AC 2010-282: TRANSFORMING THE ACADEMIC WORKPLACE: AN EVALUATION OF THE ADVANCE PROGRAM IN COLLEGES OF ENGINEERING (2001 - 2008)

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Transforming the Academic Workplace: An Evaluation of the ADVANCE Program in Colleges of Engineering (2001 - 2008)

Abstract

For over two decades, the US government has supported gender equity programs in Science, Technology, Engineering, and Mathematics (STEM) disciplines. In 2001, the National Science Foundation (NSF) initiated the ADVANCE Institutional Transformation (IT) program with the primary goal to increase the representation of women in STEM. Since 2001, 37 institutions of higher education have received the NSF ADVANCE IT awards, and 19 have completed their five-year projects. Using the American Society of Engineering Education (ASEE) data, we assess the changes in the representation of full-time tenure-track women faculty in engineering colleges. While earlier cross-institutional studies of the ADVANCE IT program focus only on ADVANCE institutions, we also compare engineering colleges at ADVANCE institutions to their university peers. Our analysis suggests that while the average gains in the percentage of full-time tenure-track engineering women faculty for Cohort 2 were almost twice the national average, the gains were uneven not only between the two cohorts, but also among the engineering colleges in each cohort. Similarly, the ADVANCE institutions showed an uneven performance when compared with their peers. We therefore raise important questions regarding how success is defined and conclude by highlighting the most interesting instances of successful and not so successful efforts along with the importance of conducting multi-level comparative analyses of ADVANCE and non-ADVANCE institutions.

Introduction

For over 20 years, the US government has invested in the development and implementation of gender equity programs in Science, Technology, Engineering, and Mathematics (STEM). The economic, technological, social, and educational benefits of creating a more diverse science and engineering workforce provide the impetus behind the equity efforts in STEM disciplines.[1] Integral to these efforts is the growth of the number of women obtaining STEM doctoral degrees and entering the academic workplace as faculty members. Although recent statistics indicate a substantive increase in the number of women receiving doctorates in STEM disciplines, the numbers of women STEM faculty fail to reflect this change.[2]

Using the metaphor of a leaky academic pipeline, social scientists observe disproportionate female attrition at critical pipeline points including receiving a Ph.D. degree, entering the assistant professor position, receiving tenure and promotion to associate rank, receiving promotion to full professor, and advancing into academic leadership positions.[2] Among factors accounting for this phenomenon, researchers point to how both the recruitment and advancement of women faculty are affected by the issues of institutional climate, including a sense of isolation[3], lack of role models[4], and lack of women in key academic leadership positions.[5] The traditional gender division of labor in the family and women's caregiving responsibilities are also mentioned as important barriers to the advancement of women in STEM disciplines.[6]

Issues affecting women's recruitment and progress through the academic pipeline are very similar across all STEM disciplines. However, women engineers face the unique challenge of the field being one of the longstanding male bastions.[7,8] Historically, engineering resisted diversity efforts[9], including the entrance of women into engineering education or academic careers.[6] Even today, male students appear to actively "engage in the process of masculinizing the subject area, and therefore marginalizing women students"[10,11] as well as women faculty.[7] With regard to faculty recruitment, Ward[12] notes that "[q]ualified women applicants are not given the opportunity to become engineering faculty because it is presumed that women will not have the time to serve as effective members of the professoriate given their family obligations." Women who do join the faculty ranks experience "bias, lack of professionalism shown toward women faculty […], visibility/invisibility, patronization, faculty spouse issues, and other women not acknowledging women engineers."[13] The prevalent cultural norm "assumes a work week of more than fifty hours a week, which continues to exclude women who have child care obligations,"[12] further hampering the advancement of women faculty.

Over the years, research showing the effects of the institutional culture and climate on the continued underrepresentation of women in STEM disciplines, including the field of engineering, provided a major impetus for different equity efforts. In 1999, such an impetus was created by the publication of the gender inequity study conducted by the Massachusetts Institute of Technology (MIT). The MIT study confirmed the existence of institutional barriers to women's advancement, including differential allocation of lab space, graduate students, and financial resources. Almost simultaneously, the National Science Foundation (NSF) recognized that the extant focus on and support for initiatives targeting women scientists, including the NSF Faculty Grants for Women Scientists & Engineers (FAW) and NSF Professional Opportunities Women in Research and Education (POWRE) programs, was misguided. The NSF reasoned that since discrimination against women is embedded in the organizational culture of STEM disciplines and the day-to-day practices of institutions of higher education[14], institutional rather than individual change is needed to address this situation. In contrast to initiatives and projects targeting individual women scientists, the NSF institutional transformation program is meant to enable the institutions of higher education to "define and implement effective approaches to increase the participation and advancement of women faculty members into the senior and leadership ranks of science and engineering, and to implement the necessary changes to institutionalize those approaches. By supporting the groundwork necessary to transform institutional practices systemically, the Institutional Transformation Awards seek to create positive, sustainable, and permanent change in academic climates."[15]

The NSF ADVANCE Institutional Transformation (IT) program was initiated in 2001 with the objectives 1) to increase the representation of women in STEM; and, 2) to encourage organizations to implement institutional changes that would empower women scientists to fully participate in STEM disciplines. Since 2001, 37 institutions of higher education have received the NSF ADVANCE IT awards totaling over $130M,[i] and 19 have completed their five-year projects. Although the nature of ADVANCE IT projects varies among universities, their common purpose is to engage both women and men faculty in an effort to create an environment in which all faculty members can thrive. An integral component of the ADVANCE IT strategy is "participation of all faculty (as opposed to using the traditional approach of addressing only the women -- aka the 'fix the woman' approach)."[16]

Recently, ADVANCE IT institutions have begun to disseminate information about their programs, including institution-specific analyses[16-23] as well as cross-institutional studies of the main factors contributing to the success of organizational changes.[14,24] Despite the growth of ADVANCE literature, not much is known about the effects of the program on gender representation in specific STEM disciplines, especially engineering, or about the effectiveness of the program compared to the non-ADVANCE institutions.

