

*The Changer and the Changed: Evolving Theories and Practices of Change  
in ADVANCE Calls for Institutional Transformation*

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**Structured abstract**

**Purpose**

The paper examines the evolving theories of change of the U.S. National Science Foundation's (NSF) ADVANCE program to increase the representation of women on academic faculties in science, technology, engineering and mathematics (STEM). ADVANCE supports efforts to transform the cultures and structures of U.S. institutions of higher education by removing gendered barriers to STEM faculty women's employment, advancement, and success, and by developing change strategies that others may adopt.

**Design/methodology/approach**

The empirical study is based on qualitative, longitudinal analysis of nine requests for proposals (RfPs) for the ADVANCE program (2001-2016), complemented by historical analysis of funded ADVANCE projects using public records.

**Findings**

The analysis identifies changes over time that suggest shifts in NSF's rationale and theory of change for ADVANCE. Increased guidance directs how institutions should best undertake change, document outcomes, and share best practices. The RfPs reveal growing attention to equity, rather than simply to representation, and to intersectionality – how gender, race, social class, and other identities intersect to produce disparate experiences and outcomes for individuals differently positioned in social systems. Gendered organizations theory helps to place these experiences and outcomes in a structural context. Iterative processes of organizational learning are postulated to account for these changes over time.

**Originality/value**

While many studies have examined ADVANCE projects' activities and outcomes, none have examined the premises and design of the ADVANCE program itself. This analysis offers insight into how the ADVANCE RfP has driven innovation and learning about transformative institutional change to advance gender equity in STEM.

**Keywords:** institutional change, gender equity, gendered organizations, intersectionality, ADVANCE, theory of change, organizational learning

**Article Type:** Research paper

***The Changer and the Changed: Evolving Theories and Practices of Change  
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The U.S. National Science Foundation's (NSF) ADVANCE program was announced in 2001 and is still active. This is long-lived for any grants program at NSF, but perhaps especially for a cross-disciplinary program focused on "broadening participation" of diverse people and institutions—at that time, a newly explicit goal at NSF (NSF, 1999). Supported by contributions from directorates in the science, technology, engineering and mathematics (STEM) disciplines, the existence of ADVANCE was no small political feat to orchestrate (Rosser, 2017). Its longevity thus speaks to NSF's commitment to foster "the most meritorious ideas" and nurture "talent wherever it may be found" (NSF, 1999, 2008). Within NSF, ADVANCE is also pioneering in its institutional approach to change, seeking to transform institutional structures and cultures to improve education and optimize the use of resources through collaboration and networking. Thus it offers an institutional change model for other education and diversity initiatives at NSF (James & Singer, 2016; Córdova, 2016).

As Rosser has traced (2004, 2010, 2017), decades of experience at NSF had demonstrated that it was not enough to simply recruit women into the sciences and support their career development. Rather, women faced barriers intrinsic to institutional structures, such as biased selection and promotion systems, inadequate structures to support those with family and personal responsibilities, and old-boy networks that excluded even successful women from receiving formal recognition or advancing into top leadership roles (De Welde & Stepnick, 2015). These barriers are enlarged and entangled when multiple marginalized identities intersect for women who are also in non-dominant groups due to their race, ethnicity, social class, sexual orientation, citizenship, or physical abilities.

Seeking increased traction on the persistent problem of women's underrepresentation on STEM faculties, ADVANCE represented a shift from dispersed, individual-directed programs intended to "fix women" scientists and engineers, to systemic, institution-directed efforts to fix the environments in which women scientists and engineers work. This shift reflected NSF's then-new understanding of the problem and how it could be solved—a change in its theory of change. While prior studies (e.g., Bilimoria, Joy & Liang, 2008; Bilimoria & Liang, 2012; Fox, 2008; Laursen & Austin, 2014) have focused on the community response to NSF's call—the actions and strategies of ADVANCE awardees—here we focus on the shifting language and meanings of the call itself, as the ADVANCE theory of change continued to develop.

Unpacking NSF's intentions and their evolution offers important context for understanding ADVANCE projects and how they have changed over time. Indeed, our analysis is stimulated by prior research on organizational change strategies in ADVANCE Institutional Transformation (IT) projects (Laursen & Austin, 2014; Laursen, Austin, Soto & Martinez, 2015), where we noticed differences in the change strategies undertaken by institutions that were funded at different times. We trace some of these changes to community learning from earlier IT projects, as investigators freely shared their successes and challenges, enabling all to adopt and adapt

tested ideas to varied institutional settings. But the evolution of NSF's call for ADVANCE proposals suggests that learning also happened at NSF. As program officers guided peer review of proposals, made award decisions, observed funded projects, and interacted with the community, their learning as individuals was institutionalized in subsequent calls for proposals, through writers' emphasis and choice of language, and in proposal rationale, guidelines, and requirements. Because of this institutionalization by program officers acting as agents of the organization (Argyris, 1977), we consider this an instance of organizational learning (Crossan, Lane & White, 1999), and the requests for proposals (RfPs) a record (albeit incomplete) of what was learned.

Here we examine how the ADVANCE theory of change has evolved over time. We track and analyze changes in NSF ADVANCE RfPs from 2001 through 2016 and make inferences about NSF's theory of change. In doing so, we answer the research questions,

1. How has the ADVANCE Request for Proposals changed over time, especially the Institutional Transformation program?
2. What can be inferred from these changes about NSF's theory of action for increasing the representation of women in academic STEM?

### **Conceptual Frameworks**

To understand the *content* of the ADVANCE RfPs, we use frameworks that consider inequalities and inequities as outcomes of institutional arrangements—policies, procedures, practices. Acker's (1990, 1998) notion of “gendered organizations” treats academic work environments as imbued with hierarchies of inequality that disproportionately and implicitly impact women. For women, academic career pathways in STEM are fraught with obstacles that arise from the structures of graduate school, postdoctoral work, and faculty careers (De Welde & Laursen, 2011). These structures are “...guided by hegemonic masculine ideals that inform decisions about employee (faculty) pay and promotion...[as well as ways] that women and men academics are segregated to varying degrees into different departments and jobs...” (Bird, 2011 p. 204).

Horizontal segregation of women across academic disciplines is one source of inequity, as over time some STEM fields become less gender-segregated, while others remain obstinately masculine. While some ascribe these patterns to “choices” (Ceci & Williams, 2011), their ubiquity across institutions, career paths, and historical contexts points to their unequivocally structural foundations. Moreover, a simplistic focus on diversity, or raw numbers of women may mask the nuanced “organizational logic” (Acker, 1990, p. 147) that shapes the daily experiences of STEM women as interlopers, tokens, or competent anomalies. These hierarchies of inequality extend beyond gender too, as women of color are even less visible across all STEM fields (Ong, Wright, Espinosa & Orfield, 2011).

