Looking Back to Look Forward: A Retrospective Examination of ADVANCE

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Abstract

The 20th anniversary of the ADVANCE initiative provides an opportune time to look back at the origins of ADVANCE. We consider these origins from two perspectives: first, the history of funding, rationale, and expectations of the National Science Foundation's initial program solicitation. Given the shift at NSF from boosting individual experiences to redressing systemic inequities, we also examine the activities, successes, and limitations of the first two cohorts of 19 Institutional Transformation (IT) projects and how they set the stage for later insights and innovations. As the evidence accumulates about gendered and racialized inequities in the impact of the global COVID-19 pandemic on teaching, research, and career advancement for academic scientists, especially for women and BIPOC faculty, the lessons learned from ADVANCE work over the last two decades become even more significant. Continuing emphasis of ADVANCE on intersectionality and institutional transformation will be critical for universities and STEM organizations as they emerge from the pandemic and reimagine themselves to survive and thrive in a post-pandemic world.

Keywords: institutional transformation; history; early cohorts; intersectionality; COVID-19

Looking Back to Look Forward: A Retrospective Examination of ADVANCE

The marking of the 20th anniversary of the ADVANCE initiative provides an opportune time to look back at the origins of ADVANCE, the rationale for funding and expectations of the initial program solicitation, and some of the successes and limitations of the earliest cohorts of Institutional Transformation (IT) projects. As the evidence accumulates about gendered and racialized inequities in the impact of the COVID-19 pandemic on teaching, research, and career advancement for academic scientists, especially for women and BIPOC faculty (Cardel et al., 2020; Malisch, et al., 2020; Myers, et al, 2020; Settles & Linderman, 2020; National Academies of Sciences, Engineering, and Medicine [NASEM], 2021), the necessity for the ADVANCE program and the lessons learned over the last two decades become even more significant. Transforming to eliminate inherent, structural racism and sexism to achieve systemic equity will be required for U.S. institutions of higher education to survive and thrive in a post-COVID environment.

Both of the article authors have long histories with ADVANCE. Sue Rosser served as Senior Program Officer for Women's Programs at the National Science Foundation from 1994-1995 and organized the 1997 Workshop that provided recommendations for future directions for women's programs at NSF and influenced the establishment and parameters of ADVANCE. Her recent writing has focused on the Professional Opportunities for Women in Science (POWRE) program at NSF (Rosser, 2001, 2004, 2012, 2017; Rosser & Zieseniss, 1998) and ADVANCE (Rosser, 2019; Rosser et al., 2019). She served as co-PI for the Georgia Tech ADVANCE grant, one of the first cohort IT (2001-2006) awards, and as the PI for the IT Catalyst grant at San Francisco State University (2016-2021). Service on the external advisory boards for ADVANCE

grants at more than a dozen institutions has enhanced her opportunities to observe the implementation and evolution of ADVANCE.

Sandra Laursen has studied ADVANCE programs for two decades. She was part of the evaluation and research team for the University of Colorado Boulder's ADVANCE IT project, Leadership Education for Advance and Promotion (LEAP, Cohort 1), from 2002-2008, and has served as external evaluator for other ADVANCE IT and PAID projects. Her collaborative research on institutional change strategies used by ADVANCE IT projects has generated resources for change leaders, including the online StratEGIC Toolkit (Laursen & Austin, 2014) and a research-based handbook, *Building Gender Equity in the Academy* (Laursen & Austin, 2020). It does not escape our notice that, as individuals, we represent some of the limitations of the early IT projects, as we are both white women whose initial contact with ADVANCE was through projects based in research institutions and led by white women in the natural sciences.

Since this special issue focuses on institutional transformation projects, this piece also centers on those, especially the first two cohorts of 19 IT projects. We chose to focus on these early cohort awardees in full recognition of how much has been learned along the way, both from early successes that later cohorts quickly adapted and adopted, and from limitations that later work sought to mitigate. As long-time participants and observers of ADVANCE, we highlight and honor this pioneering research and development work, and we acknowledge and celebrate how the most recent IT cohorts continue to press this work onward. Other types of ADVANCE awards too, including partnership, adaptation, and planning tracks, have shared the goal of transforming institutions and have likewise drawn on the examples and learning of these early pioneers to generate increasingly sophisticated approaches, to broaden the populations and

types of institutions impacted by ADVANCE, and to foster evolution of the IT initiative itself (NSF, 2001, 2020; Laursen & De Welde, 2019).

Origins of ADVANCE

A brief history of the funding for women's programs at NSF provides a context for understanding ADVANCE. This history documents shifts in NSF policies both in response to social and intellectual currents in the broader society and as a reflection of the politics of funding at the federal level. Over time, the focus shifted from funding research and career development of individual investigators to institutional and systemic approaches to increased numbers and percentages of women and under-represented minorities. Current funding emphasizes inclusion, recognizing both intersectional identities of individual STEM women and diverse research and institutional structures.