In this study, we assess institutional effects of the ADVANCE IT program by examining the changes in the representation of full-time tenure-track women faculty in seven engineering colleges associated with select public universities that had the ADVANCE IT programs between 2001 and 2006, and six engineering colleges associated with those select public universities that had ADVANCE IT programs between 2003 and 2008.[ii] To better assess the program effects, we compare changes at the 13 engineering colleges to the changes that occurred during the same time period at the engineering colleges of each university's peer institutions.[iii] We conclude by highlighting the most interesting instances of successful and not so successful efforts. We also emphasize the importance of conducting multi-level comparative analyses of ADVANCE and non-ADVANCE institution and raise questions regarding how success is defined.

Assessing ADVANCE IT Programs

To date, three cross-institutional studies assess the outcomes and effectiveness of the ADVANCE IT program. First, Plummer[25] examines the main institutional barriers to the implementation of the ADVANCE IT program as well as key strategies used to promote institutional transformation in Cohort 1 and Cohort 2 institutions. Using interviews with 35 co-PIs, faculty members and administrators responsible for the implementation of the ADVANCE IT program at 18 out of the 19 institutions, Plummer[25] observes that the ADVANCE IT projects operate at three different levels: 1) changes at the institutional level include the implementation of family-friendly policies; 2) departmental-level changes involve strategies aimed at improving both faculty search and advancement processes, and 3) individual-level strategies focus on implementing mentoring and leadership programs to help women faculty members develop professional support systems and research networks.

Given the multi-level strategies and processes involved in the pursuit of an institutional transformation, the respondents stressed that the successful program implementation depends on the leadership of well-respected senior faculty members and administrators as well as effective communication of program goals. With regard to factors that hinder change, several respondents pointed to the gender dynamics of the program,[25] including 1) perceptions that the program gives an unfair advantage to women; 2) resistance from some senior women faculty; and, 3) the limited involvement of men faculty.[25] In some cases, respondents also stressed how the NSF program guidelines limited the nature of transformation by not allowing the ADVANCE IT program be expanded to include initiatives relevant to hiring and retaining minority faculty members.[25]

In another ADVANCE study, Frehill et al.[26] compare women's representation and rank across various science and engineering disciplinary fields. Based on an analysis of national data, Frehill et al.[26] show that women are more likely than men to occupy the junior level (assistant professors, post-docs, research associates, and part-time faculty) academic positions. With regard to the ADVANCE program, the authors[26] find that it has had uneven outcomes across different institutions. Specifically, after the implementation of ADVANCE IT, horizontal sex-segregation by discipline decreased at some universities and increased at others. Accordingly, Frehill et al.[26] recommend that future research designs should not only expand the time period under study but also include the starting points—percentages of women faculty within each rank and discipline—as a comparison group for changes during and after the implementation of an ADVANCE program.

More recently, Bilimoria et al.[24] examine the outcomes of the ADVANCE IT program at 19 institutions representing the first and second cohort of the program. They argue that successful institutional transformation requires the synergy of facilitating internal factors (senior administrative support, collaborative leadership, flexible vision, and visible action), research and evaluation, change initiatives, institutionalization of changes, and outcomes. Although 18 of the 19 institutions were successful in increasing the representation of women in STEM disciplines in five years, the greatest increase in female faculty representation was at the rank of assistant professor with the percentage gains declining at higher ranks. Bilimoria et al.[24] also note that, at one university where the number of women STEM faculty declined during the ADVANCE IT period, awareness about the program, collaboration across university units, and professional development programs, were conspicuously absent. Finally, similar to Frehill,[26] Bilimoria et al. contend that comparison across diverse institutions and their interventions can be problematic due to different starting points, institution specific barriers and climates, and institutional type (research intensive doctoral versus teaching oriented).

In sum, to accurately assess institutional transformation both within and across ADVANCE program institutions, and thus evaluate the effects of this program, research designs should include a longer time frame, a complete record of institutional starting points, and the development of a general but reflexive framework to examine and to evaluate the diversity of transformation initiatives (and their outcomes) at ADVANCE institutions. In an effort to address some of these issues, this study is a comparative analysis of starting and end point data on full-time tenure-track faculty at both ADVANCE and non-ADVANCE peer institutions in the broader context of national trends.

Scope of Study

To date 37 institutions received major ADVANCE grants and 19 institutions completed their programs. Given our focus on outcomes of the ADVANCE program, we limited our analysis to select Cohort 1 (2001-2006) and Cohort 2 (2003-2008) ADVANCE institutions as shown in Table 1. Since the scope of the ADVANCE program varies across institutions, with some institutions implementing the program in a few selected departments and some also including social sciences, it is not always feasible to compare outcomes across the entire institutions.[26] Also, disciplinary fields differ considerably with regard to the number of women with Ph.D. degrees or on the faculty. Thus, in order to ensure a degree of discipline-related uniformity, we decided to focus on engineering colleges only. To ensure a greater consistency with regard to their institutional characteristics, we further limited our analysis using the following criteria: 1) public institutions; 2) doctoral engineering programs. Also, since not all ADVANCE institutions publish the information regarding the outcomes of their ADVANCE programs on their websites, we excluded all institutions that do not make such information public. Using these criteria, our analysis included seven engineering colleges from Cohort 1 and six from Cohort 2 as shown in Table 1.

Table 1. Institutions of ADVANCE Cohorts 1 and 2.

Cohort 1 Institutions (2001-2006)	**Cohort 2 Institutions (2003-2008)**
Georgia Institute of Technology	Kansas State University
New Mexico State University	Virginia Polytechnic Institute and State University
University of California, Irvine	University of Alabama at Birmingham
University of Colorado at Boulder	University of Rhode Island
University of Michigan (Ann Arbor)	University of Texas at El Paso
University of Washington	Utah State University
University of Wisconsin, Madison	**Cohort 2 Institutions Not Considered**
Cohort 1 Institutions Not Considered	Case Western Reserve University**
Hunter College of the City University of New York*	Columbia University**
University of Puerto Rico, Humacao*	The University of Montana*
	University of Maryland, Baltimore County***

*Institution does not offer B.S., M.S., or Ph.D. engineering degrees.
**Private institution.
***No ADVANCE data on web site.

