



BREAKING BARRIERS AND CREATING INCLUSIVENESS: LESSONS OF ORGANIZATIONAL TRANSFORMATION TO ADVANCE WOMEN FACULTY IN ACADEMIC SCIENCE AND ENGINEERING

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To increase the representation and participation of women and other minorities in organizations, workplaces must become more inclusive. For such change to be successful and sustainable, organizations must systematically break down the barriers constraining women's participation and effectiveness; improve their prevailing structures, policies, and practices; and engender transformation in their climates. This article presents the experience of 19 U.S. universities, funded by the National Science Foundation's ADVANCE Institutional Transformation program, that have embraced comprehensive transformation for improved gender representation and inclusion in science and engineering disciplines. It describes the facilitating factors, program initiatives, institutionalization, and outcomes of their transformation, and suggests a transformation model that all organizations can use to create an inclusive and productive workplace for a diverse workforce. © 2008 Wiley Periodicals, Inc.

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Management researchers and practitioners have long studied women's representation and inclusion in organizations (Ely & Meyerson, 2000), and organizations have tried various approaches to ensure gender equity in the workplace. Supply-side or pipeline initiatives contend that if sufficient women are encouraged to enter the workforce, gender gaps in occupational

participation, advancement, compensation, and retention may disappear (Etzkowitz, Kemelgor, & Uzzi, 2000). Affirmative action programs and antidiscrimination policies focus on increasing women's representation in organizational ranks. Mentoring, training programs, and special job assignments for women may facilitate career advancement. Demand-side initiatives to improve work-life balance, such as flex-time and child-care

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support, are other popular remedies. Some organizations have even attempted to build awareness about the tacit mental models that drive behavior (McCracken, 2000; Stuart, 1999). The outcomes of these efforts have been mixed. Some initiatives have yielded positive results (Dreher, 2003), while others have not proved sustainable. The lack of women's representation and inclusion, particularly in leadership positions, remains a widespread problem.

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The results of these initiatives indicate that simplistic or piecemeal solutions cannot eradicate systematic, historical, and widespread gender inequities. For example, infusing more women at lower levels is rarely sufficient for increased representation at higher levels, and offering individual skill development opportunities to women can be less than effective for their advancement if other organizational factors are not simultaneously addressed. Organizations need to implement wider and deeper change, transforming structures, processes, work practices, and mental models that perpetuate inequity (McCracken, 2000; Meyerson & Fletcher, 2000). To foster equity, organizations must change the character of the workplace that has traditionally been manned—literally and figuratively—by employees of a certain type to accommodate a different type (Thomas & Ely, 1996) and recast the institution-

alized routines and practices embedded in their social-structural fabric. Inclusive environments that enable organizational equity are characterized by work structures and cultural norms that support positive relations between men and women; freedom from stereotyping about women's and men's roles and occupations; work conditions (for example, job titles, work schedules, policies, and physical environment) that include both men and women; a criti-

cal mass of women; opportunities for reward and advancement based on performance and talent, not gender; and work policies that help support work-life integration (McLean, 2003). In the process of such transformation, the workplace becomes supportive and motivating for *all* its employees, not just women and other minority groups (Meyerson & Fletcher, 2000).

Issues of poor gender representation and noninclusiveness affect both the corporate world and academia (Valian, 1999). In U.S. corporations, women are less likely than men to advance to senior administrative or management positions and women are not well represented among the ranks of highly paid or highly positioned executives and managers (Catalyst, 2005; Dreher & Cox, 2000; Ragins, Townsend, & Mattis, 1998). Women historically have lacked access to the informal organizational networks that benefit corporate career progression (Dreher & Cox, 2000; Forret & Dougherty, 2004). Similarly, academia, particularly the science and engineering (S&E) disciplines, have remained inhospitable to the representation, advancement, and inclusion of women (Etzkowitz, Kemelgor, Neuschatz, & Uzzi, 1994; see also Burke & Mattis, 2007).

Recognizing that systematically enabling equity requires planning and implementing comprehensive organizational transformation initiatives, the National Science Foundation (NSF) has launched ADVANCE, a funding program to increase the workforce participation of women in academic S&E fields through institutional transformation (IT). This article describes the emerging institutional transformation experience of 19 U.S. universities, funded in the first two rounds of the NSF's ADVANCE IT program, that have aimed to increase the participation of female faculty in all S&E ranks and especially in leadership positions (Stewart, Malley, & LaVaque-Manty, 2007). We contribute to extant research on women's workforce representation and advancement by presenting a generalized framework for how organizations, academic and nonacademic, can enable equity through transforming their structures and cultures.

Women in Academic S&E: The Leaky Pipeline

The number of women with S&E doctorates increased more than sevenfold between 1973 and 2003, raising women’s share of S&E doctoral degree receipts from 9% to 30% (NSF, 2006b, Table 5-28). Yet, women’s representation in S&E faculties remains low, especially at higher levels of the academic hierarchy and in top-tier research institutions (NSF, 2006a, Table H-21). Although few differences in rank exist between men and women early in their careers, the gap widens significantly at 15 to 20 years after receipt of the doctorate (NSF, 2006a, Figure H-5). In academic careers with typical milestones, a lower proportion of women advance to each subsequent milestone as compared with their male colleagues (Etzkowitz et al., 2000; NSF, 2000). As described by Mason et al. (2005), the “leaky pipeline” has become a well-known metaphor to illustrate the loss of women faculty at each academic career transition point. Although this metaphor best describes linear career development trajectories, it is also relevant for corporate work environments with disproportionate losses of women in managerial ranks and slow advancement of women to leadership positions (Burke, 2002; Hewlett & Luce, 2005; Lyness & Thompson, 2000).

Leaks Before the Tenure Track

Factors inhibiting women’s entry into the tenure track include small numbers of women receiving doctoral degrees in certain S&E disciplines, unwelcoming search processes for tenure-track positions, and lack of development opportunities in non-tenure-track environments.

