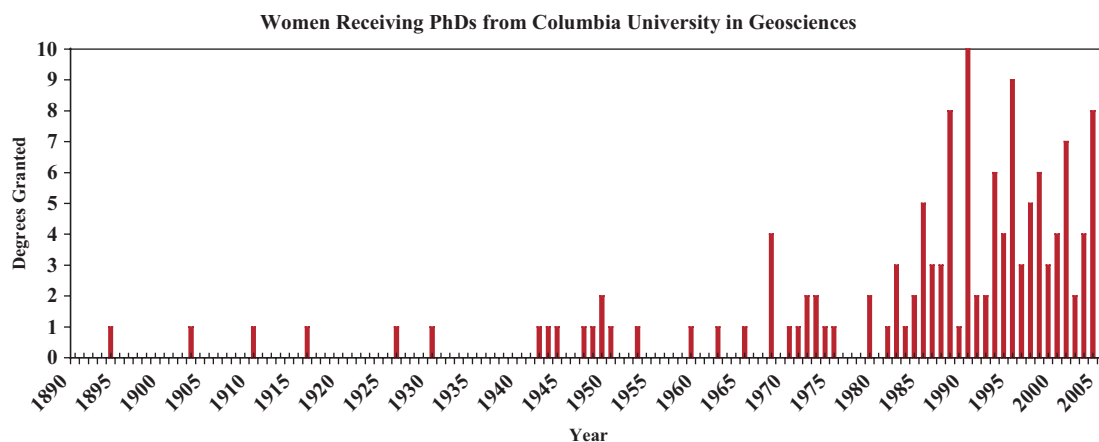


Figure 3. Number of Women granted Ph.D.s in geosciences at Columbia University from 1890 to 2005. This graphic shows the significant increase in women graduate students beginning in the 1970s and continuing through the present.

Percentage Women on the Lamont Research Staff

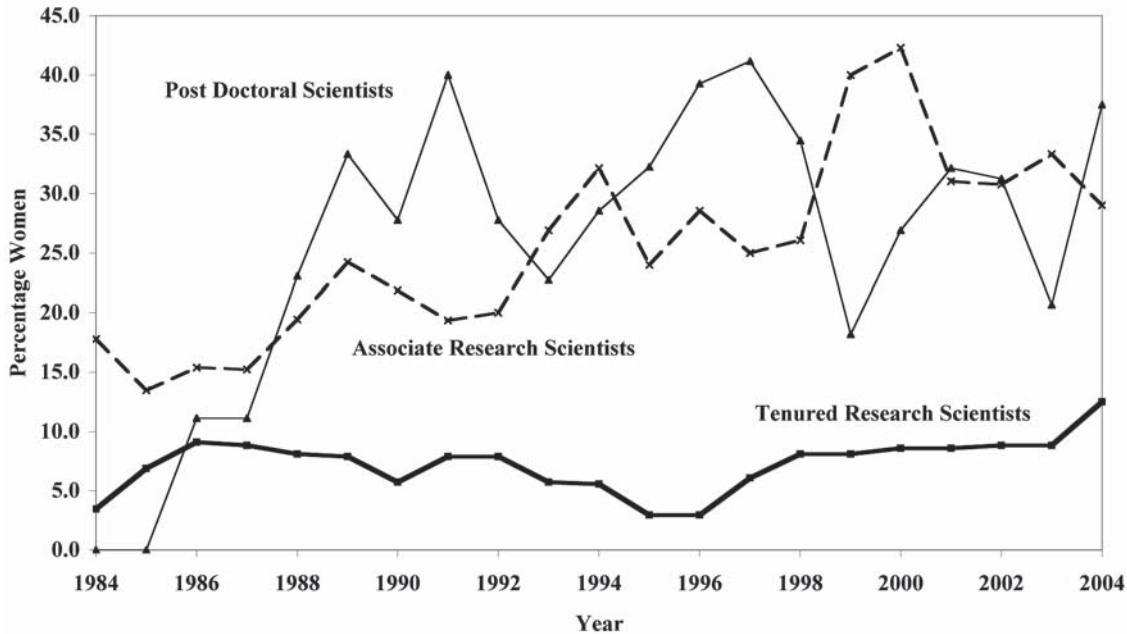


Figure 4. Percentage of women on the Lamont research staff. The research staff includes the research faculty who make up the majority of the scientists at Lamont (90). Although the Lamont research population has remained relatively constant over this same time period, the percentage of women has more than doubled from 10 to 22 percent. Tenured research scientists include research scientists, senior research scientists, and senior scholars.

students has been in place since Ellen Herron and Jessica Donahue first sailed on the *Eltanin* in the 1960s, there is now a vibrant community of women scientists at the Observatory. In addition, a number of Lamont alumnae now hold senior positions at major institutions including Scripps Institution of Oceanography and Woods Hole Oceanographic Institution. They are also full professors at research universities and liberal art colleges. Some of the other accomplishments of Lamont women include founding a petroleum service company, directing a major seafloor-imaging center, becoming a National Science Foundation (NSF) program manager, and being selected as an AGU fellow. Today, Lamont is the top school for women geoscientists in tenure-track positions at Ph.D.-granting institutions (Holmes and O’Connell, 2004).