Method

According to Frehill et al.,[26] given the goals of institutional transformation, Kanter's[27] approach to institutional analysis utilizing sex ratios as an indicator of the gender nature of organizations is very useful. Building on this idea, we examined changes in the gender composition of engineering faculty using data from the Profiles of Engineering and Engineering Technology Colleges[28] published by American Society for Engineering Education (ASEE). In addition to data regarding gender composition of full-time tenure-track faculty in engineering colleges, we collected other data, including the number of engineering faculty, five-year changes in the number of faculty, and calculated the gains in the number of women faculty as well as percentage gains in women engineering faculty. We also used some other descriptive statistics, including national and ADVANCE cohort averages.

In our analysis, we compared each ADVANCE institution to 1) other ADVANCE institutions within the same cohort; 2) the national average; and 3) the university's peer institutions. Building on Frehill et al.,[26] we assumed that since institutions select their peers to provide them with a set of benchmarks and tangible ways to define their aspirations, peer institutions provide the most adequate reference point for gender-equity related analyses. We obtained the lists of peers from the websites of the thirteen ADVANCE institutions. Tables 2a and 2b show the institutional peers for Cohorts 1 and 2, respectively. The peers of the ADVANCE institution were based on the university and not the engineering college. To be included as a university peer, each institution had to meet the following criteria: 1) college of engineering: 2) doctoral engineering programs; 3) no ADVANCE program during the time period of comparison.

Table 2a. University peers for Cohort 1 (2001-2006) institutions.

Cohort 1 Institution	**University Peers***		
Georgia Institute of Technology	North Carolina State University Purdue University Texas A&M University The Pennsylvania State University	The University of Texas at Austin University of California, Berkeley University of California, Los Angeles	University of Florida University of Illinois at Urbana-Champaign University of Minnesota - Twin Cities
New Mexico State University	Clemson University Colorado State University Iowa State University Louisiana State University Oklahoma State University	Oregon State University Texas A&M University The University of New Mexico University of Arizona	University of Missouri-Columbia University of Tennessee, Knoxville University of Wyoming Washington State University
University of California, Irvine	Stony Brook University University of California, Los Angeles	University of California, San Diego University of California, Santa Barbara	University of Florida University of Illinois at Urbana-Champaign
University of Colorado at Boulder	Michigan State University State University of New York at Buffalo Stony Brook University The Ohio State University The University of Iowa University of Arizona	University of California, Davis University of California, Irvine University of California, Los Angeles University of California, San Diego University of Florida University of Michigan (Ann Arbor)	University of Minnesota - Twin Cities University of Missouri-Columbia University of Virginia University of Washington University of Wisconsin, Madison
University of Michigan (Ann Arbor)	Michigan State University The Ohio State University Purdue University	Stony Brook University The University of Iowa University of California, Berkeley	University of California, Los Angeles University of Illinois at Urbana-Champaign University of Minnesota - Twin Cities
University of Washington	University of California, Davis University of California, Los Angeles University of California, San Diego	University of Connecticut University of Maryland, College Park University of Massachusetts Amherst	Rutgers, The State University of New Jersey University of Virginia
University of Wisconsin, Madison	Purdue University The Ohio State University The University of Texas at Austin	University of California, Berkeley University of California, Los Angeles	University of Illinois at Urbana-Champaign University of Minnesota - Twin Cities

*Obtained from Cohort 1 institution web site.

Table 2b. University peers for Cohort 2 (2003-2008) institutions.

Cohort 2 Institution	**University Peers***		
Kansas State University	Colorado State University Iowa State University	North Carolina State University Oklahoma State University	Oregon State University
University of Alabama at Birmingham	Oregon State University Stony Brook University	University of California, Berkeley	University of Houston
University of Rhode Island	Montana State University North Dakota State University	University of Maine University of New Hampshire	University of Vermont University of Wyoming
University of Texas at El Paso	The University of Akron University of Nevada, Las Vegas	University of Nevada, Reno	University of Wisconsin, Milwaukee
Utah State University	Colorado State University Iowa State University North Carolina State University	Oregon State University Texas A&M University The Pennsylvania State University	Washington State University University of California, Davis
Virginia Polytechnic Institute and State University	Michigan State University North Carolina State University Purdue University Rutgers, The State University of New Jersey State University of New York at Buffalo Stony Brook University	Texas A&M University The Pennsylvania State University The University of Texas at Austin University of California, Berkeley University of California, Davis University of Florida	University of Illinois at Urbana-Champaign University of Maryland, College Park University of Minnesota - Twin Cities University of Missouri-Columbia University of Pittsburgh University of Southern California

*Obtained from Cohort 2 institution web site.

For the purpose of interpretation, we consulted data available on the websites of ADVANCE institutions, including NSF mandated annual reports, climate surveys, site-visit reports, and final program evaluations. Also, for each university peer institution, we collected data regarding the existence and nature of various faculty development programs, mentoring efforts, climate surveys, etc. In addition, we also examined the websites of each engineering college to determine the nature of their gender-related initiatives and projects.

Analysis

Figure 1 shows the five year percentage gains in the number of full-time tenure-track women faculty for Cohorts 1 and 2 in comparison to the national average. For both cohorts the increase in the average number of women faculty during the grant period is quite similar with Cohort 1 adding an average of six female faculty members and Cohort 2 adding an average of eight women. When calculated as a five year percentage gain, however, women faculty at ADVANCE institutions grew 23.9% for Cohort 1 and 75.4% for Cohort 2. During the same time periods, the average national gain stood at 49.2% and 39.4%. This suggests that, in comparison to national trends, Cohort 1 under-performed, while Cohort 2 over-performed. Yet, upon closer examination, the discrepancy between Cohort 1 and Cohort 2 can be attributed to the differences in the average number of women faculty in ADVANCE institutions at the start of the program. Since Cohort 2 had a lower starting point, it shows a much higher average percentage gain than Cohort 1.