Doctoral Degree Receipts

The number of women seeking doctoral degrees in S&E continues to be less than the number in other fields. In 2003, women earned 38% of S&E and 58% of other doctoral degrees (NSF, 2006a). Among U.S. citizens, women earned more than 50% of the

doctoral degrees in other fields and in social/behavioral sciences, but less than 10% in engineering between 1983 and 2003 (NSF, 2006b, Table 2-30).

Entering the Tenure Track

Despite the differences noted above, sufficient numbers of female doctoral graduates are generally present in the disciplinary recruitment pools for S&E faculty (Trower & Chait, 2002), but qualified female doctoral candidates may be invisible to search committees whose composition lacks gender diversity, and whose search activities do not include systematic identification of the candidate pool, gender-blind screening of applications, and an equitable campus visit and interview process (Stewart, LaVaque-Manty, & Malley, 2004). Examining the tenure-track positions at the University of California, Berkeley, Mason et al. (2005) found that qualified female PhDs make up less than a third of the applicant pools. These same researchers noted that married women with and without young children are the least likely of all PhD recipients to secure tenure-track faculty positions.

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Women’s Experience in Off-Track Positions

There is a greater likelihood of women being employed in non-tenure-track positions, such as temporary teaching positions, research positions funded by “soft” or short-term restricted funding, part-time faculty, visiting scholars, adjunct faculty, postdoctoral fellows, and lower-level administrative positions (Harper, Baldwin, Gansneder, & Chronister, 2001; Long, 2001; National Science Foundation, 2004). In general, postdoctoral employees, adjunct faculty, non-tenure-track instructors, and part-time employees, who are disproportionately likely to be female, are rarely provided opportuni-

ties for professional advancement, may not have their performance regularly reviewed or rewarded, may rarely find their positions converted to full-time or receive priority consideration when they are, and may be shut out of the faculty governance processes by the institutions that appoint them (American Association of University Professors, 1996).

Leaks After Entering the Tenure Track

Even after gaining tenure-track S&E positions, women faculty face greater barriers in obtaining tenure, promotion, and advancement to leadership, and encounter more negative experiences in their workplaces, than do their male counterparts.

Tenure-track women faculty in S&E frequently experience isolation, have few role models and mentors, and have to work harder than their male colleagues to gain credibility and respect.

Advancement to Tenure

Female faculty are less likely to be tenured than male faculty. According to Long (2001), a nearly constant 80% of men had tenure in each year between 1979 and 1995, while for women the number increased slightly from 56% in 1979 to 60% in 1995. Among those who received their S&E doctorates 10 to 19 years beforehand, 58% of women and 72% of men were tenured (NSF, 2000).

Promotion to Professor Rank and Faculty/Administrative Leadership

The lowest proportion of women S&E faculty is at the highest professor level of the academic hierarchy. Among S&E doctorates who hold academic faculty positions in four-year colleges and universities, women are less likely than men to be full professors and more likely to be assistant professors (NSF, 2006a, Figure H-5). The percentage of female full professors in S&E ranges from 3% to 15% at the top 50 U.S. universities based on research expenditures (Nelson, 2005). Senior

women are also less likely than their male colleagues to occupy faculty leadership positions, such as endowed or named chairs, and administrative positions, such as department chairs or deans.

Women's Experience in the Tenure Track

Tenure-track women faculty in S&E frequently experience isolation, have few role models and mentors, and have to work harder than their male colleagues to gain credibility and respect (Liang & Bilimoria, 2007; Rosser, 2004). Female faculty on the tenure-track report lower satisfaction with their academic jobs than do male faculty (Bilimoria et al., 2006; Callister, 2006) and are more likely to opt out of academic S&E (Valian, 2004).

Institutional Transformation to Enhance Women's Representation and Inclusion in Academic S&E

To stem the leaks and eradicate the barriers described above, in 2001, the NSF initiated the ADVANCE Institutional Transformation program for increasing the participation and contributions of women in the S&E workforce (see www.nsf.gov/advance). ADVANCE IT awards were instituted to fund innovative programs to result in the "full participation of women in all levels of faculty and academic administration, particularly at the senior academic ranks, through the transformation of institutional practices, policies, climate and culture" (NSF, 2005). To date, 32 universities (referred to as ADVANCE institutions) have received funding.

For the purposes of this article, we conducted a thorough review of the transformational initiatives and outcomes of the 19 first- and second-round ADVANCE institutions for which data were available. Primarily, we analyzed their Web sites, NSF-mandated annual reports, publications, and research and evaluation reports. We also drew on interviews with 54 ADVANCE project team leaders and senior faculty about the nature and outcomes of their efforts (Bilimo-

ria & Valian, 2006). Highlights of the ADVANCE institutional transformation experience at these 19 universities follow.

Transformational Initiatives

Figure 1 summarizes the transformational initiatives that the universities undertook to enhance women’s representation and inclusion in academic S&E.

Pipeline Initiatives

These initiatives addressed the primary objective of ADVANCE in three ways: increasing the inflow of women into the pipeline, improving the institutional structures and processes related to academic career transition points (recruitment, promotion, and tenure), and better equipping women to suc-

cessfully progress in the pipeline. Pipeline initiatives used to improve individual career trajectories included mentoring, coaching, networking, education and training, career and professional development, leadership development, and special funding and opportunities (Bilimoria, Hopkins, O’Neil, & Perry, 2007; Burke, 2002; de Janasz, Sullivan, & Whiting, 2003; Ehrich, Hansford, & Tennent, 2004; Forret & Dougherty, 2004; Gibson, 2004; Kram, 1988).