MOTIVATION FOR AN EXPERIMENT IN INSTITUTIONAL CHANGE

Despite this progress, some challenges remain. There are now seven senior women scientists on the tenured staff at Lamont. This is a relatively recent jump: over the past two decades, the average number of women on the senior staff was only two. Of Columbia’s 26 Earth and environmental science teaching faculty members, there is only one woman. There have been no women among the six most recent external hires into this group. All of the leadership positions at Lamont are filled by men. To be sure, the absence of women in leadership positions is pervasive across the university. The administration of Columbia is exclusively white men, with the exception of the Vice Provost for Diversity and a single Dean. These conditions are not

unique to Lamont, Columbia, or the geosciences. A study of doctorate recipients across the country found that from 1979 to 1995, men had a steady 14-percentage point advantage over women in obtaining faculty positions (Long, 2001).

The findings of *A Study On The Status of Women Faculty In Science* at MIT (Massachusetts Institute of Technology, 1999) transformed the issue of persistent gender inequity in academia into a front-page news story. The findings documented frequent experiences of marginalization among women faculty across MIT quantified by disparities in resource allocation, access to leadership roles, and exclusion from high-level decision-making processes (MIT, 1999). In addition to increasing public awareness of the problems faced by women scientists, the MIT study also focused attention on the importance of using the

institution, rather than the individual, as the unit of analysis when evaluating the status of women in science.

NSF ADVANCE AWARD BRINGS INSTITUTIONAL CHANGE TO COLUMBIA

In response to the subsequent demands for systemic change across academia, NSF developed the ADVANCE Institutional Transformation Awards in 2001. The objective of these awards is to increase the representation and advancement of women in academia. While this ambition might seem far-reaching, it is rooted in a framework of social science research, with an emphasis on institutional self-studies and data collection. The five-year awards are a major investment: since its inception in 2001, the NSF ADVANCE Program has made awards to 19 institutions at \$3 million to \$4 million each. The awards also require a substantial commitment from the institutions themselves.

In the summer of 2004, the Earth Institute (EI) at Columbia University became the 19th institution to receive an ADVANCE Institutional Transformation grant. The EI ADVANCE Program is unique because it addresses the challenges specific to advancing women in the geosciences. As the largest research unit within the EI, LDEO is the setting for many of the ADVANCE program's intervention efforts. The intent of this program is to develop strategies within the EI and LDEO that can then be transferred to the rest of the university and the geosciences community. The goals of the EI ADVANCE program are to achieve institutional change by (1) identifying methods for targeting emerg-

ing 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 target 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. The ADVANCE programs at these institutions have been underway

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for three years now. At the University of Michigan, successful offers to women professors in science and engineering have doubled since the launch of the ADVANCE Program.

Based on the brief experience of the ADVANCE Program at Columbia and the collective experiences of ADVANCE Programs at other universities, five uni-

versal strategies for institutional change seem to be emerging: (1) generate awareness of the problem, (2) develop a widespread understanding of the underlying behaviors, (3) create and codify strategies to recruit and retain more women into academia, (4) provide the tools that will enable women to succeed, and (5) institutionalize accountability. (Box 2)

GENERATING AWARENESS AND UNDERSTANDING THE UNDERLYING BEHAVIORS

The initial two steps of raising awareness of gender inequities and developing an understanding of the underlying behaviors are underway here at Lamont and at the EI. As part of this process, the ADVANCE program is working with all levels of Columbia University's administration, from senior administrators to department chairs and research institute directors. By collaborating with these

groups, ADVANCE is developing a coalition, securing buy-in for intervention efforts, and instilling a sense of ownership of the program's activities across the institution. Because our expertise is in geosciences and not gender studies, we have also developed an internal advisory board of gender scholars from various departments at the university. Through this

BOX 2. STRATEGIES FOR INSTITUTIONAL CHANGE

As ADVANCE programs are being implemented, proven strategies for institutional change are emerging:

(1) **Generate awareness of the problem.** Awareness that gender bias persists even today and that it results in a loss of human capital from the academic community is a necessary starting point for institutional change in academia. In the geosciences, women comprise 33 percent of Ph.D. recipients but only 20 percent of assistant professor positions (NSF, 2004; Holmes et al., 2003). Salary gaps persist, with women earning 15 to 20 percent less than men even after rank and productivity are taken into account (Ginther 2001, 2004). These data illustrate the problem, but institution-specific data are necessary to make a case for change at the institutional level. One of the best ways to capture this type of data is through institutional self-studies, which can surface gender imbalances within institutions and disciplines. A number of ADVANCE institutions, including the University of Michigan and the University of Washington, have found that systematic self-studies not only demonstrate a need for intervention, but they also establish a baseline against which future progress can be measured.