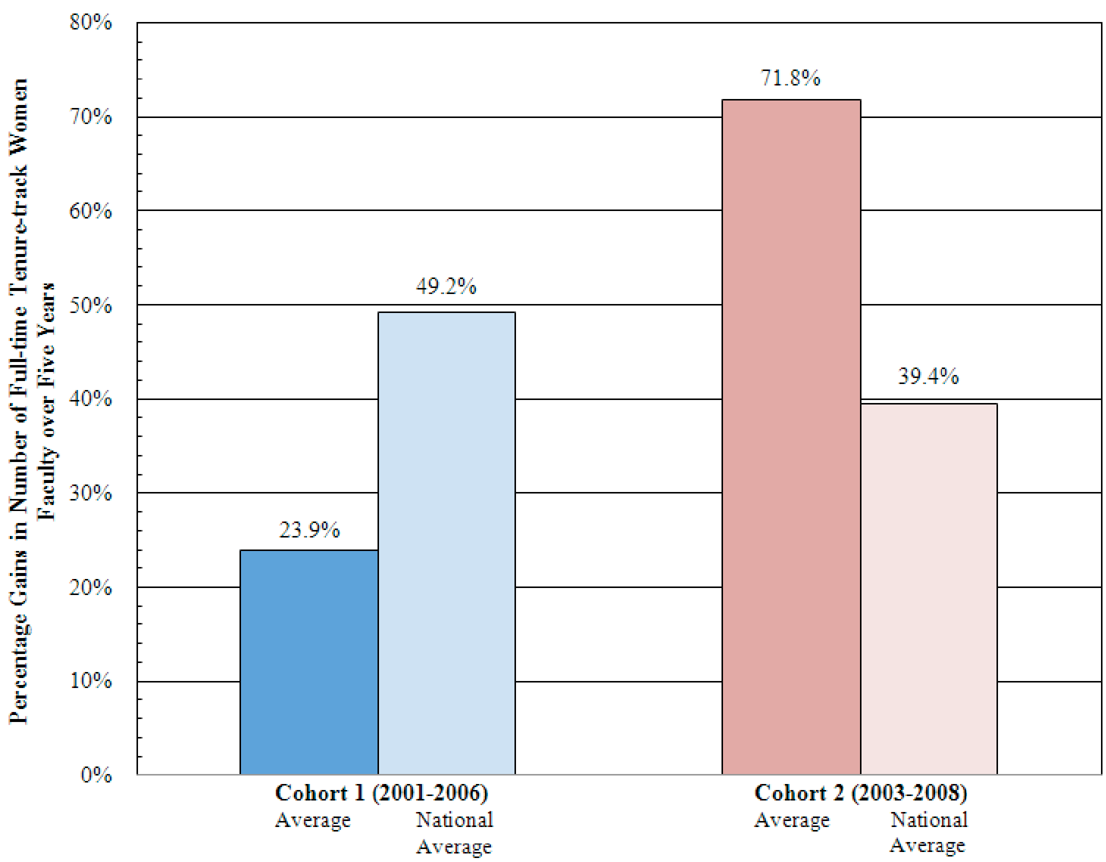

Figure 1. Five year percentage gains in the number of full-time tenure-track women faculty for Cohorts 1 and 2 versus national average.

Accordingly, keeping in mind the program's stated goal of institutional transformation mentioned above, we focus our analysis on the percentage of women faculty at ADVANCE and university peer institutions at the start and the end of the program for each cohort. Since these changes occur in the broader context of national trends, the national data representing the average percentages of women faculty provide a useful reference point.

Figure 2 shows the percentage of full-time tenure-track women faculty at the start and end of Cohort 1 and Cohort 2 ADVANCE grant versus national average. Specifically, in 2001 at the start of the Cohort 1 grant period, the average percentage of women faculty at the seven Cohort 1 institutions was almost 2 percentage points higher than the national average (10.7% versus 8.9%); in 2006, the margin of advantage somewhat declined, standing at 12.7% versus 11.3%. The data for Cohort 2 tell a slightly different story. In 2003, the average percentage of women faculty at the six ADVANCE institutions was lower than the national average (8.2% versus 9.9%). In 2008, at 12.3%, it was equal to the national average.

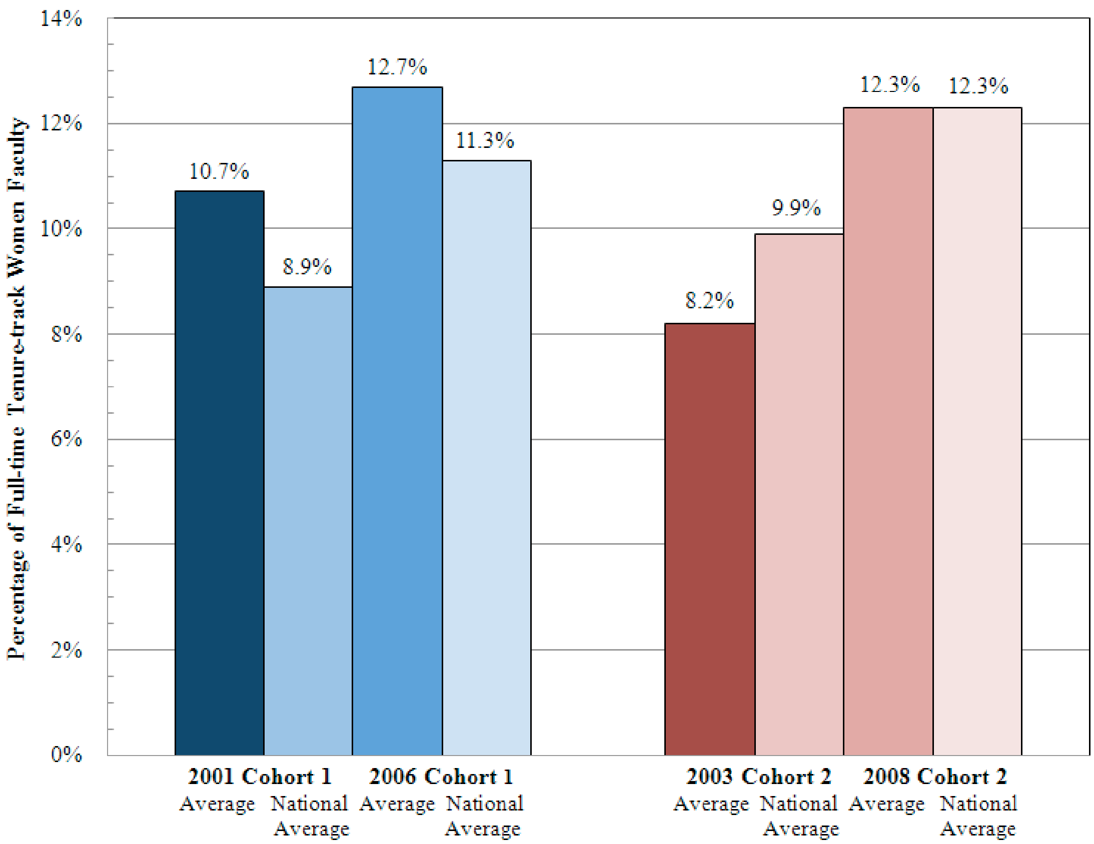

Figure 2. Percentage of full-time tenure-track women faculty at the start and end of the Cohort 1 and Cohort 2 ADVANCE grant versus national average.

