ADVANCE Institutional Transformation Award: Virginia Tech

PROJECT DESCRIPTION

Gail knows that she knows the answer to the student's question, but that it is just on the edges of her memory. Perhaps she has been thrown off by him addressing her as Mrs. Collins instead of Professor Collins or Dr. Collins. More likely, though, she is fumbling now because she spent last night on service tasks: preparing for the Dean's meeting on gender equity, outlining the K-12 outreach report, and reviewing resumes for the hiring committee. As the uncomfortable pause lengthens, the students, who are all males, shift in their seats and begin whispering. One of the cadets leans back in a smug pose. Although she maintains her poise, she knows that she is losing them.

On her return to her office, she passes two full professors (both males) heading to the gym with a recently hired assistant professor (also male). Swinging their gym bags, the professors walk on either side of the new hire and share a laugh. One of the professors politely nods to her as she walks by. They have never asked her to lift weights or go running, although they know that she regularly does both.

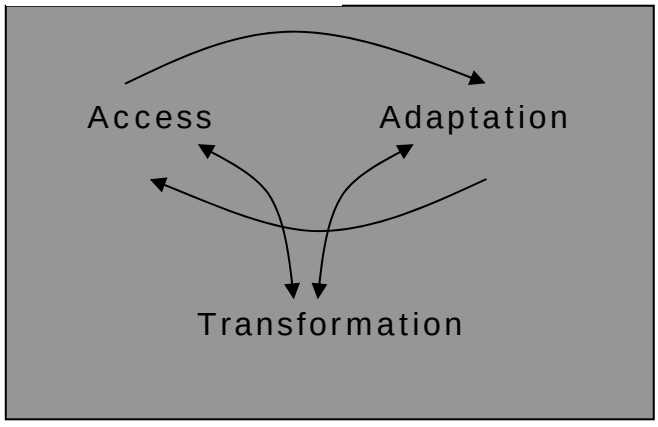
Gail's office is quiet. The phone messages and e-mails are miscellaneous requests for work. No requests for lunches. No proposals for collaboration on research. She has done good work since coming to Virginia Tech - the first year that she was here, she won an NSF Career Award. Still, no one acknowledges her success. In fact, one of her colleagues said that the only reason she won the NSF was because she was a woman. When she was in graduate school, she was respected. Even before she had finished her master's, she had become a leader in her professor's research group. She wished that she now had some of her professor's mentoring. Since they were now competing for the same pots of research funds, that relationship had become strained.

As much as she learned in graduate school, her studies did not prepare her for this job. The phone rings, and it is her Department Head. He reminds her about her meeting with a new faculty candidate tomorrow. It's on her calendar, she says. Given that the Department was considering the hiring of a second female faculty member, she was not about to forget.

Introduction

Female faculty in science and engineering (S&E) face many barriers within institutions of higher education and as a result they have often sought professional and personal support outside their home institutions, and sometimes outside the academy altogether. These women have succeeded despite their institutional settings. Given their long history and traditions, institutions of higher education have been slow to change. In particular, the fields of engineering and science have been dominated by men and by traditions that by their nature excluded women and individuals of color. Today's increasingly diverse society demands change within institutions of higher education. In 1994, members of the Pew Higher Education Roundtable argued that the longevity and vitality of any social institution requires it "to dance with change." Colleges and universities must accept the challenge to change if they are to remain vital and viable institutions.

Figure 1: Change Model



Virginia Polytechnic Institute and State University (Virginia Tech) has acknowledged the challenge of its past and has accepted the responsibility to change. In doing so, Virginia Tech will emerge as a leader in higher education for the 21st century. New academic leadership, restructuring of the colleges and disciplines, and commitment to an aggressive strategic plan currently position Virginia Tech for a successful transformation. Although a university could, and should, be able to address issues and eliminate barriers to the academic success of female faculty in S&E leading to institutional transformation,

funding of this ADVANCE grant will help us achieve our goals and aspirations more quickly and more certainly. External funding will allow us to focus our efforts to create a context for change and indicate to the university community that we are serious about institutional transformation. The process of transformation begins with **access** of women to the academy in the fields of science and engineering, continues with **adaptation** and change toward a more inclusive university, and finally results in **institutional transformation.** (Figure 1)