1980s: Data Collection and Establishment of Programs Focused on Individuals

The establishment of the National Science Foundation followed the vision laid out by Dr. Vannevar Bush in his 1945 report, "Science: The Endless Frontier," for the long-term U.S. national investment in scientific research and education through research universities, industry, and government. Considerable lobbying by women and people of color led Congress to pass the Science and Technology Equal Opportunities Act of 1980, mandating that NSF collect and analyze data and report biennially to Congress. Publishing the first of these reports on Women and Minorities in Science and Engineering in 1982, to which persons with disabilities were added in 1984 (NSF, 2000, p. xii), NSF documented that science and engineering had lower proportions of men of color and of women than were in the U.S. population overall and thus laid the statistical foundation for NSF officials to plan initiatives to address these under-representations.

Programs such as Research Opportunities for Women (ROW) and Visiting Professorships for Women (VPW) exemplified these initiatives. The director of NSF established a Task Force on Programs for Women in 1989, charged with ascertaining the barriers to women's full participation in science and engineering and recommending changes in the Foundation's existing programs to promote full participation (Clutter, 1998). The Task Force concluded that significant progress had been made but serious problems hindered women's recruitment, retention, and advancement. The problems were more severe in some fields than in others, although advancement to senior ranks was a problem in all fields (Clutter, 1998).

To address these challenges, the Task Force established two new programs. Graduate Fellowships for women provided an incentive for individual women to remain in graduate school to complete their PhD. Career Advancement Awards (CAA), initiated in 1986 focused on advancing the careers of individual women faculty by targeting junior women seen as having potential to make a significant research contribution and offered release from teaching, placing these women on a fast track to academic success in science or engineering research.

The Task Force also made several specific recommendations to expand the level of existing effort at intervention points along the so-called pipeline. First, it recommended that the NSF "incorporate the existing Research Opportunities for Women programs into Division-level strategic plans, but retain the Visiting Professorships as a Foundation-wide program" (Clutter, 1998, Appendix B). Although this approach was unevenly applied, many of NSF's divisions used a portion of the Research Planning Grant discretionary funds to add on to a grant received by a woman scientist or engineer who had never held an NSF grant or who sought reentry after a career interruption.

Visiting Professorships for Women (VPW), established in 1982, stood as the primary, foundation-wide initiative to retain women already holding faculty appointments by providing them with new equipment and supporting them to go to different, generally more prestigious institutions to develop new research methodologies and collaborations. A 1994 evaluation of VPW documented its success in its articulated goals, stating that a VPW award often came "at a critical time for keeping the recipient active in research as opposed to other academic, non-research responsibilities" (SRI International, 1994, p. 13).

Each VPW recipient was required to spend approximately 30% of her time and effort to attract and retain women scientists and engineers at the host institution by engaging in "interactive activities that involve teaching, mentoring, and other student contacts" (SRI International, 1994, p. 1). Grantee examples included forming a Society of Women Engineers (SWE) chapter, developing mentoring networks among women graduate students, and teaching women in science courses jointly with women's studies programs. This requirement underlined the dawning realization at NSF that steps needed to be taken at the institutional level; support of individual research alone might not be sufficient to increase the numbers of women scientists and engineers. As a Foundation-wide initiative that sought to improve institutional infrastructure, VPW laid critical groundwork for ADVANCE.

Early 1990s: Attempts to Shift Focus to Systemic Initiatives

The Directorate of Education and Human Resources (EHR) at NSF began to focus on systemic initiatives, recognizing that targeting individual researchers from racially and ethnically minoritized groups, women, and people with disabilities would not work as long as the system remained unchanged. Paralleling the Statewide (SSI), Urban (USI), and Rural Systemic Initiatives (RSI), NSF established the Program for Women and Girls (PWG) in 1993 to explore

comprehensive factors and climate issues that might systematically deter women from science and engineering. Within PWG, Model Projects for Women and Girls (MPWG) encouraged "the design, implementation, evaluation, and dissemination of innovative, short-term highly focused activities which will improve the access to and/or retention of females in SEM (science, engineering, and mathematics) education and careers" (NSF, 1993, p. 7). Experimental Projects for Women and Girls (EPWG) encompassed large-scale projects requiring a consortial effort with multiple target populations, seeking "to create positive and permanent changes in academic, social, and scientific climates (for classrooms, laboratories, departments, institutions/organizations) in order to allow the interest and aptitude women and girls display in SEM to flourish…" (NSF, 1993, p. 7). Although K-12 always constituted its main audience, undergraduates, graduate students, and even faculty served as primary targets of several projects at the beginning of PWG. While advancing the careers of individual researchers was not the program's intent, PWG did support some initiatives that both broadened participation and fit an individual researcher's agenda. By 2005 the program was called Research on Gender in Science and Engineering (GSE) and sought "to broaden the participation of girls and women in all fields of science, technology, engineering, and mathematics (STEM) education by supporting research, dissemination of research, and extension services in education that will lead to a larger and more diverse domestic science and engineering workforce" (NSF, 2005, para. 7).