(2) **Develop a widespread understanding of the underlying behaviors.** Cognitive science explains behaviors associated with gender bias as complex, largely unconscious, and common to both men and women (Valian, 1998). Repeated psychological experiments have illustrated that both genders tend to overestimate men and underestimate women in a variety of contexts, from assessments of height to professional ability (Biernat, 1991; Valian, 1998). These differences are small, but they build up over time. Models have shown that a 1 percent bias can accumulate into a major disparity over time (Martell et al., 1996), much in the same way that the accumulation of past interest is realized in a compound interest rate.

(3) **Create and codify strategies to recruit and retain more women into academia.** Institutions need to develop and codify strategies for recruiting, retaining and advancing women. Because women are often under-represented in applicant pools, institutions need to put the “search” back into search committees. Specific tactics include keeping the search broad to produce a more diverse applicant pool, promoting proactive searches, and developing procedures that ensure all candidates are evaluated based on a thorough review of their scholarship. Intellectually engaging search committees with social science research on stereotypes and unconscious bias can also incite decision-makers to come up with their own strategies for innovating recruitment and hiring processes.

(4) **Provide the tools that will enable women to succeed.** Academic institutions must build and maintain an infrastructure that enables women to advance. This infrastructure includes transparent promotion policies, equal access to resources, and an active community of women with a collective identity. In oceanography, polar sciences, and marine geosciences, data collection and experimentation require that scientists spend weeks and often months on research vessels in remote locations. Institutions need to recognize the financial constraints that fieldwork places on young parents, and explore alternative ways of supporting young parents in the field.

(5) **Institutionalize accountability.** Institutional change requires that universities, professional associations, and government agencies assume leadership and accountability for the problem. The interventions at MIT and the University of Michigan would not have been successful if both administrations had not taken responsibility for the problem. Calls for accountability have also been heard at the federal level. Recent Congressional hearings and a 2004 report by the General Accounting Office support the enforcement of Title IX, or the Education Amendments of 1972 that ban sex discrimination at federally funded academic institutions.

group, we are building a solid intellectual foundation for ADVANCE at Columbia University and a network of internal ambassadors for change at the university.

Matching the right message to the right audience has proven to be a critical component of our strategy to generate awareness and understanding of institutional gender disparities. Models of incremental bias effectively convey the issue to theoreticians, while findings from social experiments resonate more with observationalists.

CREATING AND CODIFYING NEW STRATEGIES FOR RECRUITMENT

The third crucial stage of institutional change is to create and codify strategies to recruit and retain more women into academia. To increase the number of women in both entry-level and senior-level applicant pools, the EI ADVANCE program is forming a senior faculty working group to develop new approaches to recruitment. 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. This group will use the latest social science literature to tackle the major gender questions facing university search committees.

Since the inception of the ADVANCE program at the EI, the dual-career issue has blossomed into a major stumbling block for search committees seeking to hire mid-career women as either research scientists or teaching faculty, an issue

that has surfaced as the result of several failed efforts to recruit and retain women at Lamont. The STRIDE Committee will address this and other similar cases, as it works 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

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tenured ranks, the EI ADVANCE Program is awarding several Marie Tharp Visiting Fellowships each year to promising women scientists. The fellowship is named after Marie Tharp, the mother of modern ocean floor cartography. A pioneer of modern oceanography (Figure 5), 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 fellowship is to provide an opportunity for women scientists outside of Columbia to conduct research at one or more of the units or related departments within the EI for a period of one to three months during their career-building years. Fellows will have the opportunity to work with EI research scientists, faculty, postdocs, and graduate students.

PROVIDING THE TOOLS FOR SUCCESS

In order to compete, the players need to know the rules of the game. When the rules of advancement and promotion are informal, women experience disproportionate setbacks. Because women are often not included in informal networks of information exchange about promotion possibilities and job openings (Ragins

and Sundstrom, 1989), procedures need to be clearly defined, well documented, and widely disseminated. Over the past decade at LDEO, efforts to clarify and codify performance review procedures have increased the transparency of promotion criteria for the research faculty. The process now includes provision for both written and oral feedback for junior scientists so that promotion criteria are discussed before the candidate comes up for promotion (i.e., before tenure panels). The ADVANCE program is extending this process beyond Lamont to all the EI units. Most recently, a policy mandating mid-term reviews for all associate research scientists was implemented across the Institute. This effort is ongoing, and it will be particularly important for researchers working in interdisciplinary fields or with multidisciplinary teams. These teams often involve more than one department, each with its own implicit as well as explicit set of expectations and criteria.