Leadership is critical to our success. Gardner (1995, p. 306) urges leaders to use their knowledge to empower, and we will draw upon our collective knowledge to empower and transform the institution. The process of transformation (Rosen, 1996) involves eight principles of leadership: vision, trust, participation, learning, diversity, creativity, integrity and community. These principles will be incorporated throughout our proposed activities and provide the foundation for the institutional context for change. We anticipate that as a result of our efforts, we will demonstrate that a land grant and polytechnic university with the vestiges of a traditional and military past can learn and transform itself to become a university for the 21st century.

The Status of Women in the Sciences and Engineering at Virginia Tech

While the percentage of women has grown incrementally over the last decade, only 21% of the overall tenured and tenure-track faculty members at Virginia Tech are female and even fewer (2.5%) are women of color. Ten percent of all full professors are women. Women are even less well represented on the faculties of the College of Engineering and disciplines to be included in the new College of Sciences (part of the university's restructuring process, further detailed below), which will be the focus of grant activities.

Table 1: Number and percent tenured and tenure track women faculty in the Colleges of Engineering and Sciences, Fall 2001

College of Engineering	No. Women	% Women	Proposed College of Sciences	No. Women	% Women
Aerospace & Ocean	0	0%	Biology	8	19.5%
Chemical	2	13.3%	Chemistry	3	10.0%
Civil & Environmental	3	7.0%	Physics	2	8.3%
Electrical & Computer	2	3.0%	Mathematics	7	14.0%
Engr Fundamentals	3	23.1%	Statistics	2	11.1%
Engr Sci & Mechanics	0	0%	Geological Sciences	3	15.8%
Industrial & Systems	5	20.8%	Economics	4	23.5%
Materials Science	1	11.1%	Psychology	5	23.8%
Mechanical	3	8.8%	Computer Science	3	9.7%
Mining & Minerals	0	0%	Human Nutrition, Foods & Exercise	9	52.9%
College Total	19	7.4%	College Total	46	17.2%

Table 1 shows that some departments have no women faculty members; in other cases, the small numbers contribute to feelings of isolation. Given the recency of female hiring in these disciplines, it is not surprising that only 42% of women faculty in the College of Engineering have tenure, while 80% of the men are tenured. In the newly configured College of Sciences, 65% of the women faculty members have tenure, while 84% of the men are tenured.

In 1998, the Virginia Tech community – all faculty, staff, and a sample of undergraduate and graduate students – were surveyed about their experiences with and attitudes toward diversity. The findings documented long-standing concerns about the climate for women and minorities at Virginia Tech. For example, women faculty assessed every aspect of the climate less positively than did men, they were more likely to have experienced discrimination or harassment, and they were far more observant about problems related to race/ethnicity, sexual orientation, and other aspects of diversity than were white men. Women were far more critical of the university's efforts related to diversity and more knowledgeable about and willing to participate in diversity-related programming than were male colleagues. The findings from this set of studies have been widely shared and helped shape the diversity strategic plan and training efforts now underway.

Several issues are apparent as a result of these and other studies: recruitment of women to faculty positions falls below our goals and current availability; an unwelcoming climate undermines the success and satisfaction of women faculty, and the paucity of women among the leaders of our research centers, departments, colleges, and university means that women have little voice, participation, or impact on decision making at all levels. These are the issues we plan to address as part of the ADVANCE grant.

Underlying Issues

Our proposal to advance the status of women at Virginia Tech is shaped by the abundant literature documenting disparities in numbers, salary, opportunities, resource allocation, and satisfaction of women faculty in general and in the sciences and engineering more specifically (CAWMSET, 2000; Fox, 1996; Glazer-Raymo, 1999; MIT, 1999; NSF, 2000, Valian, 1998; Vetter, 1996). The literature on the experiences of women of color in academe is far less abundant, yet all the more important since it reveals perspectives that have otherwise been invisible (Turner, 2002; Turner& Myers, 2000). An article by Mary Frank Fox, *Women in Science and Engineering: Theory, Practice, and Policy in Programs* (1998), provides a helpful framework for understanding gender disparities in science and engineering. Programs addressing gender disparity tend to define the nature of the problem as either a function of the attitudes, values, and behaviors of individual women, or of the structural and environmental characteristics of the settings in which women are educated and work. Programmatic solutions emanate from these definitions and understandings of the problem.