The pressure from scientists both within the Foundation and in the broader community to support research projects of individuals was relieved by the establishment in 1990 of Faculty Awards for Women (FAW). Almost all of the hundred awardees, who received $50,000 per year for a period of five years, achieved tenure—the primary stated goal of the initiative. The program

was terminated after only one solicitation, making it difficult to judge the efficacy of this program as an approach to systemic change.

Late 1990s: Increased Focus on the Individual

The November, 1994, Republican take-over of Congress where 62% of white males voted Republican (Edsall, 1995) resulted in cuts in federal spending for targeted programs that had gender or race as their central focus and spurred a reshaping of NSF EHR programs. At this time, a number of legal and ballot initiatives in the states began to challenge affirmative action. In June 1995, the U.S. Supreme Court ruled that "federal affirmative action programs that use racial and ethnic criteria as a basis for decision making are subject to strict judicial scrutiny" (in Kole, 1995, p. 1), leading President Clinton to ask executive departments and agencies (including NSF) to bring their programs in line with the Supreme Court decision. Court challenges and referendum actions resulted in California, Texas, Washington, and Florida banning affirmative action by 2000 in admissions, awarding of fellowships, and various public contracts and hiring (Lauer, 2000), leading to fears that such challenges would expand.

Although the NSF initiatives facing court challenges were focused on racial/ethnic minority programs, such as Graduate Minority Fellowships, programs targeted exclusively for women principal investigators such as VPW, FAW, and CAA were also thought to be in jeopardy. Although MPWG and EPWG targeted girls and women, some grants had men as principal investigators and did not exclude boys and men from projects, so these initiatives were considered safe.

After the 1996 VPW solicitation, NSF replaced VPW with Professional Opportunities for Women in Research and Education (POWRE), giving the first awards in fiscal year 1997 and subsuming VPW, CAA and RPG. Rather than being housed in EHR with other women's

programs, POWRE became a cross-directorate program with all directorates taking part in developing the program solicitation and providing funding and grants for POWRE. Using an approach conceived as providing some protection against challenges to affirmative action, POWRE basically dropped the structural aspect of VPW, no longer requiring that awardees devote 30% of their time to building infrastructure to attract and retain women in science and engineering, and instead designating 100% of funding to support science and engineering research of individual women (NSF, 1997, p. 1).

Moving POWRE to the STEM research directorates and focusing on individual investigators' research seemed expedient, given the political environment, but went against a growing sentiment at NSF that support for institutional and systemic approaches would be needed to increase the percentage of women at all levels in science and engineering. Now program officers from the STEM research directorates, rather than from the Program for Women and Girls, were overseeing POWRE, enabling varying commitments and support depending upon the directorate.

NSF program officers asked Sue Rosser to organize a workshop held in 1997 to examine NSF's portfolio of programs (Rosser & Zieseness, 1998), including POWRE, for faculty women's careers. After analyzing data, participants recommended structural approaches to increase the percentage of women in senior and leadership positions in most disciplines. In computer science and engineering, access at the entry level of assistant professor was also recognized as a major barrier. Although the majority of workshop participants recommended structural approaches, a significant minority still favored supporting the research of individual women scientists as the way to increase percentages of women in leadership.

Early 2000s: Returning to Effort to Address Structural Barriers

To implement the recommendations from the 1997 workshop, NSF established a committee of program officers and staff from various directorates within the Foundation. As the committee crafted its initiative in light of the recommendations, simultaneously, reports and recommendations were emerging surrounding the situation for senior academic women in STEM.

"A Study on the Status of Women Faculty in Science at MIT," released in March 1999 by the Massachusetts Institute of Technology, created a stir that spread far beyond MIT's boundaries. Senior biology professor Nancy Hopkins (1999) had collected evidence documenting that the 15 tenured women faculty in science had received lower salaries and fewer resources for research than their male colleagues. The data in the report revealed systemic, subtle biases in space, start-up packages, access to graduate students, and other resources that inhibited the careers of women scientists relative to their male counterparts. Release of the report struck a nerve on campuses across the nation and drew the attention of journalists and academic leaders. At the close of a January 2001 meeting hosted by MIT President Charles Vest, in public and in print, for the first time, the leaders of the nation's most prestigious universities suggested that institutional barriers have prevented women scholars from playing on a level field, and that academic science and engineering establishments might require significant structural changes to accommodate women (Campbell, 2001, p. 1).