Vertical segregation of white women and women of color in STEM fields—their absence in higher-status positions and in roles that offer power and authority—offers additional evidence for disparities as structural and systemic and, ironically, keeps women out of positions to lead

institutional changes to remedy that segregation. Effective institutional change initiatives attend to academic careers as unfolding within gendered organizations and address aspects of the academy that produce unequal and unfair outcomes for women. They must be system-wide and structure-focused because “simplistic or piecemeal solutions cannot eradicate systematic, historical, and widespread gender [and race] inequities” (Bilimoria, Joy & Liang, 2008, p. 424).

Because “single axis thinking undermines... knowledge production, and struggles for social justice,” (Cho, Crenshaw, & McCall, 2013, p. 787) we use intersectional theory to understand how the experiences of multiply marginalized women are reflected (or not) in ADVANCE RfPs. Gender, race, social class, and other identity categories intersect to produce disparate experiences and outcomes for individuals differently positioned in social systems—even as gendered organizations theory places these disparities in a structural context. As Cottom (2017) points out, these framings are related: “By focusing on the parts of the system that are most complex and where the people living it are the most vulnerable, we understand the system best.”

To consider the *changes* in ADVANCE’s RfP over time, we draw on theories of organizational learning (OL), defined as “the process of acquiring, distributing, integrating, and creating information and knowledge among organizational members” (Wang & Ellinger, 2008, p. 1). OL, virtually irrespective of theoretical strain, happens through recursive or iterative process(es), whether in spirals (Nonaka, 1994), cycles (March, 1991), or loops (Argyris, 1977). In a comprehensive review of the literature, Scott (2011, p. 13) proposes:

Learning is both a cognitive and a behavioral process...[It] is increasingly viewed as an active, social, and dynamic process...[It is] the process that brings about change...[It] is acquired through a cognitive process of reflecting and/or through a behavioural process of doing, [and] learning is exploited through a process of applying, spreading, and embedding the knowledge.

For example, Argyris (1977) posits single-loop and double-loop learning processes. Both occur when organizations are reflexive about their practices: using feedback or information from previous results, they adapt their actions to influence improved outcomes. Single-loop learning is a form of error correction, making modifications to procedures or practices in response to unexpected results without altering the underlying theory of action. In contrast, double-loop learning results in modified values, expectations or assumptions about the influences that govern the activity—a change in the broad strategic approach or theory of change.

In this analysis, we apply OL to ADVANCE RfPs by inferring the likely type of learning process from observed changes in the RfP text. This approach is distinguished from studies that offer advice to funding agencies based on the workings of the projects they funded (e.g., Lyall, Bruce, Marsden & Meagher, 2013); here we examine the funder’s documents directly. We take this approach because OL processes are complex and challenging to investigate empirically (Easterby-Smith & Araujo, 1999), and still further inaccessible when the organization under study, a federal agency, operates with strict codes of confidentiality around the privileged information it holds. While we infer from the evolving RfP that OL did occur, our data do not

elucidate the OL processes themselves; indeed, such data would be difficult to obtain given the procedural and political context in which NSF operates. In this analysis, we focus on *what* changed rather than *why* or *how* changes happened, drawing on OL theories in a bounded way that is appropriate for the evidence we have.

## **Methods**

We examined nine ADVANCE requests for proposals (called program solicitations by NSF), issued roughly biennially from 2001 to 2016 (see searchable list in NSF, 2001). These documents cover the entire history of ADVANCE to date and govern awards made from 2001 through August 2017, which we also analyzed. Because all sources are publicly available, no IRB approval was necessary.

First, the content of RfPs was inductively coded using *Nvivo 10* software for conventional content analysis (Hsieh & Shannon, 2005). Most codes simply marked sections that addressed specific topics (e.g., what project activities were encouraged, allowed or prohibited), though a few conceptual themes emerged at this stage (e.g., how institutional data should be used in proposals and projects). Typically 50-60 passages were coded in each document. Topical codes were then clustered into trees, and passages re-read and re-coded for emergent subthemes. For example, the cluster ‘program goals’ had six subthemes denoting different purposes or rationales for ADVANCE as stated in document texts. Scheme 1 offers coding details to clarify how the analysis arose from the text data.

Because each of the nine documents analyzed was unique in time, an additional layer of longitudinal analysis was essential. Following qualitative coding, we re-read the coded data to track the occurrence of particular programs, requirements, or ideas in a spreadsheet, forming a matrix that displayed key changes by year to easily identify substantive changes over time. In the Findings, quotations and RfP dates provide evidence to support our arguments about change over time. The themes discussed in the Findings largely mirror those in Scheme 1, but some codes showed no meaningful trends over time and are not discussed further.

Scheme 1: Qualitative Coding Structure for ADVANCE RfPs

Topical codes used to identify RfP sections		Thematic codes not associated with particular RfP sections
Code cluster	Subthemes	
Activities	Cautions against ‘fixing’ women, Dissemination, Evaluation, International, Students	Innovation Intersectionality Sustainability System approach Use of data
Award type	10 award types listed	
Expectations for proposal	Conceptual framework & research, Impact or outcomes, Plan of work, Problem statement, Status of women	
Funding level	no subthemes	
Personnel	Management, Social science expertise, STEM expertise	
Program goals and rationale	Knowledge building, Knowledge link to diversity, Nature of problem to be solved, Rationale for focus on higher education, Underrepresentation, Workforce	
Proposal and award logistics	Award administration, Budgeting, Due date, Eligibility, General boilerplate, Program officer, Reporting, Review process, Submission process	
Reference list	no subthemes	
Revision notes	no subthemes	
Summary	no subthemes	

As we conducted the qualitative analysis, we identified a need for a concise historical record of ADVANCE activity over the program’s lifetime. To construct this record, we drew on a second, publicly available source of data. We searched NSF’s public awards database ([nsf.gov/awardsearch](https://www.nsf.gov/awardsearch)) for ADVANCE-specific program element and reference codes (7690, 7650, 7568, 1739, 1738, 1681) so that we could estimate the total number and dollar amounts of awards made under specific program tracks, such as Institutional Transformation (IT) or ADVANCE Fellows. Since NSF’s codes are reused when program titles change, we recoded the data on individual awards to group them by broad program strand, where ‘strand’ identifies the general target and nature of the program. For example, the ‘planning’ strand includes two tracks of institutional planning grants that operated under different titles at different times, IT-START and IT Catalyst, and the ‘individual’ strand includes two tracks of awards to individuals, ADVANCE Fellows and Leadership awards (see Table 1). Based on start dates, awards were assigned to particular RfP years even though funds were distributed over multiple years and through multiple competitions within each RfP (awards under the 2016 RfP were incomplete at the time of writing). This separate analysis of the awards database enabled us to map the relative reach and degree of activity for different program tracks or strands, and to connect notable shifts in NSF’s theory of change to the onset or termination of particular program strands.