Figures 3a and 3b show the percentage of full-time tenure-track women faculty at the start and end dates of Cohort 1 and Cohort 2 ADVANCE grants, respectively. Specifically, the percentage of women faculty at all Cohort 1 institutions were greater than or equal to the national average at the start of the ADVANCE grant period. And, with two exceptions, all ADVANCE institutions show an increase in the percentage of women faculty during their ADVANCE programs. The two exceptions, both Cohort 1 institutions, are the New Mexico State University

(NMSU) where the percentage of women faculty declined from 9.1% to 6.2%, and the University of California (UC) at Irvine, where the percentage did not change over the five year period. In addition, during this period, both NMSU and the UC at Irvine slipped below the national average at the end of the grant period as shown in Figure 3a. Thus, only five Cohort 1 institutions still out-performed the national average when the grant ended in 2006. Importantly, among these five institutions, Georgia Tech, which in 2001 stood 2% higher in the percentage of women faculty than the national average in 2001, but was only 0.4% above the national average in 2006, actually lost some of its advantage when compared to the national average.

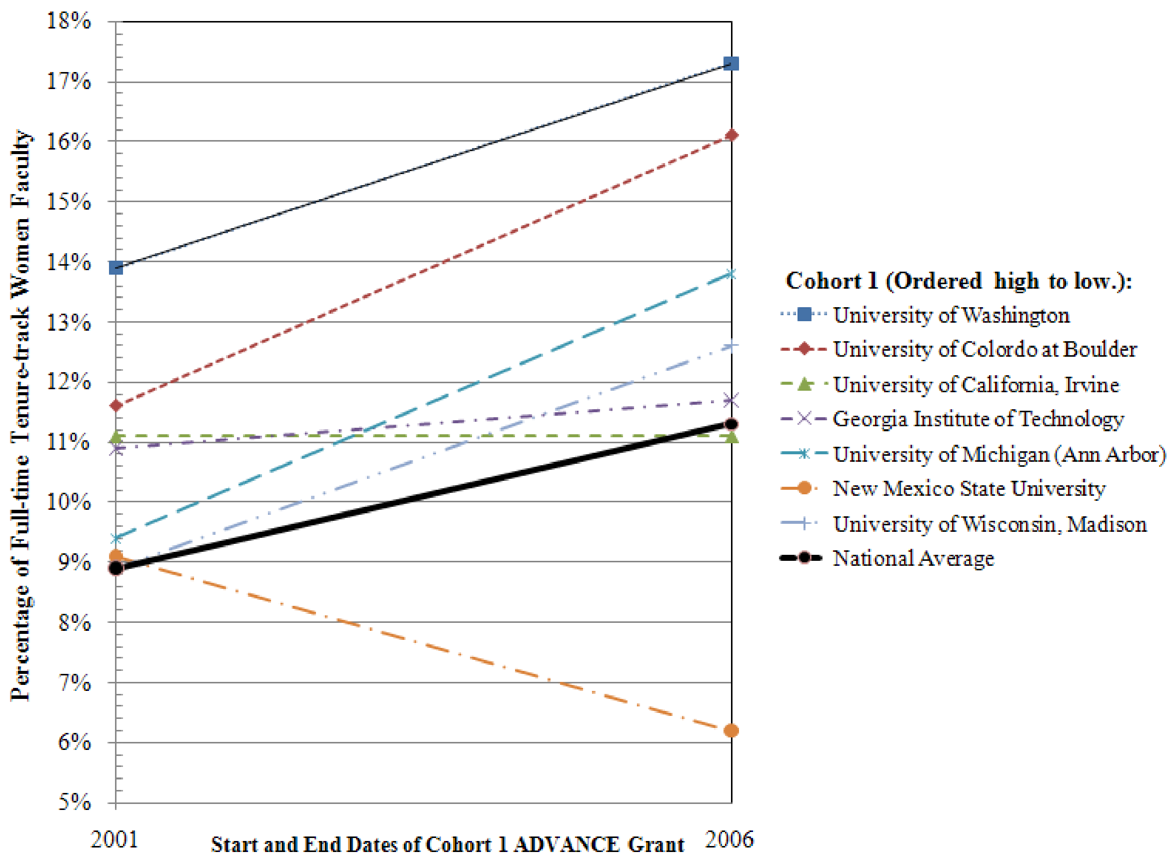

Figure 3a. Percentage of full-time tenure-track women faculty at start and end dates of Cohort 1 ADVANCE grant.

As Figure 3b shows, in Cohort 2, the percentage of women stood below the national average in five out of six ADVANCE institutions in 2003. In 2008 only two institutions, the University of Texas (UT) at El Paso and Utah State University, were still below the national average. UT at El Paso, however, doubled the number of women engineering faculty from four to eight during the grant period, and at the Utah State University, the share of women among engineering faculty increased by four percentage points, from 5.7% to 9.7%. As a result, both institutions were able to at least diminish the distance separating them from the national average.