Almost simultaneously in 2001, NSF launched the ADVANCE program, providing funding of $17 million for 2001 and offering an award for institutional, rather than individual, solutions to empower women to participate fully in science and technology, noting "increasing recognition that the lack of women's full participation at the senior level of academe is often a

system consequence of academic culture" (NSF, 2001, p. 2). Under ADVANCE, IT awards of up to $750,000 per year for up to five years were granted to promote the increased participation and advancement of women. The long-term goal of ADVANCE was to use these competitive grant awards to establish a productive, successful, and diverse academic workforce, structure STEM institutions and organizations to be equitable, develop research based on inclusive practices, and foster a STEM culture and climate supportive of a diverse STEM academic workforce. Through 2018, ADVANCE has invested some $315 million awarded to 177 nonprofit institutions of higher education—an impressive 5.3% of all such institutions in the US (DeAro, Bird & Ryan, 2019). As a nod to those who still fought to support individual researchers, Leadership and Fellowship Awards were retained to recognize the work of outstanding organizations (2001-2006) and individuals (2001-2003) and enable them to sustain, intensify, and initiate new activity (NSF, 2001). Laursen and De Welde (2019) trace these changing strands of ADVANCE grant programs and offer a qualitative analysis of changes in ADVANCE solicitations that reflects evolution in the program's theory of change.

First Two ADVANCE IT Cohorts

While the shift in NSF's intent is important, it is also important to consider how early grantees interpreted and enacted the new NSF program. The projects funded in the first two cohorts of ADVANCE Institutional Transformation (IT) projects, initiated in 2001-02 and 2004, proposed diverse approaches and hypotheses about what changes were needed and how change could or would occur. These approaches have been most studied as a group, given time to see the results of their work (e.g., Bilimoria & Liang, 2012; Fox, 2008; Laursen et al., 2015; Stewart, Malley, & LaVaque-Manty, 2007). Some of the theories of change these projects articulated were naïve, and as a group they did not recognize and address that other discriminatory

ideologies besides sexism penetrate the academy. Systemic racism, ethnocentrism, classism, ableism, and heteronormativity differentially shape women's circumstances, needs, and experiences as faculty and, thus, also demand transformative change to institutionalized structures that generate and sustain inequity.

As the research and development carried out by these projects started to build a library of ideas that others could examine and adapt, the project PIs quickly formed networks and initiated a spirit of sharing that has permeated the community for many years. With these foundations of rapidly shared ideas and collective process, later generations of ADVANCE projects have built new strategies and variations suitable to their own context, devised new strategies and tactics, and advanced the theoretical framing of this transformational work.

Common Objectives, Diverse Tactics in Early ADVANCE-led Interventions

Each ADVANCE IT institution carries out multiple, coordinated interventions to attack the multiple, intertwined challenges faced by academic women, as NSF called for in its first ADVANCE solicitation issued in early 2001. At the time, the meaning of taking a systemic approach was not well theorized and the call for proposals resembled a laundry list of possible tactics (Laursen & De Welde, 2019); the community response likewise reflected a mix of approaches and tactics within the portfolio of funded projects. Nonetheless, several types of interventions recurred in the work of early ADVANCE IT projects and remain salient in the library of effective approaches. Table 1 highlights several approaches used by IT awardees in Cohorts 1-2 (see Laursen & Austin, 2020, for a more complete catalog). Some interventions seek to change institutional structures and cultures that disadvantage women as a group. Others provide institutional support to address individual women's work-life needs and provide

professional opportunities. Table 1 also highlights work of later IT projects that expand the repertoire of approaches to address similar problems.

Table 1

Examples of ADVANCE interventions

Objective	Examples from IT awardees in Cohorts 1-2	Examples from later IT awardees
Interrupt embedded bias in institutional processes	educating search committees about implicit bias through trusted faculty peers—U. Michigan (C1) strengthening department-based processes to recruit, mentor and promote faculty—U. Maryland Baltimore County (C2)	making service work more visible, valued, and equitable– U. Maryland College Park (C5) valuing diverse contributions to institutional mission in faculty advancement—Seattle U. (C8)
Develop formal leaders' equity-related values and skills	preparing chairs for their roles through workshops—U. Washington (C1) providing individual executive coaching for chairs—Case Western Reserve (C2)	cultivating understanding and readiness to act on structural inequities—Oregon State (C7) developing women as leaders through institute & fellowship programs—U. Texas Rio Grande Valley (C6)
Empower others to be equity leaders	naming women to professorships to lead equity work in their colleges—Georgia Tech (C1) empowering equity advisors to lead education, mentoring and accountability at the unit level—U. California Irvine (C1)	developing men as advocates and allies—North Dakota State (C4) preparing bystanders to intervene in bias incidents—Wright State U. (C4), U. New Hampshire (C6)
Improve workplace climates	working closely with departments to identify and mitigate climate challenges—Utah State (C2) supporting department-based initiatives to improve climate—U. Colorado Boulder (C1)	leading departments in collaborative transformation efforts—Iowa State (C3), West Virginia (C5)
Reduce structural barriers to work-life flexibility	strengthening policies for work-life flexibility—Virginia Tech (C2) supporting faculty to resume scholarly	facilitating hiring for dual-career couples—U. Nebraska-Lincoln (C3)