### Findings from Analysis of Awards Data: History of ADVANCE Program Activity

To provide context to our text analysis of the RfPs, we summarize the history of ADVANCE programming as constructed from NSF's awards database. For conciseness, we summarize these data in Figures 1-3 and Table 1, using the following acronyms: IT for Institutional Transformation; PAID for Partnerships for Adaptation, Implementation and Dissemination; PLAN for Partnerships for Learning and Adaptation Networks; ARC for ADVANCE Research and Coordination Network; ALE for ADVANCE Longitudinal Evaluation. Narrative description of these program tracks is provided in the following section.

Figure 1 shows the lifetimes of specific ADVANCE program tracks, grouped into five broad strands: support for individuals, transformation of single institutions, partnerships and adaptations, planning grants, and central resources.

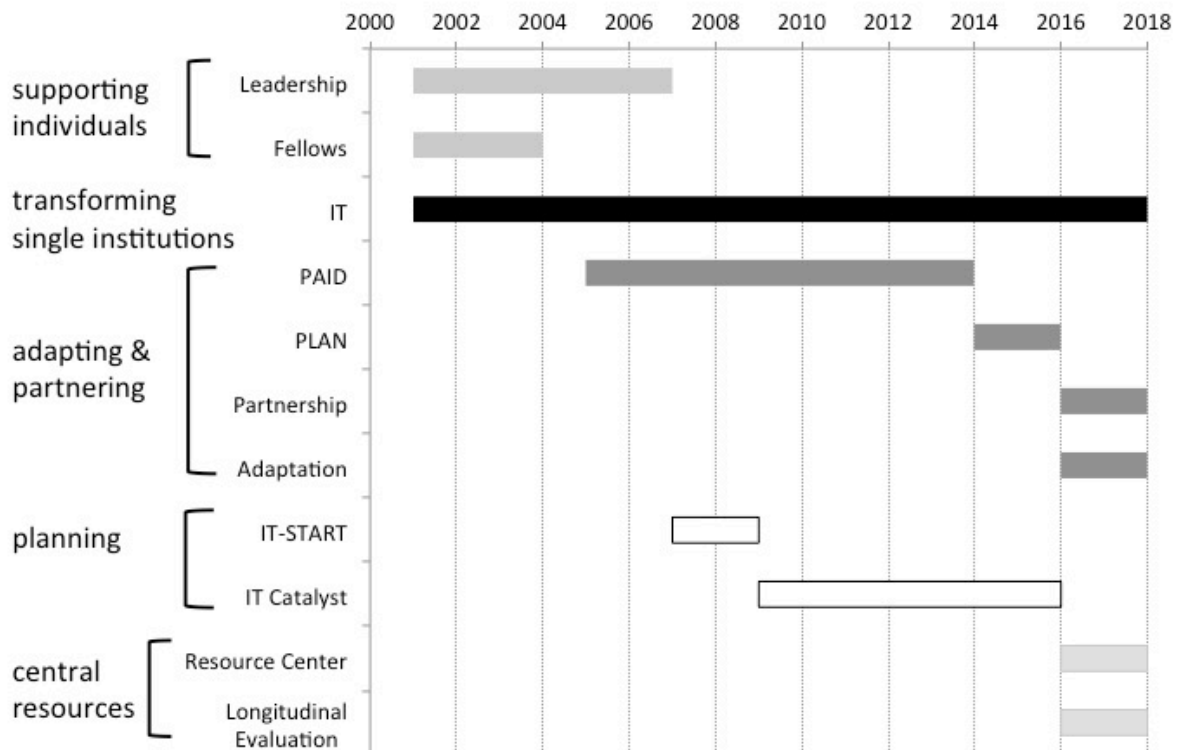


Figure 1: Lifetime of NSF ADVANCE programs by RfP year.

Table 1 summarizes available information from the RfPs about award sizes, durations, and anticipated funding levels, while Figures 2 and 3 show trends in the actual numbers and amounts of awards within each broad program type. In all, we tallied 338 unique awards totaling \$305.0M from 2001 through August 2017, comparable to NSF's own figure of \$270M (NSF, n.d.). Both numbers of awards and dollars awarded have clearly fallen since the early years, and emphasis has shifted as new programs were introduced and old ones retired.

Table 1: Anticipated funding for ADVANCE awards, by year and program strand, from RFPs.

year	single institutions	individual support		adapting & partnering projects				planning grants		central resources
	IT	Leadership	Fellows	PAID	PLAN	Partnership	Adaptation	IT-START	IT Catalyst	ARC, ALE
2001	5 yr \$750k/yr 5-10 awds	3 yr \$200k 8-12 awds	3 yr salary + PD support 20-40 awds							
2002	5 yr \$750k/yr 5-10 awds	3 yr \$300k 8-12 awds	3 yr salary + PD support 20-40 awds							
2005	5 yr \$750k/yr		3 yr \$300k	3 yr \$500k						
2007	~\$750k/yr 8 awds			~\$250k/yr 20 awds				2 yr \$200k 10 awds		
2009	~\$750k/yr 8 awds			1-5 yr 20 awds					2 yr \$200k 10 awds	
2010	<i>no data</i>			<i>no data</i>					<i>no data</i>	
2012	~\$680k/yr 6 awds			1-5 yr \$750k 10 awds					2 yr \$200k 6 awds	
2014	5 awds				5 yr \$750k 10 awds				3 yr \$250k 5 awds	
2016	5 yr \$3M total 5 awds					3-5 yr \$1M 6 awds	3 yr \$1M 6 awds			1 ARC awd 5 yr, \$1M/yr 4 eval awds

~ indicates that the annual award amount is estimated from other statements.



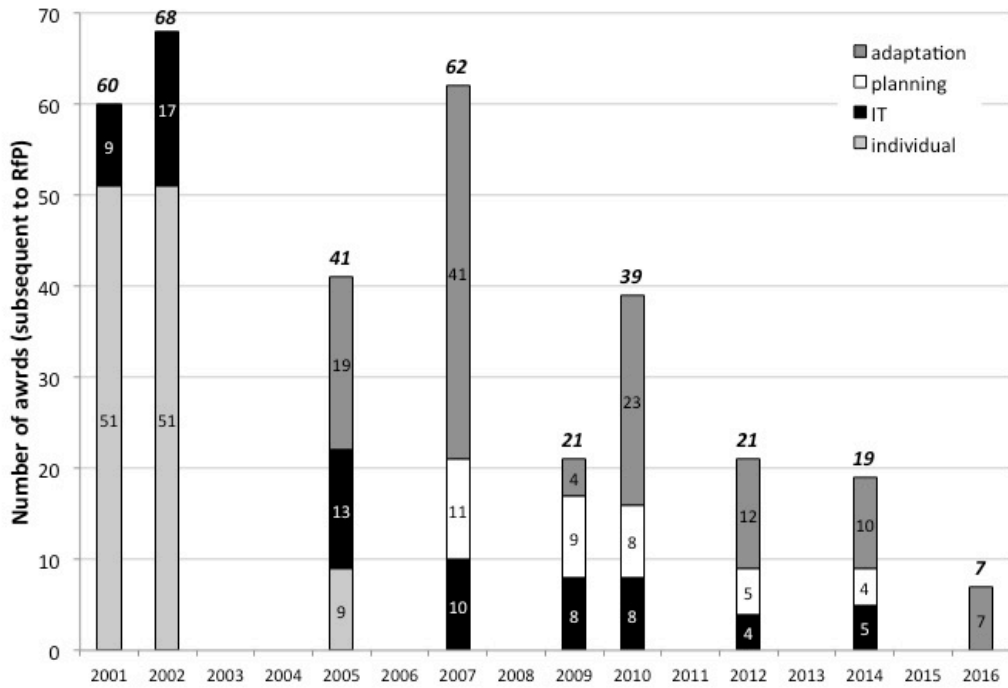


Figure 2: Number of ADVANCE awards, by program and RfP year.