Figure 5. Marie Tharp, renowned oceanographic cartographer, working on Ocean Floor Map in Lamont Hall. From the Lamont-Doherty collection.

In order to identify the factors that most influence a scientist's career development, we are using the rubric of key events associated with prolific publishing that vary by gender developed by Elizabeth Creamer at Virginia Tech (1998) (Figure 6). Publication output is the measure of success in science. It is the principal metric used to determine tenure status, promotions, pay raises, and access to resources. Creamer's analysis presents a career trajectory with the key events that individually account for small career advancements, but which accumulate over time into large disparities in professional visibility, productivity, access to resources, and salary.

In an effort to enable women scientists to maintain their research productivity during times of transition, the EI ADVANCE Program will provide research assistance for women scientists during periods in which they are forced to limit their research time because of family life transitions such as childbirth, adoption, or elder care responsibilities. For the geosciences, fieldwork and time at sea are critical activities that determine access to resources, professional networks, visibility, and eligibility for leadership roles. Fieldwork is a major attraction to graduate students in the geosciences, but it becomes increasingly difficult for early and mid-career scientists, particularly women

with children. The EI ADVANCE Program has developed a competitive fund for women seeking childcare while they are in the field or at sea. If the impact of this funding is positive, we envision that support of childcare during extended fieldwork will ultimately become an allowable expense on NSF grants, in the same way that sea pay is now routinely budgeted into grants to cover the hardships of sea-going experiences.

In response to another key factor in Creamer's analysis "interaction with influential colleagues," the ADVANCE program has developed a program of career development through research. This competitive program will enable

Key Events Associated with Prolific Publishing that Vary by Gender

Figure 6. Model of key events that vary by gender that impact productivity. Adopted from Creamer (1998). Reprinted with permission of John Wiley & Sons, Inc.

KEY FACTORS	Doctoral Study	Post-Doc Study	Entry Faculty	Pre-Tenure	Post-Tenure	Sr. Scholar
Resources						
Prestigious Ph.D. program degree					ADVANCE Initiatives	
Prestigious post-doc appointment						
Work assignment w/ opps for research						
Eminent mentor						
Early publishing opportunity						
No career interruptions	Life transition and fieldwork support grants					
Access to resources			Work environment survey			
Prestigious faculty appointment			Faculty working groups			
Rewards						
Publishing and rewards linked			Transparency initiative			
Rapid promotion						
Reinforcement						
Interaction w/ influential colleagues	Workshop leadership grants					
Recognition						
Acknowledgement from colleagues				Workshop leadership grants		

Source: Creamer, E.G. 1998, *Assessing Faculty Publication Productivity: Issues of Equity*, ASHE-ERIC Higher Education Report Vol 26, No 2.

women scientists to broaden their professional networks by convening small, focused research workshops in collaboration with senior scientists at Columbia University, as well as with other scientists and professional organizations around the world. These workshops will not only enable women to develop leadership skills, but it will also give them an opportunity to define the research agenda in their field.

In addition to providing funding opportunities, the ADVANCE program is strengthening the network of women scientists at Lamont and at EI through a series of monthly meetings. These meetings have opened the door to discussion

on topics which were formally taboo, alleviated feelings of marginalization, and cultivated a community capable of providing critical support for a university-wide institutional change effort through its commitment and activism. The topics covered in these meetings include work/life balance, publication productivity and impact, and tactics for effective negotiation.

INSTITUTIONALIZING ACCOUNTABILITY


The EI ADVANCE Program will only have a long-term impact if accountability for gender disparities is institutionalized. The tendency for women's salaries to di-

verge from men's has been observed over several decades at Lamont. One-time adjustments, while welcome at the time, do not change the system. Annual reviews of the gender distribution of salaries are necessary to alleviate long-term and persistent disparities. Institutionalization requires a commitment from leaders and decision-makers. A crucial component of the ADVANCE proposal process at Columbia was securing the support of the university—from the President on down—to financially contribute to the ADVANCE program over its five years and then to independently fund the successful facets of the ADVANCE program across the entire university.

ADVANCE is a social experiment. NSF designed the program so that universities could develop solutions that fit their culture and organizational topography. What works at one ADVANCE institution might not work at every institution. However, NSF has made great efforts to make sure that all of the ADVANCE institutions learn from each other. As part of the EI ADVANCE Program, we are discovering the factors that enable women oceanographers and geoscientists to succeed. This process often raises personal and political issues that scientists would prefer to ignore. 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). The lessons learned here and at the other ADVANCE institutions are a tremendous resource for other oceanographic and geoscience institutions seeking to support a diverse research and teaching faculty.

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