	work after a career timeout—U. Wisconsin (C1) centralizing information on parental leave policies & resources —U. Montana (C2) expanding access to childcare and lactation spaces—Utah State (C2)	helping people navigate work-life policies through family advocates—Montana State (C6)
Invest in the career success of women faculty	mentoring early-career women in cohorts—U. Texas at El Paso (C2) awarding faculty development grants to foster collaborations—Hunter College (C1), Kansas State (C2) strengthening research support for STEM women in a teaching-focused institution—U. Puerto Rico Humacao (C1)	supporting women's advancement to full professor through writing retreats – Jackson State (C5) supporting early-career faculty of color with on- and off-campus mentors– Texas A&M (C4) developing STEM women as entrepreneurs—Ohio State (C4)

Central to the ADVANCE approach are interventions that focused on changing organizational structures and cultures. In seeking to "fix the system" rather than "fix women," these organization-directed interventions remain at the very heart of ADVANCE, and are most distinct from prior, individual-focused supports for women in STEM. For example, efforts to interrupt implicit bias, especially in hiring, emphasized training search committee members and chairs to understand how unconscious biases based on gender schemas (Valian, 1999) affected perceptions and decision-making about applicants for faculty positions. In working with search committees to enhance the chances that well-qualified women and men of color would be identified and advanced in applicant pools, these approaches engaged "organizational catalysts" to deploy their own legitimacy, power, and networks to advance organizational equity goals (Sturm, 2007). Efforts to educate search committees were often complemented by initiatives to broaden the pool of applicants and make start-up packages equitable. Later efforts have

addressed biases that surface in other areas of faculty life, such as how faculty service work is distributed and valued.

Other organization-directed efforts focused on improving the culture of workplace environments at the departmental and institutional levels because these work environments shape women's job satisfaction and decisions to leave or persist in a job. Leadership development programs targeted to formal leaders sought to bolster the crucial role of chairs, heads, and deans in setting a tone, distributing resources, and establishing more equitable decision-making processes. Other projects focused on increasing the numbers and capacities of women as leaders, offering forums for women to hear from peers in leadership positions, to learn about the variety of leadership roles open to them, and to assess their own leadership skills and interests. And some initiatives worked with departments directly to identify ways to improve processes and dynamics that affect departmental climate.

Complementing approaches that strengthen the capacities of those who already hold formal leadership roles are efforts to expand the ranks of equity leaders. In many programs, specific people were made responsible to lead networking and mentoring in their colleges, collaborate on cross-college initiatives, and serve as liaisons and advocates in their own spheres. Some also held accountability for equity concerns in hiring, promotion, and awards. Different institutions crafted these roles in a variety of ways, whether as equity advisors, named ADVANCE professorships, designated roles in the chair's or dean's office, or even committees—but together they may be seen as ways to expand the ranks of those motivated and prepared to lead everyday equity work. From this perspective, such approaches can be argued to share goals with more broadly targeted interventions that prepare men to be gender equity advocates and allies, or that empower bystanders to intervene when they observe harassment or

microaggressions. Moreover, these grassroots efforts may be reinforced by the strategic use of visiting speakers to influence institutional leaders by normalizing equity work, emphasizing how excellence arises from diversity, and relating campus work to that of institutional peers, in addition to their more public educational role of elevating women's scientific achievements and explaining barriers that face women through social science research.

Early efforts also took on structural barriers that impede women faculty members' efforts to manage both professional and personal responsibilities. For example, new policies were crafted to offer greater flexibility in faculty appointments over time, enable adjustments between full-time and part-time appointments, or re-balance research, teaching, and service in response to needs such as child or elder care. Policies to support dual-career academic couples aimed to make the institution more attractive places to build careers for women partnered with another academic. Some work-life initiatives provided individuals with resources, connections, and advice. These practical efforts augmented policy changes by aiding individual women in finding and using available resources to mitigate their specific work-life challenges.