Climate Initiatives

Climate refers to “the feeling that is conveyed in a group by the physical layout and the way in which members of the organization interact with each other, with customers, or with other outsiders”(Schein, 1992, p. 9). Work-climate factors have been

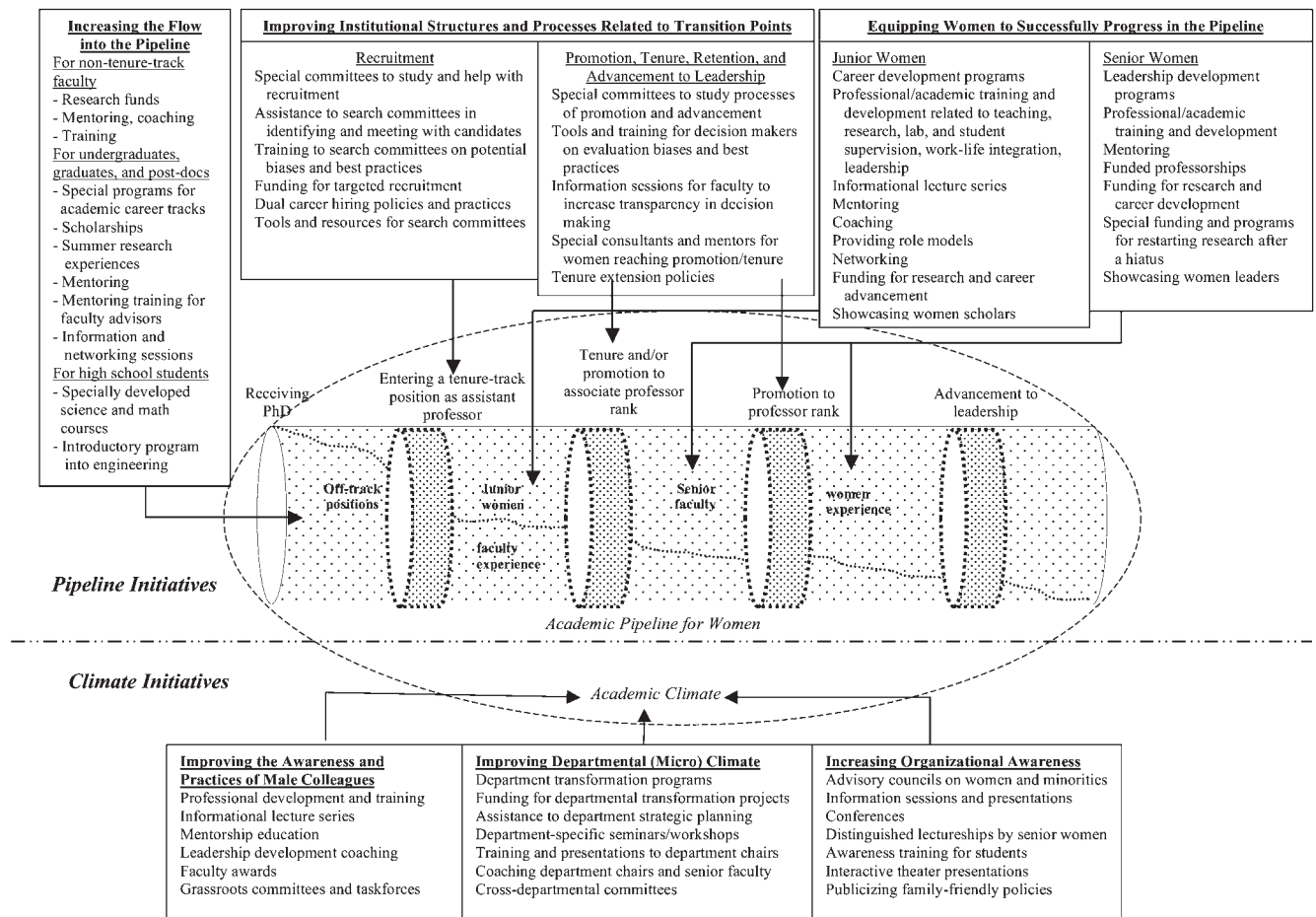


FIGURE 1. Summary of the Transformation Initiatives Undertaken by NSF ADVANCE Universities

linked to several important organizational outcomes, such as satisfaction, productivity and/or performance, retention, and emotional support (August & Waltman, 2004; Carr et al., 2003). Initiatives at ADVANCE universities included improving the awareness and practices of male colleagues through education, training, and development; engaging in efforts to make departments (micro-climates) more collegial, egalitarian, equitable, and transparent; and increasing organizational awareness of diversity and inclusion issues (Blakemore et al., 1997; Peterson & Spencer, 1991; Rosser, 1999; Schein, 1992).

An organizational transformation project is an incubator for generating ideas and initiatives and testing them for their feasibility, acceptability, and sustainability.

The Outcomes of Institutional Transformation

An organizational transformation project is an incubator for generating ideas and initiatives and testing them for their feasibility, acceptability, and sustainability. The success of such projects depends not only on achieving results during the finite periods when they are live, but also on effectively sustaining and leveraging the results into the future, infusing meaning into the institutional system for the times to come. Weaving the changes into the socio-structural

fabric of the organization (institutionalization) is an important phase in the change models proposed by Lewin (1947), Judson (1991), Kotter (1995), and Eckel and Kezar (2003). In the case of the 19 ADVANCE universities studied, institutionalization occurred as follows.

New Structures, Positions, and Groups

Several ADVANCE universities created new positions such as ombudspersons, equity advisors, endowed chairs, institutional researchers, and provosts/deans for faculty development and diversity. Family-friendly structures, such as child-care facilities and

lactation centers for nursing mothers, were opened at some universities.

New and Modified Policies

ADVANCE universities have modified or created new permanent policies to support the inclusion of women and other minorities. Such policies include dual-career hiring (funding to hire both partners or help a partner find suitable employment), job sharing (arrangements whereby spouses/partners can share a single job if they belong to the same academic area), work-life integration (active service-modified duties or a work release policy where supplemental funding is provided and the workload is modified in the event of a crisis), tenure clock extension (whereby the faculty member is allowed more time before a mandatory tenure review), and family-friendly policies (such as maternity/paternity leave in case of child birth or adoption; family medical leave in case of sickness of any member of the family, including parents; and domestic partner health benefits).