Fox found some programs clearly worked from an individual-level definition, designing programs to remediate deficits such as lack of confidence or motivation, or lack of technical skills. Other programs addressed environmental and organizational determinants of women's condition, such as an inhospitable climate, or the culture of competition that permeates these fields. Yet other programs adopted a mixed micro-macro perspective where both individual and environmental issues played a significant role. While programmatic solutions paralleled the definitions and perspectives to some degree, implementation was not always able to address successfully problems associated with environmental or structural dimensions. Fox states:

….in the university, as in other organizations, the current distribution of power, and efforts to maintain it, are basic political processes. Attempts to fit individuals to existing structures meet less resistance than struggles to change organizations and their hierarchies. Thus, individual level definitions of the problem of women in science and engineering are more easily translated into commensurate individual level solutions – such as attempts to enhance students' skills, backgrounds, and experience…-than are environmental definitions. (p. 214)

Our proposal builds on the premise that gender hierarchies are key to maintaining the relatively unequal status and opportunities for women in S&E, and that changes in culture are extraordinarily difficult to accomplish. We propose a comprehensive set of strategies that address both individual and structural issues, which will result in greater progress than might be possible with a more limited approach.

Our vision for this project and beyond is to create a shared understanding and commitment to the principle that greater diversity is not antithetical to, but rather a necessary part of the pursuit of excellence. The ADVANCE initiative allows us to focus attention on the colleges of engineering and sciences with the goal of incorporating gender equity and diversity concerns into their missions, policies, and practices, creating an environment that welcomes women and individuals of color and nurtures their success as part of the colleges' own definition of excellence. Ultimately this moves Virginia Tech from a place where women and individuals of color join the faculty on terms defined by and for majority males to a community that values the differences brought by all of its members.

Virginia Tech in Transition – The Institutional Context for Change

Virginia Tech is a public, land-grant university located in rural southwest Virginia. The largest university in the Commonwealth, Virginia Tech enrolls 28,000 including 6,600 graduate students, and employs more than 1,400 tenured and tenure-track instructional faculty. Virginia Tech was founded in 1872 as an all-male, all-white land grant college. Until the mid-1960s, students were required to participate in the Corps of Cadets, which only opened to women in the 1970s. Over the last three decades, Virginia Tech has transformed itself into a comprehensive research university with a student body that is now 41% female and 5% African American (the largest minority group in the state).

Virginia Tech is a nationally recognized leader in engineering and scientific research and education. The College of Engineering with 280 faculty members, 4,760 undergraduate students, and 1,630 graduate students is among the largest in the country. Our engineering programs are highly ranked –15th in the most recent *U.S. News and World Report* (2002) survey of undergraduate programs and 23rd in graduate program rankings. The institution is also a national and international leader in information technology, and its programs in the sciences are fully developed, some ranked in the top 20 of their disciplines. Virginia Tech had approximately $216 million in research expenditures during FY 2001; $15 million in FY 2002 were from NSF-funded projects. Virginia Tech plays an important role in addressing the current need for a workforce that is well educated in technology, science, and mathematics. Thus Virginia Tech, by virtue of its history as a polytechnic institution, current excellence, and large enrollments in S&E fields is in a position to have a major impact nationally and on the disciplines themselves if it is successful in increasing the representation and success of women in S&E fields.