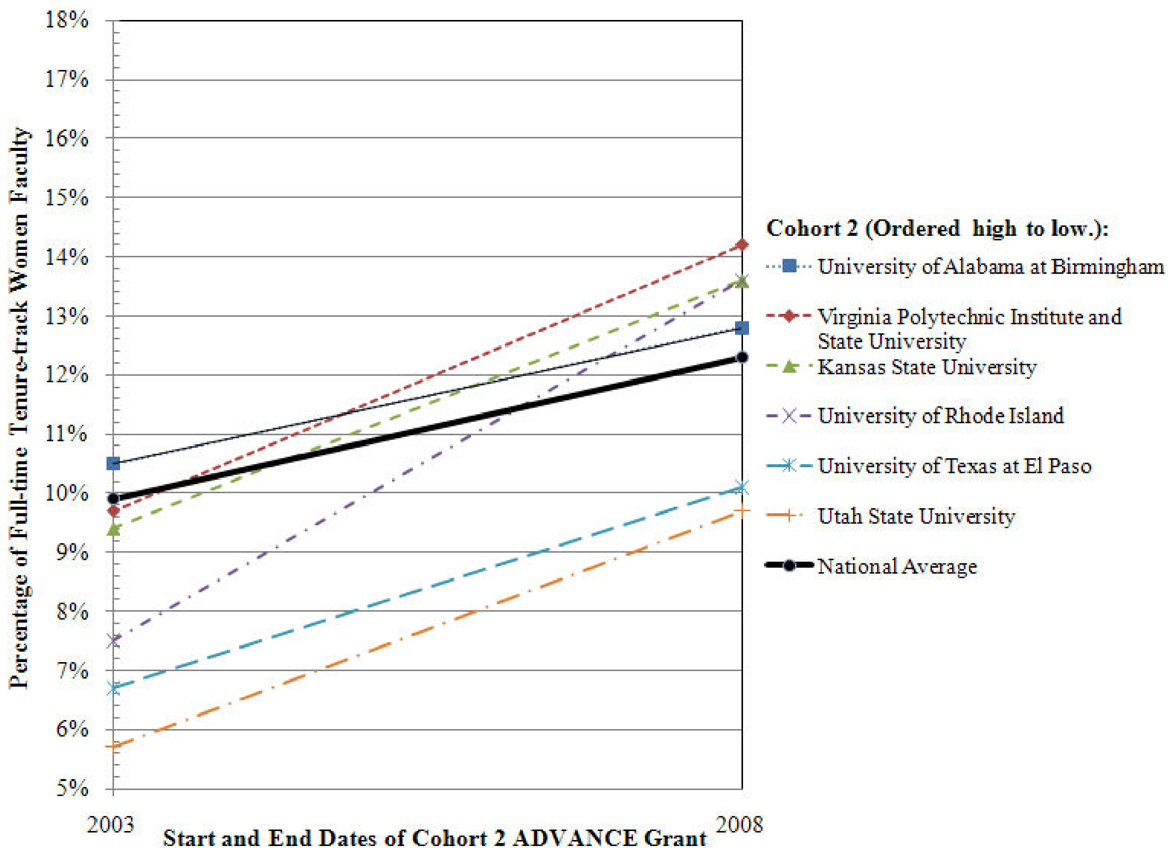

Figure 3b. Percentage of full-time tenure-track women faculty at start and end dates of Cohort 2 ADVANCE grant.

Compared to the national average, the ADVANCE engineering colleges from each cohort demonstrating the most impressive performance are the University of Colorado (UC) at Boulder, the University of Washington (Cohort 1), the University of Rhode Island, and Virginia Tech (Cohort 2). First, in terms of net gain in the percentage of women faculty, the University of Colorado at Boulder and the University of Rhode Island showed impressive increases going from 11.6% to 16.1% and 7.5% to 13.6%, respectively. Second, in terms of the overall performance, the University of Washington maintained its leadership position among Cohort 1 institutions and finished as the top performer among all ADVANCE institutions examined here (17.3%). In Cohort 2, Virginia Tech started below the national average (9.7% versus 9.9%), but finished as the third best performer, after the University of Washington and the UC at Boulder, with regard to the percentage of women faculty among all of the institutions (14.2%).

Tables 3a and 3b show the rank of Cohort 1 and 2 institutions, respectively, with their university peer group at start and end of ADVANCE grant. In terms of how ADVANCE colleges of engineering compare to their university peers, two findings stand out. First, during the time periods covered in this study, 2001-2006 and 2003-2008, some engineering colleges at ADVANCE schools lost their standing in relation to their peers. Second, although the majority of the ADVANCE engineering colleges improved their relative standing, several of their peers show much stronger final result in terms of the overall proportion of women faculty.

With regard to the first point, in Cohort 1, for example, in its peer group, the University of Washington[iv] had the highest percentage of women at the start and the end of the ADVANCE program, 13.9% and 17.3% respectively. While the University of Washington was able to maintain its top ranking, the UC at Irvine, which occupied the top position at the start of the ADVANCE program, did not. Specifically, the UC at Irvine started and remained at 11.1% of women faculty members. Accordingly, the engineering college at Stony Brook University overtook the top position at Irvine's peer group increasing the percentage of female faculty from 10.8% to 14.5%. A different dynamic occurred at Georgia Tech's engineering college, which declined in ranking from the 3rd to the 5th position despite the net gain of seven women faculty members. Purdue University[v] led Georgia Tech's peer group by adding 18 women and increasing women's representation on the faculty from 9.5% to 15%. NMSU was the worst performer among Cohort 1 institutions. Here, the net loss of one female faculty member resulted in the NMSU sliding from fifth to the 13th position among its peers with respect to female faculty representation.

Besides the University of Washington, which maintained its top standing across all comparative dimensions examined here, only three other Cohort 1 institutions, namely the University of Colorado at Boulder, the University of Michigan at Ann Arbor and the University of Wisconsin at Madison, performed in accordance to what would be expected of ADVANCE schools by increasing their standing relative to their peers. The University of Colorado at Boulder moved from the 2nd to 1st place, the University of Michigan moved from 6th to 3rd place, and the University of Wisconsin moved from 4th to 2nd place in percentage of female engineering faculty in their respective peer groups. It is worth mentioning that Purdue University, which is in the peer group for both the University of Michigan at Ann Arbor and the University of Wisconsin at Madison, ended the grant period with the highest percentage of women faculty in both peer groups.

Table 3a. Rank of Cohort 1 institution with university peer group at start and end of ADVANCE grant for percentage of full-time tenure-track women faculty.

Cohort 1 Institution	**Rank with University Peers***	
	Start 2001	**End 2006**
Georgia Institute of Technology	2/11	4/11
New Mexico State University	5/14	12/14
University of California, Irvine	1/7	2/7
University of Colorado at Boulder	3/18	2/18
University of Michigan (Ann Arbor)	4/10	3/10
University of Washington	1/9	1/9
University of Wisconsin, Madison	4/8	2/8

*See Table 2a for list of Cohort 1 university peers.

Note: Shaded cells denote no change or increase in rank compared with university peers.