Adoption of Change Initiatives as Regular Organizational Processes

ADVANCE universities have institutionalized successful and stabilized initiatives, such as special funding, leadership development programs, and mentoring programs, incorporating them into existing structures.

Tool Kits, Guidelines, and Resources for Improved Practices

ADVANCE universities have systematically documented their best practices for the benefit of future decision makers and HR practitioners in the form of tool kits, guidelines, best practice guides, evaluation forms, training manuals, presentations, and pamphlets covering the critical aspects of recruitment, promotion, retention, and leadership development of women and other minorities (see the ADVANCE IT portal Web site, <http://research.cs.vt.edu/advance/index.htm>).

The objective of the ADVANCE IT effort was to increase the representation of women

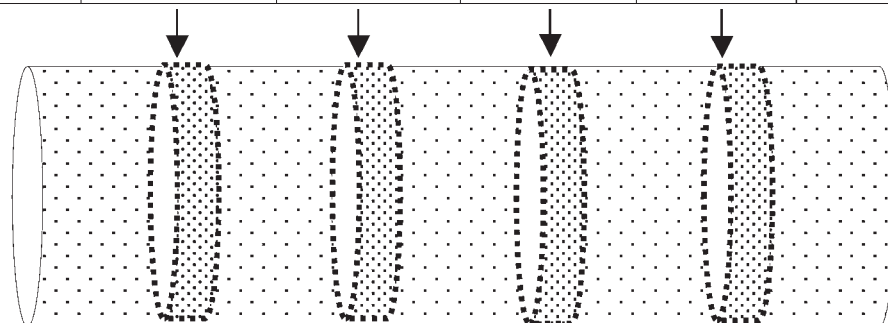
at all levels in academic S&E, especially leadership positions, by improving the structures, policies, practices, and climate of the workplace environment. To monitor their progress, ADVANCE institutions have annually tracked and reported their female faculty numbers at each career stage. Table I presents a frequency distribution of the percentage increase reported by 13 ADVANCE universities from whom specific outcome data were available. Although each ADVANCE IT project lasted five years, these 13 universities were at different stages of project implementation at the time of our review and had different numbers of female faculty at each rank at the start of their projects. The outcomes reported in Table I for these 13 universities ranged within a period of three to five years of the

start of their projects. Given the limited time frames, the data offer a positive trajectory of emerging impact on the representation of women in the S&E tenure-track pipeline.

The last column in Table I indicates that all except one university reported an increase in the overall number of women in their tenure-track S&E pipeline. The data by rank (columns two to four) also indicate that there has been a general increase in the number of women in tenure-track S&E ranks at most institutions. The greatest increase in the representation of female S&E faculty was at the assistant professor rank, with five out of 13 institutions reporting at least a 50% increase in their number of female assistant professors in a three- to five-year period. Percentage increases in the numbers of associate

TABLE I Number of Universities Reporting Changes in the Representation of Women in the S&E Tenure-Track Pipeline Since NSF ADVANCE IT Program Implementation

% Increase in 3–5 Years	Assistant Professors (Junior Rank) (n = 13)	Associate Professors (Middle Rank) (n = 13)	Professors (Senior Rank) (n = 13)	Leadership Roles (n = 11)	Total Number of Female Faculty (n = 13)
1–9%		2	1	1	1
10–19%		3	3	2	2
20–29%	2	3	4	1	3
30–39%	2	2			3
40–49%	1		2		2
50–59%	2		1	1	
60–69%	1				
70–79%					1
80–100%	1		1		
>100%	1			2	
Total # of Universities Reporting % Increase	10	10	12	7	12
No Change		2	1		
% Decrease	3	1		4	1



professors and professors were relatively lower; however, the preponderance of institutions reported gains in these ranks. Table I also shows that the number of women in leadership positions in ADVANCE universities also has generally increased.

Besides increasing the representation of women in faculty positions, ADVANCE has also been helpful in enhancing academic climate and achieving other outcomes. For instance, at the end of four years of its ADVANCE IT initiative, the Georgia Institute of Technology found that female faculty expressed greater satisfaction with resource availability and their working environments, and faculty in general reported that they found their colleagues more able and willing to collaborate.

In many ADVANCE institutions, senior administrators provided resources, guided the process, and created new administrative structures and policies to support the transformational efforts.

Factors Facilitating Transformation

Key internal and external elements facilitated successful implementation of initiatives, effective institutionalization, and measurable outcomes at ADVANCE universities.

Internal Factors

Transformation involves changing the institution's culture (Eckel & Kezar, 2003). Transformational change depends on pervasive, deep, and sustainable institutional strategies that can counter competing priorities, resource constraints, and misunderstandings (Rosser & Chameau, 2006). Eckel and Kezar (2003) identified the following core strategies common to institutions undergoing transformation: senior administrative support, collaborative leadership, flexible vision, and visible action. Together, they serve as the internal factors facilitating transformation.

Senior administrative involvement is a prerequisite for successful organizational change (Eckel & Kezar, 2003; Garvin, 2000). In many ADVANCE institutions, senior ad-

ministrators provided resources, guided the process, and created new administrative structures and policies to support the transformational efforts. Change models also stress the importance of having change agents spread across ranks and functions in an organization for the message of change to spread, creative ideas to emerge, and grassroots change to take place (Eckel & Kezar, 2003; Garvin, 2000; Kotter, 1995). ADVANCE IT teams have sought to make the constituencies affected by change become the agents of change (Armenakis & Bedeian, 1999) by engaging and involving male and female faculty and administrators at all ranks (Mento, Jones, & Dirndorfer, 2002).