Finally, early ADVANCE projects identified a role for individual career support and career development opportunities. While these may seem to resemble earlier NSF-funded programs to "help women," ADVANCE IT projects recognized that their efforts to change the system would move too slowly to assist individual women in reaching their own career milestones: slow structural changes must be complemented by programs to support women directly. Faculty development programs sought to strengthen STEM women's career-related skills and knowledge and to support women's ambition and confidence in their career decision-making. Grants to individual women supported them to develop new lines of research and develop collaborations on or off campus; structures that built in connections to other scholars

were particularly effective in meeting these goals. Mentoring programs provided individual guidance and coaching for career decision-making and provided access to confidential help with professional challenges. Often connected to faculty development, networking events facilitated access to social networks from which women otherwise might be excluded due to their gender.

2006-2018: Mid-course Reckoning and Attempts at Correction

Analysis of early cohorts' activities uncovered missing elements. One of these is institutional diversity. Seventeen of the 19 institutions funded in the initial (2001-04) cohorts were research-oriented institutions; the two primarily undergraduate institutions were Hunter College and the University of Puerto Rico-Humacao, both in Cohort 1. Most project leaders were white, and most awardee institutions were also primarily white; UPR-Humacao and New Mexico State University in Cohort 1, and University of Texas at El Paso (UTEP) in Cohort 2 are Hispanic Serving Institutions. This led to critiques about racial bias, elitism, and exclusion of other organizations where significant numbers of women scientists are employed (Hunt, Morimoto, Zajicek & Lisnic, 2012, Torres, 2012; Zippel & Ferree, 2019).

NSF responded by incorporating other award tracks into solicitations after 2005, seeking to involve a greater variety of academic institutions, and to support ideas from change leaders in STEM non-profits and professional societies. For example, realizing that heavier teaching loads, reduced staff support, and different reward systems for faculty working outside primarily white, research-focused institutions made it very difficult for them to compete for IT awards, ADVANCE instituted planning awards (START and Catalyst) to support a broader range of institutions to undertake the institutional data collection and self-assessment work needed to identify systemic gender inequities and plan how to address them. And, as ADVANCE managers began to recognize historical and institutional context as critical in determining effectiveness of

particular strategies or approaches in eliminating bias and facilitating change, they developed tracks for adaptation and partnership (variously known as PAID, PLAN, Adaptation, Partnership). Since strategies developed at research-focused institutions did not necessarily transfer readily to institutions with other missions, these grants have sought to help a broader range of institutions modify and test institutionally appropriate methods to transform STEM disciplines, workplace, and professions on the national or regional level (NSF, 2020). This approach has had mixed success, as IT awards continue to be dominated by research institutions and by predominantly white institutions (Laursen & De Welde, 2019; Zippel & Ferree, 2019).

2018-Present: Towards Intersectionality and Inclusion

In response to the finding that ADVANCE privileged white women's experiences and needs (Hunt et al., 2012; Torres, 2012), NSF has placed increased emphasis on intersectionality (Laursen & De Welde, 2019; Rosser, 2019), emerging from feminist and critical race theory (Crenshaw, 1989; Hill Collins, 2015), which recognizes the effects of overlap of gender with race, ethnicity, class, religion, sexuality, and other social identities. STEM workplace stigmas against people with different physical and mental abilities, LGBTQIA identity, country of origin and education, and age, are increasingly recognized as significant for understanding the experiences of STEM scholars of all genders in varied institutional contexts. Indeed, this movement is building strength within the federal government, as socioeconomic status, rural location, and LGBTQIA identity have more recently received formal recognition by the NIH (2020) as factors leading to underrepresentation of women in science and medicine. Recognizing difference is a first step toward identifying and removing institutional "blind spots" around how structural obstacles may differentially affect women or how programs designed for dominant groups of (white, heterosexual, abled) women may fail women from non-dominant groups.

Current scholarship points to both affordances and challenges of incorporating intersectional perspectives into institutional transformation work (e.g., Armstrong & Jovanovic, 2015, 2017; Hunt et al., 2012; Morimoto et al., 2013). Good quality data disaggregated by gender, race, and ethnicity have become critical for understanding intersectionality, as well as for measuring the impact of specific interventions on participants and, ideally, on progress toward institutional change. Baseline data, common definitions of terms, and "clean" data offer metrics against which changes implemented can be measured—but the messiness of institutional change work also means that transformative work should not be delayed until data collection is perfected. Disaggregated data may provide evidence of gendered and racialized inequities that can be used to inform and persuade key actors to support and provide budgets for actions, and to develop targeted action plans by naming and specifying the issues in particular contexts (Zippel & Ferree, 2019).

Yet, as quantitative data are further disaggregated to reveal distinctive perspectives and insights, the "small N" problem surfaces: by placing focus on small populations within any particular intersection of identities, the structural sources of oppression are obscured and individuals become more vulnerable to tokenism (Armstrong & Jovanovic, 2015). Armstrong and Jovanovic (2015) suggest flipping the problem on its head, connecting individual differences to systemic issues through a "large N" interpretation that considers how people with multiple privileged identities benefit from unearned structural advantages. They also emphasize the importance of qualitative methods and case studies for gaining nuanced understandings to guide program design and decision-making, echoing findings of Nielsen and coauthors (2005) about the difficulties of using quantitative instruments to measure progress toward social justice goals (Morimoto & Zajicek, 2014).