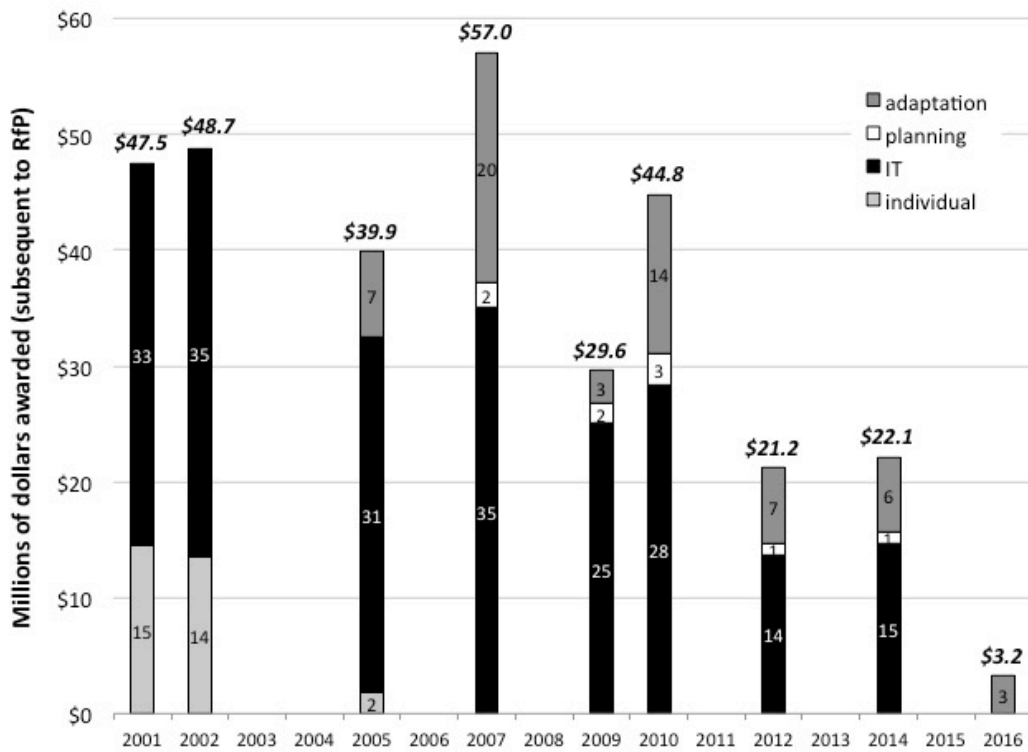


Figure 3: Dollars awarded by ADVANCE, by program and RfP year.

These data provide context for the text analysis in the next section of findings, by showing how program activity shifted among strands as NSF tested different elements of its theory of change.

### **Findings from Analysis of ADVANCE RfPs: An Evolving Theory of Change**

Based on the qualitative analysis of the RfP texts, we describe patterns of consistency and change of two broad types:

- language that communicates evolving understanding of *what* ADVANCE projects should accomplish, alone or as a group—that is, changes to the goals, design, and central ideas of ADVANCE, especially as these may suggest NSF’s evolving theory of change for ADVANCE
- expectations that communicate *how* ADVANCE projects should do this work—that is, changes giving advice to proposers on organizing proposals and implementing successful projects

The textual analysis focuses on the long-lived Institutional Transformation (IT) program, but we also discuss other programs as windows into the evolution of NSF’s theory of change over time (Figure 1). We use the textual and historical evidence to highlight key themes and to make inferences about the existence and processes of organizational learning on NSF’s part. We first discuss the RfPs’ language on *what* problem ADVANCE projects are intended to solve and *what* goals they were to accomplish: both the overall rationale for ADVANCE and the ways that different program strands have addressed different aspects of the evolving ADVANCE theory of action. Then we discuss RfP language that indicated *how* ADVANCE projects—particularly the large IT projects—should accomplish the desired aims, by considering NSF’s expectations and advice for different project components.

#### **Rationale for ADVANCE**

In all the RfPs, women’s underrepresentation in STEM fields serves to diagnose the problem to be solved: women are underrepresented; this reflects the cumulative effect of multiple causal factors; thus the very fact of underrepresentation points to problems in the processes and environments for academic STEM work. The language of this argument remained stable for several years (2001-07):

A number of factors have been hypothesized to account for the lower proportion of women in the senior ranks of science and engineering faculties, e.g. differential effects of conflicts between work and family demands, unequal access to resources such as space and supporting facilities, underrepresentation of women in important departmental decision-making processes, to name a few. The cumulative effect of such diverse factors has been to create formidable barriers to the advancement of women in academic science and engineering. (2001)

Initially, the only evidence for underrepresentation was women’s percentage on STEM faculties, but over time additional data were added: the low percentages of minority women on STEM

faculties (2002) and in the STEM workforce at large (2005), women's share of STEM full professorships (2007) and of STEM PhDs (2009). The 2010 RfP acknowledged that women's representation varies by "discipline, rank, type of institution, and type of appointment..., race and disability status." These data underscored that women's presence is not only limited, but uneven, and more limited in positions of higher status—facts not explained by their absence among PhD earners. By 2016, however, such statistics were largely abandoned.

The role of multiple factors that together shrink women's representation (Valian, 1999) was also noted from the start. The 2009 RfP made explicit that these factors are "external to [women's] ability, interest, and technical skills," but was still vague as to how and why they affect women. Eventually the barriers were more firmly located, with descriptors of barriers as "institutional" increasing in 2009-2012. In 2016 reference to "organizational" and "cultural" factors increased, and the causal mechanisms by which these may affect women were detailed, as in this excerpt:

Organizational barriers that inhibit equity may exist in areas such as policy, practice, culture, and organizational climate. For example, practices in academic departments that result in the inequitable allocation of service or teaching assignments may impede research productivity, delay advancement and create a culture of differential treatment and rewards. (2016)

But why does women's representation in STEM matter? Initially, diversity was asserted to improve the quality of knowledge creation, because both "the pursuit of new scientific and engineering knowledge and its use in service to society require the talent, perspectives and insight that can only be assured by increasing diversity" of the STEM workforce (2001-2007). While this language emphasized benefits to the nation from knowledge-building, it also suggested that these benefits multiply if diverse perspectives are included (see McClellan, Williams & Deetz, 2010). In 2007, national benefit was complemented by benefits of fairness in opportunities and outcomes for individuals through a "broadly inclusive" STEM workforce, expanded "scientific literacy of all citizens," and assertions that "every American" should have "an opportunity to achieve and to contribute." But such aspirations for individual opportunity were not repeated. Rather, the focus shifted to workforce size (2009-2014), where "full participation of women and utilization of their talent is required for sustained US global competitiveness and innovation." Here women were not seen as making distinctive contributions or adding new perspectives, but as simply bolstering the net numbers of STEM workers.