According to change theorists, it is critical to establish a clear vision of the end state (Galpin, 1996; Garvin, 2000; Jick, 1991; Kotter, 1995). ADVANCE institutions established goals with intermittent milestones of increases in the representation of women on S&E faculty. These institutions drew on the philosophy of "small wins" (Kotter, 1995; Weick, 1984)—small, targeted, and achievable change initiatives that result in concrete and visible results that build momentum to create a cascading change effect. Making actions and outcomes visible is a final internal facilitating factor. Armenakis and Bedeian (1999) recommend using multiple strategies to communicate organizational transformation efforts, and ADVANCE institutions have accordingly attracted internal and external attention through myriad ways.

The importance of these internal factors in facilitating organizational transformation cannot be overstated. In the one university where the overall number of women S&E faculty decreased (see Table I), several of these internal factors were missing. An evaluation report of this ADVANCE IT program pointed out that awareness about change initiatives was generally low throughout the university, activities were limited only to women (male faculty and students were not included in interventions), there was little collaboration between the project and other university offices, and focused professional development programs, such as mentoring and coaching, were absent.

External Factors

In addition to the internal factors recommended by change theorists, two external factors facilitated institutional transformation at the 19 ADVANCE universities studied: legitimacy from an external agency (NSF) and a network of peer institutions also undergoing transformation. These external factors facilitated the exchange of information, resources, ideas, best practices, and solutions. Many change theories posit that external factors (such as government regulations, economic or trade conditions, competition, and technology) influence an organization’s decision to change by threatening its very existence (Armenakis & Bedeian, 1999; Barnett & Carroll, 1995). Our review found that external institutions may alternatively serve as partners and facilitators that take an active role and benevolent interest in organizational change.

Legitimacy is a generalized perception and assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions (Suchman, 1995). Institutional theorists posit that compliance with the directives of external agencies, such as the government, the legal system, and funding agencies, increases an organization’s legitimacy (DiMaggio & Powell, 1983; Meyer & Rowan, 1977). For the 19 ADVANCE institutions, the NSF served not just as the agency that provided and monitored funding, but also as the leader of positive institutional change: adopting a developmental role, convening interaction among institutions, and providing continuous, constructive, and collaborative guidance for change project implementation. Interviews (Bilimoria & Valian, 2006) revealed that backing from the NSF was crucial to the success of program initiatives among administrators and male scientists in particular because it gave “moral legitimacy” to the objective of transformation and “procedural legitimacy” to the specific change initiatives (Suchman, 1995).

A supportive network of peer institutions was a second external factor that facilitated transformation. Seeking to model themselves after best practices, organizations often un-

dertake change initiatives inspired by other organizations that have benefited from similar projects (Barnett & Carroll, 1995). In the case of the 19 ADVANCE institutions, the peer institutions went beyond serving as passive role models for change and actively supported change within each of them. The ADVANCE institutions shared learnings and best practices, accumulated a substantive knowledge base on organizational change and gender equity, created and shared tool kits and resources, and undertook collaborative research projects and consulting services to further their overall objectives of institutional transformation.

Research and Evaluation in Support of Transformation

Research-driven initiatives were an important element of the institutional transformation efforts at the 19 ADVANCE institutions. In most change interventions, the role of research is, at best, to monitor progress. Some change theorists, however, such as Galpin (1996), have acknowledged the need to diagnose and analyze the current situation to generate recommendations and to conduct pilot tests in addition to measuring outcomes. The ADVANCE institutions undertook three types of research activities: tracking key indicators of inclusion, evaluating effectiveness of specific change initiatives, and improving data collection and analysis systems.

Tracking Key Indicators of Participation, Resource Equity, and Inclusion

Transformational outcomes have been primarily measured through annual tracking of several key indicators prescribed by the NSF, such as faculty composition by rank and gender; tenure, promotion, and attrition rates; years in rank and time at institution; and compensation, resources, and space allocation. To supplement these data, some institutions

The ADVANCE institutions undertook three types of research activities: tracking key indicators of inclusion, evaluating effectiveness of specific change initiatives, and improving data collection and analysis systems.

have used such additional monitoring tools as cohort analyses and flux charts. In a cohort analysis, specific male and female faculty members who joined at a particular period are tracked periodically to note their promotions, tenures, and separations. A flux chart helps to graphically represent the number of male and female faculty in each rank in each year and the movements (new hires, promotions, tenure, separations) between years. Both tools are helpful in diagnosing trends in faculty representation in the S&E pipeline.

Climate studies at the ADVANCE institutions indicate that as compared to men, the women on S&E faculties perceive the internal climate at their universities as more disrespectful, noncollegial, sexist, individualistic, competitive, nonsupportive, intolerant of diversity, and nonegalitarian.

Benchmarking, Research, and Evaluation Studies

The universities that were reviewed undertook a variety of studies, including interview and focus-group studies, resource equity studies, benchmarking studies of leading departments and universities, and evaluation of interventions. The most prevalent studies among the ADVANCE institutions were climate surveys that assessed the macro (university) and the micro (departmental) climate. The results from a sample of the institutional climate surveys are described in Table II. Climate studies at the ADVANCE institutions indicate that as compared to men, the women on S&E faculties perceive the internal climate at their universities as more disrespectful, noncollegial, sexist, individualistic,

competitive, nonsupportive, intolerant of diversity, and nonegalitarian. ADVANCE teams found that climate surveys were useful in not only narrowing down the areas to focus on while implementing change initiatives, but also in helping both administration and faculty members understand existing strengths and challenges.

Additionally, a variety of studies examined women's experience in the academic pipeline. The spectrum of studies covered the

career-choice behavior of female PhDs; the most effective methods for teaching women and girls; the characteristics of the interactions between female faculty and their students; the impact of gender and nationality in adviser-advisee relationships; the potential for non-tenure-track female faculty to switch to tenure track; the elements that contributed to the success of women in S&E; the gender differences in the constitution of job satisfaction; women's self-perceptions of leadership; and the experience of new faculty and those who left. Evaluations to obtain feedback on the effectiveness of individual program initiatives also were conducted. These may have involved pre- and postintervention studies or participants' evaluations of program benefits.