The patterns are very different with Cohort 2. First, at the start of the grant period, none of the ADVANCE institutions had the highest percentage of female faculty in their peer group. Second, with the exception of the University of Alabama which maintained its standing, all other Cohort 2 engineering colleges improved in their relative ranking. For instance, Kansas State University moved from 4th to 2nd place (9.4% and 13.6%), University of Rhode Island from 5th to

3rd (7.5% to 13.6%), UT at El Paso from 5th to 2nd, Utah State University from 9th to 8th, and Virginia Tech from 10th to 6th. The top performers in the respective peer groups at the end of the examined period (2008) include Oregon State University (14.5%), University of Vermont (17.1%), University of Arkansas (12.6%), and University of California (UC) - Davis (17.6%). It is worth noting that some of the Cohort 2 peer institutions, such as Oregon State University and UC-Davis, started from a much better position than the ADVANCE institutions in those groups, i.e., Kansas State University and Virginia Tech. Other peers, however, such as Stony Brook University and University of Vermont, clearly outperformed the ADVANCE institutions.

Table 3b. Rank of Cohort 2 institution with university peer group at start and end of ADVANCE grant for percentage of full-time tenure-track women faculty.

Cohort 2 Institution	**Rank with University Peers***	
	Start 2003	**End 2008**
Kansas State University	4/6	2/6
University of Alabama at Birmingham	4/5	4/5
University of Rhode Island	5/7	3/7
University of Texas at El Paso	5/5	2/5
Utah State University	9/9	8/9
Virginia Polytechnic Institute and State University	10/19	6/19

*See Table 2b for list of Cohort 2 university peers.
Note: Shaded cells denote no change or increase in rank compared with university peers.

Beyond the Numbers: Defining and Measuring Success

In this paper, we conducted a comparative analysis of the changes in the representation of full-time tenure-track women faculty in 13 engineering colleges associated with select public universities that implemented the ADVANCE IT programs between 2001 – 2006 and 2003 – 2008. Our contributions to the emerging body of literature examining the outcomes of the ADVANCE IT programs are two-fold. To our knowledge, this is the only cross-institutional analysis of the ADVANCE-related changes in the percentage of women faculty in engineering colleges. Also, this is the first assessment of the ADVANCE IT program wherein the engineering colleges at ADVANCE institutions are compared to their non-ADVANCE institutional peers. Below, we summarize our main findings, provide an initial interpretation of the observed changes, and discuss study limitations.

Findings

First, our study suggests that, in comparison to national trends, engineering colleges at Cohort 1 institutions under-performed, while Cohort 2 colleges over-performed in terms of the average gains in the percentage of women faculty. This performance disparity can be attributed to the differences in the starting points of the Cohort 1 and Cohort 2 colleges. Specifically, with the overall average of nine women faculty, the engineering colleges at Cohort 2 institutions had a lower starting point than those at Cohort 1 institutions, where the average stood at 21 women faculty. Since Cohort 2 had a much lower starting point, it shows a much higher average percentage gain than Cohort 1.

Second, in terms of the representation of women faculty, the engineering colleges in Cohort 1 show mixed performance, with some of them losing their standing as compared to the national average. For instance, the percentages of women faculty at all Cohort 1 institutions were greater than or equal to the national average at the start of the ADVANCE grant period in 2001. However, by the time the grant ended in 2006, two of the Cohort 1 institutions (NMSU and the UC at Irvine) slipped below, and one Cohort 1 institution lost some of its initial advantage in relation to, the national average. In contrast, all Cohort 2 institutions show the expected upward trend, even though two of the six engineering colleges in this cohort (Utah State University and UT at El Paso) remained below the national average at the end of the ADVANCE program.

Third, the ADVANCE institutions also showed an uneven performance when compared with their peers. In Cohort 1, three engineering colleges lost their standing in relation to their counterparts associated with their university peers. Interestingly, although all of the ADVANCE engineering colleges in Cohort 2 either maintained or improved their relative standing among their institutional peers, some of their non-ADVANCE peers showed much stronger final result in terms of the changes in the overall proportion of women faculty.

Thus, it appears that across all comparative dimensions examined here, while the colleges of engineering associated with Cohort 1 of ADVANCE institutions showed mixed results, their counterparts associated with Cohort 2 show trends that are more in line with what would be expected of ADVANCE institutions.

Interpretation

We attribute the performance differences between the engineering colleges in Cohort 1 versus Cohort 2, to their *different starting points*, including the two year lag between the two cohorts. In fact, although we did not examine the overall institutional characteristics of Cohort 1 and Cohort 2 universities, it appears that the NSF ADVANCE program directors looked for different types of institutions and initiatives in each round of proposals.[29] Based on our analysis, we can say that the colleges of engineering represented in each of the two cohorts are different. For instance, at the start of the ADVANCE program, the average number of full-time tenure-track faculty at the engineering colleges in Cohort 1 was 198 versus 107 in Cohort 2. Structurally, it may be more difficult to transform larger institutions. Also, Cohort 1 of the ADVANCE institutions did not have access to the same information sharing experiences as did Cohort 2, which, due to the two-year time lag, could draw on what worked or did not work for their predecessors.

An important question to ponder in this context is how much the overall success of the ADVANCE program at both the university and college level, may depend on A) its timing, B) the structural characteristics of participating institutions and colleges, and C) the ability to draw on the collective experience of other ADVANCE recipients. Another important issue to consider is *what constitutes success*. While the "success" of ADVANCE is defined by the overall goal of the program, i.e., to increase the participation and advancement of women in academic science and engineering careers, the meaning of the central concepts, including the connotation of the target population, does seem to have somewhat shifted with the various cohorts.[29] If this is the case and future ADVANCE proposals will be judged on whether they have "fully developed strategies for supporting the participation and advancement of women of color in academic science and engineering,"[29] then such shift will influence the definition of success.