Policy changes offer another example of how intersectional perspectives are essential to crafting institution-level transformation that accounts for variation in individual experience. High proportions of ADVANCE IT institutions addressed policy changes in recruitment, hiring, research support, tenure criteria, standards of promotion to full professor, and work-life balance (DeAro, 2018). Introducing new policies only goes so far in addressing gender issues: to be effective, policy change must survive frequent turnovers in institutional leadership, thus requiring that policies are buttressed by accountability structures and by ongoing efforts to develop institutional leaders who value, disseminate, and use the policy. Once in place, policies can be difficult to eliminate, even if they have unintended consequences, as in the case of tenure-clock stoppage policies. These are intended to benefit all new parents but appear to particularly benefit men in heterosexual couples, who can more readily continue to produce research during a parental leave (Antecol, Bedard & Stearns, 2018). That is, in crafting a policy aimed at the single-identity category of "parent," the policy may benefit parenting men and harm parenting women. The same risk arises as institutions request COVID impact statements about the challenges faculty faced during the pandemic. While seemingly intended to acknowledge and mitigate these impacts, the time and relived trauma to document these experiences also lands most heavily on those who faced greater challenges from disability, caregiving, or living alone, and on faculty of color who took on extra institutional work, student support, and community engagement surrounding COVID-19 and during the racial reckoning of summer 2020 (Bates, 2021; Fulweiler et al., 2021; NASEM, 2021; Schuman, 2021; Tevis, 2021). These examples highlight the importance of recognizing STEM women's intersectional identities and attending to their varying needs and interests.

Considerations for the Future

With an eye to learning from the past two decades, we draw some lessons for the future, considering the institutional, multi-institution, and agency levels. Within an institution, appropriate leadership commensurate with the level and scope of the desired systemic change is critical for success and institutionalization of changes that can truly be considered systemic. Women's leadership and significant involvement with ADVANCE have yielded both negative and positive results for their own career trajectories. For some, it has provided an opportunity to demonstrate or develop administrative skills and visibility, providing a pathway for advancement to administrative leadership. For others, when their institution failed to recognize ADVANCE scholarship as research, the heavy time commitment and service duties have slowed or derailed their perceived appropriate research trajectory. Men have less often been deeply involved in seeking ADVANCE grants, although they have implemented the projects and benefitted from policies, practices, and resulting changes (Morimoto, et al., 2013). In order to enact sustainable, systemic change, STEM men must be involved too. Moreover, to accomplish institution-wide change, a diverse and active project management team must be complemented by senior leadership from the provost or president. Leadership change is a challenge: 38% of administrators who served as ADVANCE PIs also left the institution (Furst-Holloway & Miner, 2019).

More generally, leaders of ADVANCE projects must build a coalition of stakeholders and begin early to move from acceptance to enthusiasm to sustainability. In early IT cohorts, natural scientists were predominant on institutional teams; as solicitations emphasized the need for social scientists, the pendulum has swung the other way. Clearly social science expertise on issues of gender, representation, and organizational change complements the lived experience of

women scientists and their personal knowledge of STEM cultures and ways of knowing. While NSF focuses on STEM disciplines, campuses that planned early to extend programs to non-STEM disciplines—where issues of women's visibility and leadership also loom large—have met with the greatest success in sustaining programs and having deep and broad impact.

Non-tenure-track faculty are a sizable constituency, too, but largely ignored. Universities increasingly rely on non-tenure-track instructional faculty to teach STEM introductory courses and support graduate student teaching assistants. During the pandemic, they have provided critical support to students and mentored colleagues unfamiliar with online teaching; they are often the most skilled faculty in their departments at using research-based instructional strategies known to improve student learning and retention. Many of these faculty are women, yet little attention is paid to their career development, retention, or recognition—keeping them in a permanent underclass. As the NASEM Report (2021) states in its Finding 10 regarding Academic Leadership, "Fast decisions greatly affected contingent and non-tenured faculty members—positions that are more often occupied by women and People of Color" (p. 113). How might institutional transformation for gender equity enhance institutional transformation of teaching and learning if we recognize the crucial role of these faculty as part of the higher education landscape and work with them to offer more equitable career opportunities and advancement paths within the academy?