Improving Internal Collection, Analysis, and Use of Data

ADVANCE IT projects have played a critical role in helping their universities upgrade existing data collection and analysis systems to strengthen the infrastructure for continuous monitoring of transformational outcomes. In some universities, ADVANCE IT projects have created templates for faculty databases, provided initial resources for database creation and maintenance, created just-in-time training tools for more equitable personnel decision making, and presented analyses and recommendations to senior administrators to assist in HR functions.

A Model of Institutional Transformation for Enhanced Representation and Inclusion of Women and Other Minorities

Figure 2 summarizes the institutional transformation experiences of the ADVANCE universities in a generalized model of organizational transformation that fuses facilitating factors, research and evaluation, change initiatives, institutionalization, and outcomes. Extending beyond the ADVANCE universities, the model can be applied to academic, corporate, and nonprofit organizations seeking improved representation and inclusion of women and other minorities.

T A B L E I I Examples of Climate Surveys and Findings at ADVANCE Institutions

School	Respondents	Measures	Major Findings
Case Western Reserve University (2004) www.case.edu/admin/aces/	39% response rate (508/1,303)	Quality of collegiality and support in primary unit, support for work-life integration, effectiveness of chair/dean, mentoring, resource allocation processes, and satisfaction.	Female faculty felt less valued and included in their primary unit in comparison to men and reported lower ratings of effective departmental leadership; junior faculty and female faculty perceived that compensation supports were less equitably distributed; female faculty were less satisfied with their overall job experience than men faculty.
Georgia Institute of Technology (2002-03) www.advantage.gatech.edu/measure.html	76% response rate	Teaching and research, work environments, evaluative processes, and work-family arrangements and experiences	Men were more likely to speak daily about research, more likely to report willingness of faculty to collaborate, and more likely to characterize their home units as "exciting," "helpful," and "creative." The most significant gender difference is "helpfulness."
University of Colorado, Boulder (2003) advance.colorado.edu/research.html	78% response rate (449/575)	Interpersonal relations, collegiality, chair leadership, mentoring, institutional support, and diversity	Tenure-track men had a more favorable rating of interpersonal relations than women; women were more likely than men to believe that diversity is important; tenure-track men rated their chairs higher than women.
University of Michigan (2002) sitemaker.umich.edu/advance/reports_publications_and_grant_proposals	38% response rate (536/1,398)	Career experiences and satisfactions, productivity, recognition, resources (effort and satisfaction), mentoring, service, stereotyping, discrimination, and sexual harassment	Male and female scientists and engineers differed in the amount of effort it takes to secure resources such as office space, research space, and lab equipment. Female scientists and engineers were less likely than their male counterparts to rate their departmental climate as supportive, less likely than both male scientists and engineers and female social scientists to rate their departmental climate as tolerant of diversity and their department gender atmosphere as egalitarian.
Utah State University (2004-05) http://websites.usu.edu/advance/Document/index.asp?Parent=6308	74% response rate (308/416)	Empowerment, access to information, isolation, intention to quit, and job satisfaction	Women reported lower levels of job satisfaction, empowerment, and access to information and higher intentions to quit and feelings of isolation. Affective and instrumental department climate mediate the relationship between gender and both job satisfaction and quit intentions.
Virginia Polytechnic Institute and State University (2005) www.advantage.vt.edu/Measuring_Progress/Faculty_Survey_2005/Faculty_Survey.htm	Total participants: 1,209	Faculty recruitment, job satisfaction, policy, administration, leadership, and general climate with regard to diversity	Women and men differed in their perceptions of female and minority leadership and representation. More women (78.3%) than men (48.9%) felt that there are too few women and minorities in leadership positions; overall campus climate was rated fairly favorably, but departmental climates varied significantly.

Sharing several features (for example, leadership, vision, involvement of other key members, and communication) with existing, more generic organizational change models (Galpin, 1996; Garvin, 2000; Jick, 1991; Judson, 1991; Kotter, 1995), this model offers a specific solution for organizations that want to create an inclusive workplace. Other change models generally emphasize forces within the organization to drive change initiatives. Adding to the internal facilitating factors mentioned in the literature (particularly Eckel & Kezar, 2003), our model proposes that forces outside the organization (such as industry trade groups, professional associa-

tions, funding agencies, and peer organizations) also can be effective collaborators and drivers of change. Partnership with external parties may be especially useful for transformation that requires not only organizational change but also social change. Inclusivity of women and other minorities is not just an organization-specific issue. It has social roots, for which wider social change is needed to eliminate systematic, institutional underrepresentation and inequity. For such goals, industrywide alliances may give greater visibility and legitimacy to change initiatives among employees as well as the public. Moreover, this kind of a change may benefit entire in-