Finally, the 2016 RfP shifted focus to "equity" as a desired goal, using this term 70 times, compared to 0-12 uses in each of the prior RfPs.

The ADVANCE program is designed to address gender equity through the identification and elimination of organizational barriers that impede the full participation and advancement of women in academic institutions. (2016)

ADVANCE solely targeted academic institutions and their STEM faculties, excluding other knowledge-building organizations such as federal laboratories. This was justified in consistent language about the roles of faculty and administrators as

intellectual, professional, personal, and organizational role models that shape the expectations of many prospective scientists and engineers. Persistent underrepresentation of women faculty, especially in leadership positions, may affect all students' critically important relationships with mentors, participation as members of research and education teams, and self-identification as potential researchers. (2012)

While faculty influence on students remained a central justification for ADVANCE's focus on higher education, in 2016 the language shifted from emphasizing women's presence in STEM learning environments to emphasizing that they must have equal status there:

The ADVANCE program contributes to the development of a more diverse science and engineering workforce because of the focus on equity for STEM academic faculty who are educating, training, and mentoring undergraduate and graduate students and postdoctoral scholars. (2016)

### **ADVANCE Theory of Action**

With this understanding of how NSF viewed the problem over time, we can examine the stated goals and infer a theory of action for ADVANCE. The theory of action comprises the logical links from the problem to be solved to the chosen strategies and anticipated outcomes—the assumptions and strategies for how to move from the current state to a desired future (Connolly & Seymour, 2009). Early RfP language stated the primary goal of ADVANCE,

to increase the representation and advancement of women in academic science and engineering careers, thereby contributing to the development of a more diverse science and engineering workforce. (2001-2005)

In 2007, a slightly revised goal identified “systemic approaches” as the means to achieve this goal, which remained explicit through 2016. In this section, we describe program strands offered by ADVANCE to achieve this primary goal. We view new program tracks as the most important changes observed across the RfPs, because they reflect major changes in the conception and design of ADVANCE. Such changes offer the clearest glimpses into NSF's theory of action that are possible from the documents—and thus offer strong evidence for double-loop learning that reflected an evolving understanding at NSF of how institutional transformation proceeds.

#### **Transforming individual institutions.**

Institutional Transformation (IT) is the flagship program of ADVANCE, with 74 awards totaling over \$215 million from 2001-2016 (Figures 2-3). Of these, 58 were the large, five-year IT projects that many consider the signature of ADVANCE. The IT track exemplifies a key feature of the ADVANCE theory of change, that individual institutions are where change needs to happen. Institutions are workplaces for women, but also holders of culture; they are sites in

which the multiple and interlinked influences on women's career trajectories are enacted through multi-level processes. To combat the cumulative and systemic barriers that emerge from such institutional arrangements, systemic change is required—a transformation indeed, as these extracts show.

...[T]he lack of women's full participation at the senior level of academe is often a *systemic consequence of academic culture*.

...Institutional Transformation Awards provide flexibility... 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, [IT awards] seek to create *positive, sustainable, and permanent change in academic climates*.

...Proposals... should show an *integrated approach to addressing the complex institutional factors* affecting the full participation and advancement of women in academic science and engineering careers. The project may be directed at review and transformation of one or more departments or schools of science or engineering, or of an entire institution or system. (2001, emphases added).

The long duration and large size of IT awards acknowledged that transformative change would require multiple initiatives to tackle different aspects of the problem. The 2001 RfP suggested a menu of activities—faculty development, mentoring, work/life programs, training for department chairs. However, the menu was soon abandoned for more general guidance on the scope, goals, and audiences of activities, which could include direct support to women faculty, institutional self-study to diagnose problems and develop solutions, and work to improve institutional policies and practices (see Laursen & Austin, 2014). Proposers had “maximum flexibility” (2009) to argue which activities would be transformative at their institution and why.

### **Supporting individual women scientists.**

While IT applicants were cautioned to “focus on ways in which the institution can foster supportive organizational environments... rather than ...on ways to augment the skills and experience of women faculty” (2002), other early ADVANCE programs continued to supply just such a boost to individual women (Figure 1, Table 1). Awards to ADVANCE Fellows targeted women who had experienced gendered career limitations but who had “high potential to develop or resume” academic careers. Resembling the POWRE program that preceded ADVANCE (Rosser, 2010), the Fellows program may have helped to ease the transition at NSF from individual support to institutional change, and to build buy-in among the STEM directorates that managed Fellows awards; it was phased out after two RfPs. Similarly, Leadership awards to individuals sought to “recognize and encourage outstanding contributions” to advancing academic STEM women. This program seeded smaller-scale innovations and was folded into the Partnerships strand in 2007. As Figures 2 and 3 show, these programs were well subscribed in

their early years. Thus the termination of these program tracks focused on individuals may signal NSF's wholehearted commitment to a theory of change that is firmly focused on institutions and, perhaps, its increasing confidence that this approach would work.

### **Adapting prior efforts.**

PAID (Partnerships for Adaptation, Implementation and Dissemination) awards joined the ADVANCE portfolio in 2005 (Figure 1). Through smaller, shorter grants (Table 1), this track sought to broaden the impact of IT projects that had developed strategies to advance gender equity, and to expand the networks of people and institutions who knew about these strategies. Drawing on interventions already proven in one setting, PAID projects supported adapters to apply and evaluate selected interventions under new circumstances, or enabled developers to share effective practices by training other change leaders. Explicit language invited proposals from institutions of types thus far underserved, including predominantly undergraduate institutions (PUIs), minority-serving institutions (MSIs), and women's colleges. Partnering among institutions was encouraged but not required. In 2007, new language encouraged projects targeting a STEM discipline, and, in 2009, PAID-Research projects were invited to study gender in the academic STEM workforce. PAID was thus intended to “speed the diffusion of innovative approaches” and to “continue building knowledge about effective institutional practices and policies (what works under what circumstances), thereby strengthening the cycle of innovation” (2005). In these ways, the RfP signaled NSF's rising interest in building collective knowledge about how to accomplish these desired but challenging transformations toward gender equity. This suggests double-loop learning: as NSF saw evidence that some interventions developed by early IT awardees were portable to other institutions and need not be reinvented wholesale, the theory of change was expanded to enable change strategies that were still institution-focused but built on ideas first developed by others.