Just as coalitions within institutions prove important for project success, ADVANCE has now recognized the potential significance and mutual benefits of forming coalitions with other NSF-funded programs. One approach is by encouraging ADVANCE projects to partner with other efforts that focus on inclusion and transformation through partnerships with NSF funded programs such as AGEP, IUSE, and INCLUDES (NSF, 2020). Because efforts to diversify the

types of institutions undertaking gender equity initiatives have been less successful, it may also be time for new conceptions within ADVANCE of how to engage and support varied institutions. For example, what new strategies and progress could be achieved if institutional transformation were carried out collaboratively through networks of like institutions? While ADVANCE partnership projects take a step in this direction, partners generally divide modest resources to implement separate institutional projects. Yet, US higher education offers many examples of pre-existing coalitions of institutions that already find common ground and join to solve common problems, and thus might together develop shared models to make more equitable workplaces, such as regional associations of liberal arts colleges, state-based networks of institutions that prepare K-12 STEM teachers, or two-year college districts.

Finally, a notable need is to include gendered intersectional lenses in research and policy. Work by Schiebinger (2008) and colleagues (Nielsen, Bloch & Schiebinger, 2018) shows the importance of integrating sex and gender into the methods and questions of science and technology research, as well as in the composition of research teams. Examples of research findings on topics as diverse as the efficacy of drugs, the safety of automobile seat belts, and decision-making in community climate change mitigation have been shown to be importantly influenced by considering sex and gender in the research design. Yet until recently, different governmental and funding agencies have taken different approaches to this facet of increasing women's presence in STEMM. For example, while the National Institutes of Health (NIH) has drawn attention to sex and gender in research content with its focus on sex as a biological variable and mandates to include women in clinical trials (Furst-Holloway, et al., 2018), NSF has focused its attention on gender in science education and institutional structures (Rosser, 2012), with few exceptions. To use the terminology of Schiebinger (2008), both NSF and NIH have

tried to fix the numbers (of women), but then their primary funding strategies diverged: NIH has attempted to fix the knowledge (research), while NSF has focused more on fixing the institutions (institutional transformation).

Now NSF is also beginning to support transformation of basic research to include gender and race in NSF research directorates outside of SBE and EHR. For example, recent studies have revealed that artificial intelligence (AI) algorithms exhibit gender and racial/ethnic bias in programs used for facial and voice recognition and in diagnoses from radiologic images of breast cancer (Buolamwini & Gebru, 2018). These revelations have opened the door for NSF to fund projects to explore how implicit biases in gender, race, ethnicity, and other intersectionalities constrain design, methods, analyses and conclusions drawn from research in areas such as computer science and engineering. How can the knowledge gained from ADVANCE become increasingly significant for these areas, as faculty grapple with research in arenas where gender was not previously understood as impacting basic research? What incentives or learning will prompt researchers to do so? Similarly, how can experiences from ADVANCE IT inform journal reviewers, tenure and promotion committees, and professional societies as they seek to revise their policies and practices and transform their expectations to include gender and intersectionalities in disciplines where these have not traditionally been included as part of graduate and research training? One forward-looking example is a series of workshops in 2019-2021, jointly funded by NSF and its Canadian equivalent NSERC, for researchers, journal reviewers, and policy-makers on Inclusive and Intersectional Engineering and Computer Science Research (NSF award 1936570).

The continuing emphasis of ADVANCE on intersectionality and institutional transformation will be critical for the future of universities and STEM organizations as they

emerge from the pandemic and reimagine themselves to survive and thrive in a post-COVID world. Just as the pandemic stripped the veneer of equity and merit to uncover deep racial, ethnic, gender, and socioeconomic inequities in the broader U.S. society, simultaneously, studies have begun to document that women and BIPOC faculty have experienced more disruption to their research and a heavier workload than the majority of their white male colleagues (Langin, 2021; Settles & Linderman, 2020; NASEM, 2021). Mothers, in particular, because they took on more childcare and household duties, have lost 33% in hours of research productivity, even in comparison with fathers (Deryugina, Shurchkov, & Stearns, 2021).

In light of findings such as these, we must consider mechanisms not only to even the playing field for men and women, such as affordable day care for all parents, but also to transform expectations (McClinton, 2020; Misra, Mickey & Clark, 2020). For example, as the National Academies Report states in Finding 5 (p. 112), "…while colleges and universities have offered extension for those on the tenure track and federal and private funders have offered extensions on funding and grants, these changes do not necessarily align with needs expressed by women, such as the need for flexibility to contend with limited availability of caregiving and requests for a reduced workload, nor do they generally benefit women faculty who are not on the tenure track." A rush to return to pre-pandemic "normal" without transforming the underlying structural racism and sexism in the academy and STEM, and without listening to the voices of women and BIPOC faculty, will perpetuate the status quo and lead to exclusion rather than inclusion. Since the charge to the National Academies Committee that put together the Report was "to inform, without making recommendations," we must look elsewhere for effective practices and leverage the two decades of knowledge from ADVANCE IT projects to ensure that

institutional policies and practices are built upon inclusive, intersectional foundations of excellence needed to solve the challenges of the next twenty years.

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