This is a time of extensive organizational change for Virginia Tech, a context that creates special opportunities for achieving the goals of the NSF ADVANCE institutional transformation grant. Strategic planning and examination of Virginia Tech's goal to be among the top 30 research universities have resulted in substantial institutional restructuring. Changes in senior academic leadership (new provost and graduate dean, and up to five college deans) also offer an opportunity to institute initiatives that deliberately address the inclusion of women in S&E. Virginia Tech has asserted its commitment to diversifying the faculty and student ranks and the activities of the ADVANCE project will help create an infrastructure and programs that address the under-representation of women scientists and engineers on the faculty. This proposal deliberately ties into these organizational changes with the intent of incorporating the advancement of women in S&E as a priority during the crucial development stages of these units. Several organizational changes relevant to this proposal are described briefly below:

Restructuring the Academic Colleges: Virginia Tech currently has eight academic colleges. In May 2002, after university-wide dialogue, the Provost outlined the major organizational changes Virginia Tech would implement to position the university to achieve its goals. The largest existing college, Arts & Sciences, will be divided into two units: a College of Sciences and a College of Liberal Arts. The new College of Sciences will be formed by the end of 2002-03. The creation of a new college focused on the sciences provides new, significant leadership opportunities for women faculty and the possibility of embedding concerns of gender equity in college practices.

Creation of the Virginia Tech Institute for Critical Technologies (VTICT): The vision for VTICT is an organizational structure of collaborating research units with a thematic concentration on areas of science and technology that are growth-oriented and seen to have the highest potential for further development, education and economic impact. VTICT will enhance the university's capability to engage in large research projects, to provide a single pipeline to R&D units in engineering and the sciences for corporate or government sponsors, and to create new administrative mechanisms to facilitate interdisciplinary research. The ADVANCE grant will allow us to achieve synergy between the goals of increasing the participation of women in science and technology and the establishment of high priority, large research initiatives through VTICT.

New Academic Leaders: This is a moment of change, entirely coincidental, in the academic leadership of Virginia Tech. Dr. Mark McNamee began as University Provost and Vice President for Academic Affairs one year ago and has led implementation of the university's ambitious strategic plan. Dr. Karen DePauw joined the senior leadership as Vice Provost for Graduate Studies and Dean of the Graduate School this summer. Both bring an exceptional commitment to and understanding of gender equity issues in the academy. We are completing the search for a new dean of the College of Engineering, and we will soon be making a decision about leadership for the newly designated College of Sciences. These recent and pending changes in leadership provide Virginia Tech with an opportunity to identify the advancement of women and minorities as important priorities.

Faculty Recruitment: Severe reductions in state revenues have resulted in major budget reductions to all of Virginia's colleges and universities. We have addressed these reductions aggressively in order to optimize our capacity to achieve our goals when the funding picture improves. Numerous retirements allow us an unusual opportunity to improve the gender and racial diversity of the faculty if we are successful with our aggressive

recruitment efforts; greater accountability for search committees, department heads, and deans; and our plans to develop "cluster" hiring.