In assessing the ADVANCE program, attention is typically given to the overall institutional culture and climate at the university where the ADVANCE program is implemented. However, the developments at the UC at Irvine also point to the importance of the broader context. Specifically, the relative lack of progress in increasing the representation of women among engineering faculty may be better understood by examining broader trends in the State of California.[26] In 1995, the UC regents abolished affirmative action within the system. A year later, California passed Proposition 209, a state-wide anti-affirmative action initiative that, according to West,[30] had a detrimental effect on hiring women faculty in the California state system. Although during the 2000 – 2004 period UC at Irvine actually out-performed the rest of the universities in the system,[26] it is possible that the anti-affirmative action climate eventually stalled the progress. The case of the UC at Irvine demonstrates that state policies can work at cross-purposes with institutional goals. Thus, if our assessment focuses on public institutions, it may be important to also examine broader policy trends and challenges to equity efforts.

Our analysis also highlights the importance of conducting comparisons across different disciplinary fields and/or appropriate college or school units within the same university. For instance, the university-level gains in female faculty may not be evenly distributed across disciplinary fields. In fact, while NMSU engineering showed setbacks during the ADVANCE grant period, the overall percentage of STEM women faculty at NMSU increased from 15.9% in 2001 to 20.6% in 2006.[31] Conversely, although engineering faces the most challenging pipeline issues, some ADVANCE schools show better outcomes in engineering than in other fields. Thus, between 2003 and 2008, the overall percentage of women faculty at Virginia Tech changed by three percentage points; yet, the percentage of women faculty in the College of Engineering increased by 4.5% and in the College of Sciences by only 2%.[32] The cases of UC at Irvine, NMSU, and Virginia Tech illustrate the importance of examining the results of the ADVANCE program within the broader, i.e., state level, policy context, on the one hand, and across different disciplinary fields within the same institution.

Our comparison of ADVANCE institutions with their peers suggests that some of the engineering colleges at non-ADVANCE institutions, including Stony Brook University, Washington State University, University of Vermont, and Purdue University, more successfully increased women's representation on the faculty than the colleges associated with ADVANCE institutions examined here both in terms of final results and the pace of change. Interestingly, some of these top performing institutions (e.g., Purdue University, Washington State University) received ADVANCE IT awards during the most recent (2008) round of ADVANCE solicitations. Although we were not able to access information regarding the specific efforts underlying the increase in the percentage of women engineering faculty at these four institutions, the case of Purdue may provide a glimpse into this subject. Independent of the ADVANCE program, in 2001 Purdue implemented a strategic plan establishing a set of benchmarks for progress in diversity efforts. In this context, the university engaged in retention efforts, considerably increasing the university-wide eight-year female assistant professor retention rates from 33% in 2001 to 53% in 2005.[33] In 2008 when Purdue was awarded the NSF ADVANCE IT grant, the NSF panel commented on Purdue's "institutional readiness and commitment for large scale transformation."[34] In this context, an interesting question to ponder is the extent to which the NSF is interested in changing the institutions to which it provides support or "rewarding" the institutions that are already making progress.

Limitations

An important caveat here is that both our conclusion and the aforementioned question are based on numerical outcomes without considering the changes in the overall institutional culture and day-to-day practices at the ADVANCE versus non-ADVANCE institutions. It is possible that, in the long run, the ADVANCE institutions are more successful both with regard to numerical results and the less tangible outcomes such as institutional climate and faculty satisfaction. This caveat also points to some other limitations of our analysis.

Increasing the overall representation of women faculty is an important aspect of institutional transformation as it allows us to assess progress toward the creation of a critical mass of women faculty.[vi] And, it is also a critical *first step* toward a more prominent institutional change by creating a greater likelihood of women entering the leadership positions. Given that one of the most critical factors ensuring success of an institutional transformation is leadership support,[35] the presence of women in the leadership positions not only transforms the authority structure but also creates further opportunities for successful institutional change. However, although gender composition is an important indicator of institutional transformation,[25] our exclusive focus on this measure is also a limitation of this study. An adequate understanding of institutional transformation requires the inclusion of other quantitative as well as qualitative indicators, such as the number of women in the highest academic ranks and leadership positions or the heightened awareness of equity issues, which are also better indicators of lasting change.[vii]

Institutional transformation is a long-term, ongoing process, which often requires a much longer time horizon than five years.[36] A more accurate understanding of the nature and extent of transformation can be gained by expanding the time-frame for comparisons beyond the five year period.

With these limitations in mind, we believe that in order to understand why some institutions are successful and some are not, and how success is being defined, it is important to continue comparing ADVANCE institutions across different institutional levels and over time. Moreover, in addition to providing us with a better understanding of the different strategies and initiatives, such comparisons can also tell us what else may be important to look at, such as different starting points, policy contexts, and the success stories that may materialize even without ADVANCE funding.

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Endnotes

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[i] In addition to 37 major ADVANCE grants, the NSF also awarded four smaller grants to support promising initiatives. For the full list of ADVANCE IT institutions see the NSF website http://www.nsf.gov/pubs/2009/nsf0941/nsf0941.pdf.

[ii] The eleven institutions include: Cohort 1 ADVANCE Institutions (2001-2006): Georgia Institute of Technology (Georgia Tech), University of Michigan (Ann Arbor), New Mexico State University (NMSU), University of California, Irvine, University of Colorado at Boulder, University of Wisconsin, Madison, University of Washington; Cohort 2 ADVANCE Institutions (2003-2008): University of Rhode Island, University of Texas El Paso, University of Alabama at Birmingham, and Virginia Polytechnic Institute and State University (Virginia Tech).

[iii] In a discussion of different assessment strategies, Frehill et al.[26] suggest that using an institution's own peers for comparison purposes is especially well suited "to understand the extent of change relative to gender equity goals."

[iv] The Washington State University received the ADVANCE IT grant in 2008.

[v] Purdue University received the ADVANCE IT grant in 2008.

[vi] The concept of critical mass is related to the gender-ratio indicator. In her pioneering work Kanter (1977) distinguished among four gender ratio categories: the female token category ranges from 0 to 17%, the female minority ranges from 18 to 35%, and the sex-balanced ratio stands between 36 t0 64%. The critical mass indicator is typically designated at the high end of the female minority category, i.e., at 30%.

[vii] Recognizing the need for a more robust understanding of institutional transformation, in 2002, the principal investigators representing the nine Cohort 1 institutions developed a set of twelve indicators that all ADVANCE IT institutions use for the purpose of a national-level comparative evaluation. Subsequently, in 2003, the ADVANCE IT working group developed an additional set of assessment strategies, including qualitative methods, to provide a more multifaceted understanding of program's effects.