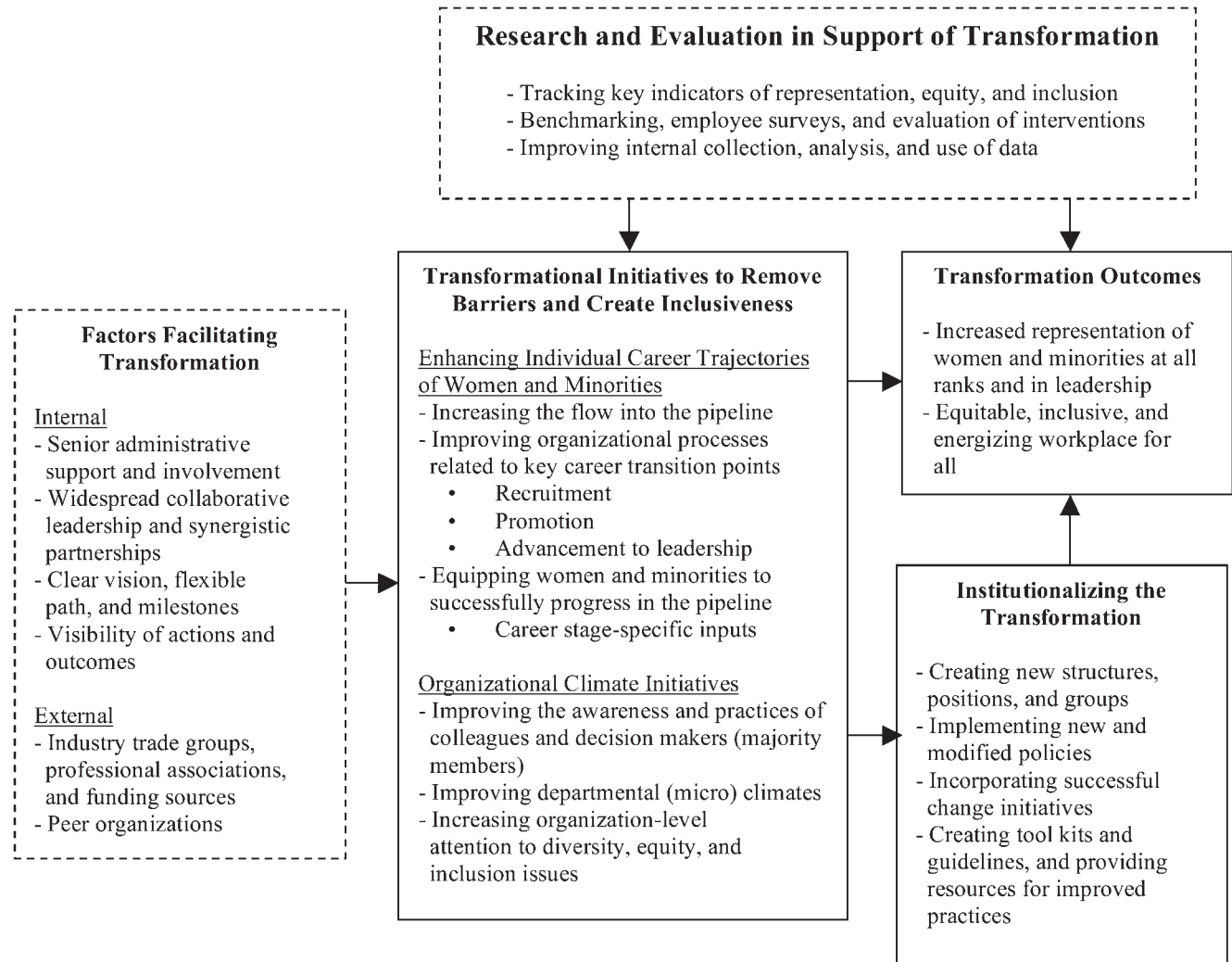


FIGURE 2. A Model of Organizational Transformation for Enhanced Representation and Inclusion of Women and Minority Groups

dustry sectors, not just single organizations, attracting larger numbers of underrepresented minority group workers and increasing overall talent pools.

The model also emphasizes the conduct of research and evaluation to support transformation aimed at improving the workforce participation of women and other underrepresented minority groups. Such research may include conducting studies of best practices and collecting employee survey data regarding resource equity and inclusion. Research helps to avoid assumptions about the experiences of women and other minority group members in the workplace, look at the various aspects of the issue afresh for designing interventions, get feedback on the effectiveness of interventions, and track overall change.

Focusing on the issue of breaking down barriers and creating inclusiveness, our model contextualizes and expands Kotter's (1995) general steps of organizational transformation: establishing a sense of urgency; forming a powerful guiding coalition; creating and communicating a vision; empowering others to act by removing obstacles and changing systems or structures that undermine the vision; planning for visible performance improvements; consolidating improvements and producing still more change; and institutionalizing new approaches (articulating the connections between the new behaviors and success, and embedding the changes into ongoing structures and practices). Our model suggests that the implementation and institutionalization of change initiatives that have both an individual and organizational focus collectively lead to successful and sustainable increases in the representation and inclusion of women and other minorities, offering the possibility of breaking down any barriers to their participation and improving the environment for all. By placing transformation-facilitating factors and research and evaluation in dashed boxes, our model suggests that these are contingencies of institutional transformation. When internal and external facilitating factors are reduced or missing, or research and evaluation are inadequate to

support the transformational initiatives, actions undertaken may be less likely to result in desired transformation outcomes.

Recommendations for Institutional Transformation

In this review, we used the metaphor of the leaky pipeline to identify the problems in women's representation, equity, and inclusion in academic S&E. Based on diverse interventions undertaken at 19 NSF ADVANCE institutions studied in this review have taken deliberate steps to improve gender representation and inclusion at all ranks and especially in leadership positions in academic S&E. From their experiences, it is possible to develop a general framework of institutional transformation to guide organizations seeking to improve the representation and inclusion of women and other minorities. Some recommendations for institutional transformation in academic S&E, as well as more general implications for HR practitioners in corporate and nonprofit environments, follow.

Universities can begin to increase women's representation in academic S&E by creating and supporting a transformation team composed of senior faculty leaders and administrators to comprehensively tackle the issues of women's underrepresentation.

Recommendations for HR Practitioners and Organizational Leaders in Academia

Universities can begin to increase women's representation in academic S&E by creating and supporting a transformation team composed of senior faculty leaders and administrators to comprehensively tackle the issues of women's underrepresentation. Such a team can help align and deploy the internal and external factors that facilitate transformation, as identified in our model. As shown in Figure 1, universities also should systematically engage in a combination of top-down and grassroots change efforts, targeting the removal of barriers constraining women at specific transition

points in the S&E pipeline and improving the macro- and micro-academic climates in which female faculty work. Resources for institutionalizing successful and stable initiatives, as determined by campus-specific research and evaluation, must be made available.