In 2014 PAID was replaced by PLAN, Partnerships for Learning and Adaptation Networks, seeking to create “communities of adapters” who would apply an intervention and document their learning about how to make it work in diverse institutional and disciplinary settings. Like PAID, PLAN emphasized adapting prior innovations, but also called for formal learning from this process. In 2016, PAID's two ideas were formally separated: the Adaptation track supported a single institution to adapt and implement proven strategies, again with special welcome to two-year and masters-granting institutions, MSIs and PUIs, while the Partnership track supported collaborative efforts to increase gender equity within STEM disciplines, highlighting requirements for “sustainability and/or scale-up, communication of outcomes and lessons learned, and evaluation of the project's impact” (2016). In altering program tracks to explicitly place emphasis on formal learning from these adaptation experiments, these recent changes are consistent with other, earlier changes to the RfPs (discussed below) that emphasize ADVANCE's intent to build generally useful knowledge about change strategies and processes. In this respect, they may be viewed as resulting from a multi-year cycle of double-loop learning—not new ideas *per se*, but manifesting this intent in an additional way. In contrast, calls

to engage disciplines may be interpreted as trials of a new theory of change that considers the discipline, in addition to the institution, as a locus of change—the type of change that typically results from a double-loop learning cycle. Overall, as Figures 2-3 show, attention to adapting and using the work of prior projects has been an explicit part of the ADVANCE theory of change since this strand was formally introduced a few years after the program's onset.

### **Planning.**

The IT-START program was initiated in 2007 to support modest planning grants for institutions to take initial steps—data gathering and analysis, policy reviews—to identify specific issues for their women faculty and do the “catalytic groundwork” (2007) to prepare a full IT proposal. It recognized the lack of “administrative and professional staff infrastructure [required] to undertake a comprehensive review and analysis of institutional data” (2007) at many institutions, such as teaching-intensive colleges and MSIs. START was replaced in 2009 by IT-Catalyst, which likewise supported institutional self-assessment to spark transformation. This program strand may reflect single-loop learning, seeking to reduce a barrier that prevented some institutions from doing the preliminary work needed to apply successfully for an IT award. As Figures 2 and 3 show, the planning strand had steady but modest activity through its lifetime. However, out of 37 awards, we could identify only 2 IT and one adaptation award made to institutions that had previously held START awards.

### **Centralized programs supporting new goals.**

The preceding sections describe grant mechanisms by which ADVANCE sought to achieve its main goal of increasing women's representation and advancement in academic STEM careers. Two other goals became explicit in later years: to contribute to research knowledge on gender equity in academic STEM disciplines (2012-16) and to develop “innovative and sustainable ways to promote gender equity in the STEM academic workforce” (2014-16). These two goals formalized a growing emphasis on building knowledge so that other institutions—not only those funded by ADVANCE—could use practices and findings developed with ADVANCE support.

Two program tracks introduced in 2016 directly support these knowledge-building goals. ADVANCE Longitudinal Evaluation (ALE) awards support collaborative studies of change at previously funded IT institutions, seeking to “develop shared metrics... and evaluate the long term impact of the ADVANCE IT grants on organizational systems, culture, and climate in these institutions.” The ADVANCE Resource and Coordination Network (ARC Network) will “facilitate the adoption and implementation of evidence-based systemic changes” through activities such as research-to-practice translation, curation and sharing of proven tools and materials, and fostering communication among decision-makers, researchers, and faculty. Combined, these programs seek to strengthen knowledge about and promote use of research-based best practices for change—thus creating, preserving and centralizing community knowledge of how organizations can promote and sustain gender equity. These programs may reflect a culminating stage of the shift in ADVANCE's theory of change, from a focus on fostering change to studying it and sharing this knowledge.

## Project Components

The preceding section details *what* ADVANCE as a whole, and the projects it supported, were intended to accomplish. While the overall rationale for ADVANCE was largely stable, the changing menu of program strands reflects shifts in the ways NSF leaders thought these goals could be achieved. Even more profound changes are seen in the instructions to proposers about *how* they should organize their work toward these aims. Over time ADVANCE RfPs became progressively more directive, particularly for IT proposals. The RfP nearly doubled in length from some 55,000 words (2001) to nearly 110,000 words (2012), its tone increasingly bureaucratic. But we also see evidence of NSF learning from prior projects in efforts to shape later proposers' work in ways thought to make it more effective and impactful.

Here we examine instructions to IT proposers about proposal content—what writers should address in the proposal—and project structure, or how projects should be conducted. We interpret evolving expectations about project *structure* as evidence for single-loop learning from experience, as NSF saw and tried to prevent common problems encountered by previously funded projects. In contrast, changes to proposal *content* requirements tend to offer additional evidence for shifts in NSF's theory of change that we conjecture to result from double-loop learning processes.

### Proposal content.

The expectations for IT proposals illustrate how NSF imagined a compelling case for transformation. From the beginning, proposals were expected to include data on the status of women. By 2009, this had evolved into lengthy guidance on the use of data to justify the proposed work, capped by an ironic warning not to overdo it:

Contextual information on the proposing institution... is important to explain the potential impact of the proposed project. This information should include a description of current and past activities and initiatives that are related to the proposed project and how these activities will be incorporated into the proposed project....

Comprehensive institutional data on faculty is required in the project description.... Proposals should present data on the status of women faculty and compare such data to national statistics when possible. ...The data and ...analysis should serve as part of the justification for the proposed IT project and the specific strategies outlined in the proposal. The data should provide the readers a clear understanding of the current status of women at the proposing institution, which will allow the readers to evaluate the impact and feasibility of the proposed project objectives and goals.

...[T]his section should not consume a significant portion of the project description since it is also very important to fully describe the other aspects of the proposal.... (2009)

With mounting emphasis on data came growing acknowledgment that, "As indicated by the extremely low number of women of color in science and engineering, different strategies may be



required to address their increased representation” (2002). Again, underrepresentation was treated as signaling a problem. Over time, several characteristics identified “special populations” of women faculty who might be targeted in project activities, and about whom data must be provided: race and ethnicity (2002); disability status (2007); sexual orientation (2012); foreign-born and foreign-trained status and faculty appointment type (2016). Even more significantly, in 2016 intersectionality was called out as a guiding theory of ADVANCE, to be addressed by all proposals:

The ADVANCE program is centrally focused on funding projects to support systemic change for gender equity in STEM academic careers. Barriers to gender equity may not be identical for all groups of women faculty in [STEM] disciplines, however.... All ADVANCE proposals are expected to address intersectionality and should offer strategies to promote gender equity for all faculty. (2016)

This language represents a shift from recognizing that strategies may not benefit all women equally, then sorting women into ever-snugger demographic pigeonholes, to acknowledging that both the lived experience and the social meaning of gender is modulated by women’s other characteristics, such as sexual orientation or race—and thus change strategies must accommodate these modulations (Armstrong & Jovanovic, 2017). The appearance of intersectionality as an explicit intention represents a significant revision to the theory of change that is consistent with a double-loop learning process.