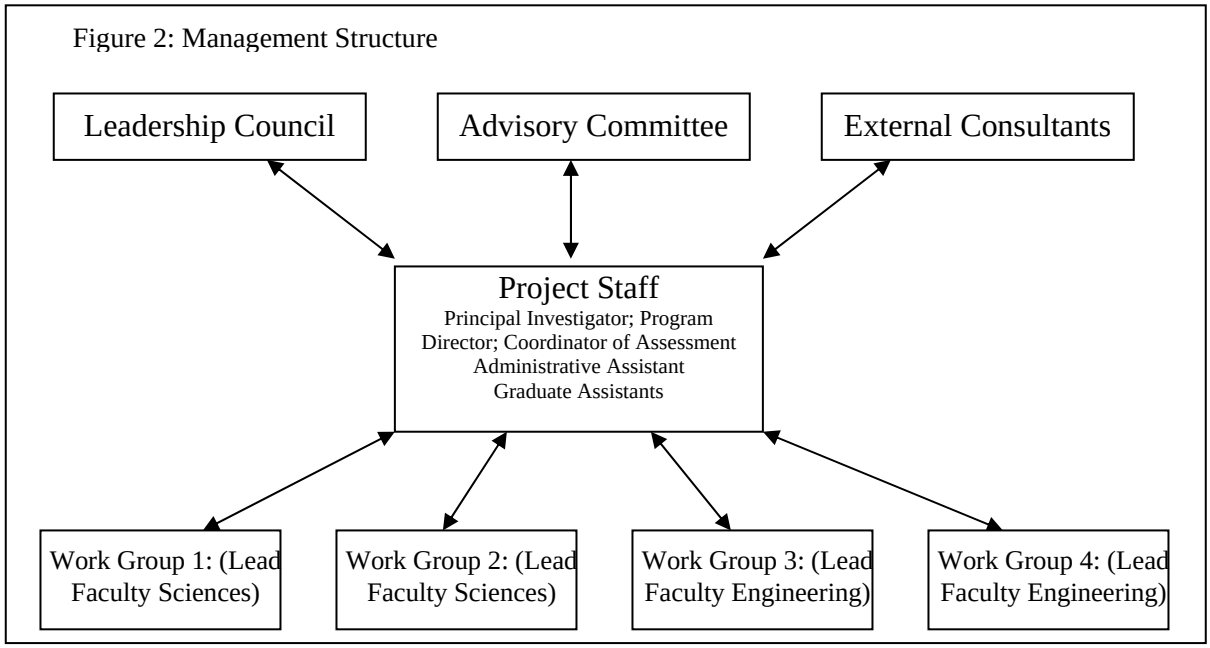
In summary, this institution, like many others, has serious challenges. Institutional leaders have chosen a very aggressive posture in addressing these challenges, clearly looking for new solutions and opportunities that will result in moving us toward the goals we have set. The ADVANCE project enjoys the strong support of Provost McNamee who has committed matching funds and personal involvement in achieving the project goals. The current leaders of the two colleges (Deans Chang and McPherson) and the Vice Provost for Graduate Studies (Dean DePauw) have also pledged their support and involvement in the Leadership Council, in providing resources to the project, and in managing the change effort within their units (see supporting letters). They welcome the opportunity to focus attention and resources on increasing the representation and success of women faculty.

Over the last 15 years, Virginia Tech has invested in a wide variety of programs and initiatives designed to increase the awareness of issues related to race and gender, and to improve the representation of women and minorities among the faculty, staff, and student body. A list of initiatives already in place--some of long standing and some recently established--is provided in the appendix. The ADVANCE project allows us to move further with issues of gender by strategically and deliberately targeting fields that have had less involvement to date. The project will also allow us to give greater visibility to existing initiatives among faculty and administrators, thereby enlarging their impact on the sciences and engineering.

Program Elements

The proposed project has four major program elements: (a) institutionalizing change, (b) empowering women as leaders and scholars, (c) increasing the representation of women and building a critical mass, and (d) advancing women into faculty careers. Each program element aims to address institutional barriers that have constrained Virginia Tech's ability to advance women faculty members in engineering and the sciences. Program elements are designed to directly target institutional culture, practices, and leadership development needs specific to Virginia Tech. The importance of identifying and adopting strategies congruent with the institutional norms and culture is an important aspect of our work and likely effectiveness (Kezar & Eckel, 2002). The Leadership Council, composed of key institutional decision makers, will provide oversight for the entire initiative, give visible leadership for the project's ambitious goals, and deal with policy matters that emerge. An Advisory Committee, composed of department heads, the lead faculty members, faculty and administrators with relevant expertise, and women faculty members from the two participating colleges will determine the priority, timing, and resource allocation to various project elements; coordinate activities across

Figure 2: Management Structure



the Work Groups; and provide advice on effective strategies to accomplish the goals.

The agenda and activities for each of the areas will be coordinated by a lead faculty member and a Work Group of faculty and departmental and college administrators. The Work Groups will develop, implement, and evaluate all aspects of program element activities; will review departmental or individual requests for funding from announced ADVANCE initiatives, and will coordinate with the Advisory Committee for continuous program improvement. Broad involvement in project goals and activities is intended to build understanding and ownership of the change effort. The co-principal investigators will each take leadership for one of the Work Groups and two other lead faculty members will be recruited for the project. To ensure that these faculty members will be able to devote significant time and energy to the project, they will be provided a course release for each semester in which they serve in this role, and summer salary where appropriate.

We have built in a reflective research and assessment component throughout all program elements. In addition, we have invited external reviewers to provide consultation and periodic evaluation of the overall project. This management structure creates a dynamic system for effective change, illustrated in Figure 2.