Gender equity data should be tracked and research findings shared regularly among decision makers. Keeping university administrators and faculty members aware of the status of faculty composition, climate, and resource equity focuses attention on the outcomes of institutional initiatives. There is also a need for more dissemination of information on available gender equity resources. Family-friendly policies, for example, have been in place for many years at most universities, but faculty members and administrators often are not aware of their existence or understand them fully or clearly (Quinn, Lange, & Olswang, 2004). To increase awareness and use of such programs, universities should use multiple communications channels to describe them to employees and to others.

Finally, systemwide efforts must be undertaken across academic S&E to develop and institutionalize the data collection and reporting practices that ADVANCE IT efforts have suggested is instrumental for transformation

in academic institutions. To this end, it would be helpful for external institutional funding agencies, such as the National Science Foundation and the National Institutes for Health, to encourage self-study and reporting activities about gender representation in all academic institutions that receive their funding.

Implications for Leaders and HR Practitioners in Nonacademic Organizations

Although there are differences between academic and nonacademic work environ-

ments, the general framework described here is relevant to HR practitioners and organizational leaders who face similar challenges as they strive to make their work environments more inclusive of women and other minorities.

As in academia, a clear goal and adequate resources are critical in any corporate transformation. Procedures to identify problems, supported by adequate statistical and research resources, should accompany that vision. Organizational change agents must be prepared to field questions and encounter resistance regarding women's underrepresented status and unsatisfactory experiences. They must also identify the resolution of those problems as essential to the long-term success of the organization. It is not enough for employees to recognize the problems as general public concerns. Rather, change agents should urgently identify these problems as issues that have serious implications for the long-term success of the organization.

Understanding, buy-in, and support from grassroots organizational members regarding the need for and activities of culture change are just as important as strong support from institutional leaders and senior organizational members. Particularly for gender equity-related institutional transformation, engaging male members at all levels of the organization in the culture-change effort is particularly critical in trying to achieve gender equality. As Dominguez (1992) points out, it is not women's inabilities that prevent their advancement, but rather their male managers' or peers' inabilities to deal with someone who is different and may not fit their paradigm. As the ADVANCE IT experience highlights, special initiatives and activities encouraging the partnership of men in gender equity changes at all hierarchical levels must be undertaken. Comprehensive institutional change to promote gender equity and inclusiveness requires simultaneous multi-impact initiatives. There is need for varied kinds of action at multiple levels at the same time. Hence, awareness creation, skill building, empowerment, leadership development, process im-

Understanding, buy-in, and support from grassroots organizational members regarding the need for and activities of culture change are just as important as strong support from institutional leaders and senior organizational members.

provements, and structural changes need to occur simultaneously.

Institutional transformation to advance women and other minorities can be amorphous and contested. The disadvantages that women and minorities experience may be largely invisible to others (Adler, Brody, & Osland, 2000). To demystify gender equity culture change, organizational leaders and HR practitioners can use metaphors to represent the typical career trajectory and to shed light on the minority experience. Although the academic pipeline is a good metaphor to capture linear academic careers, corporate career trajectories that involve lateral movements to other functions and divisions in addition to vertical movements may be better served by other metaphors. Pyramids and glass ceilings frequently have been used as metaphors to represent corporate movement. Recently, Mainiero and Sullivan (2005) introduced the kaleidoscope as a metaphor for women's careers, while Eagly and Carli (2007a, 2007b) introduced the labyrinth as a metaphor to describe women's path to leadership. They suggest that the complexities of the career decisions and obstacles that women and other minorities face may be depicted as vestiges and cul-de-sacs where women and minorities get trapped. HR practitioners may find it useful to track cohorts of women and minorities who joined the organization during different time periods to determine what kinds of vestiges and cul-de-sacs they enter and their long-term career outcomes.

Transformative change endures after the specific change project ends. To make representation and inclusion changes sustainable, leaders and HR practitioners should be alert to institutionalizing successful features promoting cultural and structural change and to mobilizing adequate resources to support the changes in the long run.

Suggestions for Future Research

Although our recommendations for developing an integrative model of institutional transformation for gender equity contribute to existing HR literature, future research is re-

quired to establish the specific contingencies under which specific transformational initiatives work best. Since the interventions were conducted, by and large, simultaneously within each ADVANCE institution without careful attention to experimental conditions, manipulations, or controls, our review could not tease out which solutions worked better than others. Future empirical research should attempt to identify the specific circumstances and structures needed for effective gender equity solutions within a comprehensive change project.

Future research also should more specifically address the role of external facilitating factors in nonacademic institutions. Our review hinted at the powerful facilitating role that external agencies and peer institutions may play in the gender equity-related transformation of academic institutions. Is there a similar impact from external agencies, possibly professional or trade associations, on corporations and nonprofit organizations? What examples do we have of cooperative and facilitative actions by peer organizations that typically operate as competitors in corporate environments? In addition, the institutionalization of change initiatives to yield sustainable outcomes needs to be studied more carefully. Future research should address the implications of sustainable transformation in the context of gender representation and inclusion and how best to achieve it.

Whereas the present review focused exclusively on the context of academic science and engineering, similar studies of other contexts, such as corporations and professions, need to be undertaken to shed light on how leading workplaces remove barriers and create an environment of inclusiveness. More detailed studies of context within academic S&E also may be useful. For example, how does the type of university (public versus private, research versus teaching, urban versus

Future empirical research should attempt to identify the specific circumstances and structures needed for effective gender equity solutions within a comprehensive change project.

rural) affect the goals, nature, and outcomes of the transformational initiatives undertaken? Finally, future research should more critically question whether achieving equitable gender representation, even in leadership, will energize the workplace for all.

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