Another notable change is the expectation for IT projects to state an explicit theory of change based in scholarship. The first RfP asked proposers to

[d]escribe the specific barriers to women's advancement that the project is intended to address; supply relevant data. Discuss the vision, goals, and anticipated impact of the proposed project. (2001)

By 2002, proposals were to be “well grounded in the research and practice on issues affecting women scientists and engineers in higher education.” And by 2005, the RfP explicitly called for a guiding conceptual framework or theory of change based in both scholarly work and analysis of the local context:

[IT] proposals must clearly state the conceptual framework for the proposed project, identify relevant research findings, and build on existing research and practice. ...Proposals should demonstrate the connection between the conceptual framework, the issues identified through analysis of institutional data, and the proposed plan. (2005)

By this time, proposers were also expected to consult the growing body of publicly available work from prior ADVANCE awards in designing their plan. This, coupled with increasing emphasis on “innovation” and the availability of specific program tracks to support adaptation, signaled that IT proposers should not reinvent already-existing wheels.

A major change in 2009 was the required “rigorous social science study” examining some innovative element of the IT effort. Proposers were asked to precisely “illustrate how the study will contribute to the knowledge base and scientific understanding of institutional transformation” through publication in peer-reviewed venues. In an extra five-page document, writers described their conceptual framework, grounding theory, methods, and how the study would attend to multiple identity characteristics besides gender. Acceptable research studies were described as experimental, hypothesis-driven designs; not until 2016 did the RfP language accommodate other types of research questions and other ways to consider intersectionality besides disaggregating quantitative data. The inclusion of a social science research study is another example of how RfPs evolved to place more emphasis on knowledge-building, an idea increasingly central to the program’s theory of change, and thus further evidence for double-loop learning that is evident within the RfP in multiple places.

### **Project structure.**

While the prior section details intellectual components of the proposal to lay out an IT project’s rationale, justification and plan, other elements of the RfP spoke specifically to how awardees should manage and monitor their projects.

For example, the RfP increasingly specified target audiences for ADVANCE interventions, stipulating inclusion of social and behavioral sciences within STEM, and preventing expenditures to support students, postdocs, and non-STEM faculty. Leadership expectations too became more detailed, directing proposers to include men and women (2001), social scientists (2005), and STEM faculty (2014) on the leadership team. The social scientists were tasked to inform the innovation with current scholarly knowledge on gender issues and organizational effectiveness; as later projects were stacked with social scientists (Laursen & Austin, 2014), teams were reminded to include those with direct experience of and professional credibility within STEM workplaces.

The principal investigator was expected to manage the project and to develop an administrative structure to develop a shared vision and support faculty engagement in achieving project goals. Over time, RfP language spelled out expected elements of this structure, such as the need to coordinate multiple efforts occurring in different arenas of the institution and at differing paces (2005). Proposers were asked to provide “clear evidence of institutional readiness” for this boundary-spanning work. Too, the visibility of ADVANCE IT projects raised expectations to engage with a national network and to establish the value and impact of this work by gathering evidence and sharing useful practices. Thus, project directors and their institutions were put on notice that IT efforts should be well organized and institutionally supported. Signaling that such expectations should be negotiated in advance, letters of institutional commitment for time and infrastructure were required from key people and offices.

To help with these challenges and to monitor them, the RfP recommended (2009), then required (2011), both an internal steering group and an external advisory group. The internal steering group was “to help manage the project implementation, resolve project issues, and ensure that

the project is on track for meeting project goals” (2009), and the external advisory group was to advise on project implementation and progress, separate from the external evaluator. Proposal writers were instructed to define these committees’ roles and responsibilities, with advice given as to size, composition, and meeting frequency.

To buttress local oversight, RfPs also specified increased accountability to NSF. From the start, a list of performance indicators and management goals was included in the binding cooperative agreement between NSF and the institution that defined terms of an IT award (2001). Later accountability measures included a third-year site visit “to conduct an in-depth evaluation of performance, assess progress toward goals, provide advice and recommendations for enhancing project performance, and to determine continuation of support for the project” (2007), quarterly in addition to annual reports (2009), and first-year site visits to provide technical assistance with award management and for evaluative purposes (2012).

Expectations for program evaluation similarly increased over time. Initial requirements for a “credible plan” naming “indicators and specific measurements” and led by someone external to the project (2001) were expanded to require that evaluation “ascertain which of the activities implemented are more or less effective” (2002), then further elaborated to call for “objectives, benchmarks and indicators of progress” that would be used to strengthen project implementation and to define the “essential factors for judging accountability” (2005), complete with examples of such measures. By 2009 the RfP language had stabilized and provided concrete details about the content of formative and summative evaluation plans and the coordinated roles of internal and external evaluators. The 2014 RfP declared that evaluating outcomes of specific activities was “not sufficient” and instead highlighted the need to measure activities’ impact on achieving overall project goals.

Expectations for dissemination likewise increased over time. The first RfP required only a “plan for sharing best practices” (2001), but by 2005, institutions were directed not just to transform themselves but to gather and share information so that others could do the same:

The program encourages dissemination of knowledge... to organizations and institutions that can implement reforms based on what has been learned. Since the goal of the program is to contribute to a national knowledge base, it is important to show that the investigator is aware of appropriate channels... and is committed (including allocating resources) to make sure that the investment in the project leads to this contribution and that peers in the community will benefit. (2005)

The 2007 RfP required awardees to attend the annual program meeting, which sought to build awardees’ networks for sharing research and practice. By 2009, the RfP declared that “simply making materials, tools, research, and practices available to others is not effective.... Rather, an effort to teach and/or train [others] how to adopt or adapt the information is expected as well.”

Finally, later RfPs ratchet up expectations for institutional commitment—not only to provide administrative and practical support, but to sustain its activities and outcomes after the award

period. The 2001 RfP asked reviewers to consider the institution's commitment to sustaining the effort; by 2002 specific tactics were suggested, including participation by senior faculty and administrators, "development of appropriate policies and practices," and "long-term evaluation and intervention." By 2010, detailed post-award sustainability plans for "successful efforts" were required and evaluated under a solicitation-specific criterion. By 2016, the RfP stated that

sustainability should be considered at every stage of project implementation and should become a specific project activity with dedicated staff time at least from the third-year site visit through to the end of the project.

These changes likely arose from program directors' observations that ADVANCE activities were challenging to sustain without the visibility, funding, and committed staff afforded by an award (Rosser & Chameau, 2006). Five years is a short time to accomplish real change in climates for women (UM ADVANCE, 2013)—but projects that began thinking early about institutionalization were more likely to succeed at doing so (Laursen & Austin, 2014).

### **Discussion**

In this section, we consider the broad trends that are evident in the cumulative set of changes observed in the ADVANCE RfPs over time. Some of these are supported by multiple lines of evidence. We also speculate on the processes that led to these changes over time.

Some themes in ADVANCE RfPs are constant: that underrepresentation is a sign of lack of diversity in STEM faculties, that lack of diversity hampers discovering new knowledge and preparing future scientists, and that the cumulative effect of multiple societal factors external to women causes this lack of diversity. The emphasis on equity rather than representation in 2016 is important in recognizing that even if women's numbers rise, this does not mean their working environments and opportunities to advance are equitable. These changes over time demonstrate a more nuanced theory of change, consistent with a double-loop mechanism of learning.

Other key ideas in the RfPs also matured over time. Multiple aspects of the RfP reflect growing awareness of how scholarly expertise could assist in designing and running IT projects, and of how these implementation projects afforded parallel opportunities to build new knowledge about the outcomes, processes, and challenges for institutional transformation in varied contexts, through rigorous research and evaluation. The RfPs evince growing awareness that "one size does not fit all"—both in recognizing variation in women's needs and interests, and in encouraging exploration of ways to adapt successful strategies to new contexts. Driven by what we see as double-loop learning from early projects and the growing community of IT leaders, growing emphasis on innovation, social science research, and dissemination throughout the RfP places value on exchanging this learning within and beyond the ADVANCE community. Thus, if ADVANCE cannot single-handedly transform all institutions, it can at least develop and share knowledge of how to do so. In this way, R&D work done by grantees to develop productive change strategies is amplified as good ideas spread to other sites.

In some respects, then, ADVANCE serves as a case study of how NSF operates as both the ‘changer’ and the ‘changed’: the agency issues an open call for new ideas and practices, the community of grantees innovates and pushes the envelope that in turn informs the next cycle of innovation as expressed in the RfP. In contrast with the hands-on approach of other federal funders to actively shape the projects that they wish to support (Colatat, 2015), here the agency itself does not innovate but rather establishes goals and conditions under which community members will innovate.

We view ADVANCE as distinctive among NSF programs in that this cycle of innovation and learning was unusually rapid and open. We conjecture multiple influences arising from the program’s content, structure, culture, and leadership. Community members were tightly focused on a common challenge and broad strategy of multi-level system change. Since no one had previously tackled this challenge in quite this way, cooperative learning was essential. The community quickly established persistent norms of generosity; ineligible for renewal, grantees had no incentive to withhold ideas. Most ADVANCE projects were led by highly committed senior women with a passion to improve things for those who came after them, who together formed an intellectually unstinting community.

We suggest that, as community members too, and with early access to non-public information through grantee reports and site visits, ADVANCE officers also learned quickly and cycled their learning back into later RfPs. While as researchers we have no direct access to these organizational learning processes, nonetheless the small scale and tight focus of ADVANCE enable us to infer that double-loop learning processes involving iteration between NSF and the ADVANCE community have accounted for refined ideas of how change may occur that are evident in the RfPs. In contrast, single-loop learning processes are responsive to information from funded projects but take place internally at NSF; they have led, for example, to firm guidance of proposers toward organizing structures seen to have aided prior projects to succeed. Indeed, such direction may hint at the high stakes for ADVANCE as a small, cross-directorate program, where it may be politically important that each project succeed.

This analysis also reveals some failures of ADVANCE. Two-year colleges, PUIs and MSIs are not well represented among grantees. With increasing emphasis on knowledge-building comes a privileging of research institutions, where faculty have more time, incentive and infrastructure to undertake the scholarly and administrative work needed to support an IT project, compared to faculty whose roles focus on teaching and service. Discipline-focused projects have also been few in number. Perhaps it is harder for proposers to imagine how to leverage change strategies within disciplinary societies, or feel less compelled to work in that arena than at their home institutions. And, while ADVANCE has supported much important research, its focus on formal, peer-reviewed publication as the main route of dissemination has not led to rapid sharing and uptake of research findings to a degree concomitant with the uptake of best practices shared more informally.

The RfPs do show an increasingly sophisticated appreciation for and understanding of the links between intersectionality and institutional change. Though initially inattentive to women of color and treating women as a monolithic category, the RfP now foregrounds intersectionality and equity—an important shift from an “additive” approach to addressing the unique experiences of minoritized women with a more inclusive scope. As Armstrong and Jovanovic (2017) argue, “Without an intersectional perspective, the systemic issues particular to URM women can remain hidden in a structural ‘blind spot,’ unseen and unaddressed by the institutions that wish to support them” (226). And while an additive approach may be insufficient for authentic and integrated institutional change, initiatives of this type have nonetheless contributed (in limited ways) to achieving NSF goals across the life of ADVANCE (Armstrong & Jovanovic, 2017). Indeed, intersectionality is a good example of how incorporation of a new theoretical perspective into NSF RfPs may lag decades behind its widespread use by scholars. We speculate that increasing attention to and application of this theory by leaders of funded projects led to its explicit inclusion in the RfP that in turn elevates this idea within new ADVANCE projects.

With this we argue that the ADVANCE program itself is on an improving trajectory. NSF has seemingly learned to hold institutions accountable for a more inclusive approach to transformation. Double-loop learning informed organizational knowledge creation that led to revised and, from gendered organizational and intersectional perspectives, improved efforts towards inclusivity and diversity. Attention to “organizational” and “cultural” aspects of institutions (2016) foregrounds key areas of institutions where gendering occurs (and thus inequities) and shapes how we imagine transformational change. That this responsive shift is evident and now explicit in ADVANCE RfPs and successful proposals is encouraging. Future research should explore whether explicit attention to intersectionality is influencing other U.S. NSF programs, or initiatives in other countries.

More recent IT projects have learned from earlier successes (and failures) to better integrate change approaches throughout varying levels of an institution and address multiple kinds of barriers: structural, cultural, macro- and micro-climate (Laursen & Austin, 2014). To succeed, the chosen change strategies must mirror the various ways in which an institution is gendered—and racialized, classed, and heteronormative. Thus inequalities may be “dismantled on multiple levels: (a) *structurally*, through policies and procedures that privilege certain groups (often in unseen ways); (b) *institutionally*, through institutional cultures that shape social interactions between constituents; and (c) *individually*, through organizational members’ individual identities” (De Welde & Stepnick, 2015, p. 288, original emphases).

In sum, we see NSF’s shift from addressing disparities for STEM women at the individual level to targeting institutional change as an appropriate response to women’s underrepresentation in academic STEM careers, pushing the community toward more effective systemic approaches even if in practice efforts may fall short (e.g., Morimoto et al., 2013). Likewise, the embrace of intersectionality is an encouraging trend, though not yet fully realized (Armstrong & Jovanovic, 2017). NSF’s rhetoric remains in flux; its current director speaks of “intentional equity”

(Cordova, 2016) yet still invokes a monolithic “equity for women.” Thus, we are (cautiously) optimistic that NSF will further develop and encourage the linking of *institutional and intersectional transformation* efforts to advance women in STEM careers. In documenting the outcomes of organizational learning at NSF that have led to stronger and more inclusive ADVANCE IT initiatives, we hope this linkage will become a signature of other NSF programs.

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