Program Element 1: Institutionalizing Change

Measurable Outcome: A change in the awareness, attitudes, and behaviors of key administrators and faculty members in engineering and the sciences regarding gender equity issues.

Project Activities:

1. Retreats and work groups to build awareness among faculty and departmental/college leaders
2. Visits to and interaction with other ADVANCE project sites, or peers with successful programs addressing gender in S&E
3. Focus groups and/or qualitative interviews with women faculty members in S&E to explore their experience in male-dominated fields and to provide the basis for training materials that can be used with retreats and work groups
4. Review of institutional policies and programs

Through the campus climate studies, a pilot project on faculty hiring in the College of Arts and Sciences, and diversity awareness training, Virginia Tech has started raising awareness about diversity issues and the gap in perceptions of climate for women and faculty of color and those of majority men on campus. For many faculty members and administrators in the sciences and engineering, issues of gender have little to do with their daily activities and priorities, and they remain relatively unaware of the slights, isolation, or difficulties that women may encounter as they try to fit within a culture designed by and for men.

We propose a variety of strategies to increase awareness including workshops, retreats, or other venues in which faculty and administrators can increase their understanding of gender issues. We will conduct annual retreats including S&E department heads and faculty, involving 50 participants per year for a total of 250 participants. In the first years of the project, consultants with expertise on gender issues in S&E will help set the agenda; in later years, the retreat agendas will be developed based on information from assessment activities.

Change at the departmental level is critical since this is where most faculty members live their lives. To encourage change, department head peer groups will be assembled combining leaders from departments that have successfully implemented programs improving the gender climate with those who are considering or developing new programs. Departmental teams will be invited to participate in the retreats and led through structured activities to identify goals and initiatives relevant to their department to which they will commit energy and effort over the coming year or two. Progress in achieving these goals will then be monitored and documented. Best practices from Virginia Tech and other institutions will be showcased in a variety of ways, including visits from experts on other campuses, trips to benchmark practices elsewhere, and dissemination of articles, reports, and materials. Funds to support travel, release time or summer stipends, printing of documents and materials, and other strategies are included in the budget to facilitate departmental involvement in change activities.

By virtue of their training, scientists and engineers often respond to data that document issues that may have previously gone unnoticed. For example, the MIT study on differential resources allocated to women scientists was able to galvanize commitment to change at that institution (MIT, 1999). An assessment team led

by Dr. Cathy Turrentine will conduct both qualitative and quantitative research on issues of gender to support the project aims. The campus climate surveys conducted in 1998 have been important tools in increasing awareness of the gap in perceptions between women and men faculty at Virginia Tech. These university-level findings would be more useful to academic leaders if we extended the study through qualitative methods to document the specific experiences and perceptions of women in the sciences and engineering, where small numbers create statistical challenges. Because of the small number of women in these disciplines, however, they may be reluctant to participate in interviews. Additionally, the ways in which these qualitative data can be used may be limited due to concerns about confidentiality. The data gathered from the qualitative research, therefore, will be used to generate examples or case studies as discussion-starters for training workshops or retreats.

A commitment to institutional transformation requires us to go beyond nurturing individual behavioral changes, and to take on the difficult challenge of reviewing policies and practices that create barriers for women's access and achievement in these fields. Kolodny (1998) describes how promotion and tenure policies and long-standing practices were rethought under her leadership at the University of Arizona in order to create more fair, less mysterious, and more family-friendly faculty personnel practices. While we have had a stop-the-tenure clock provision in place for more than a decade for faculty members with unusual personal circumstances, often the birth of a child, this one strategy does not change the demanding nature of a faculty career in the sciences and engineering and the particular difficulties faced by women who seek a reasonable balance in their personal and professional lives. Using what is learned from interview data with women about perceived barriers and desired improvements, and an informed view of current policies and options at other universities, we will examine and modify our policies and practices to determine how they might better support women's participation and advancement in faculty and administrative careers.

Outcome Assessments: Portfolio of the best evidence of commitment to the goal and objectives of this project by faculty and administrators. This portfolio could include documents such as departmental policies or memos; results of questionnaires or surveys; white papers from site visits; and summaries of qualitative research results.

Process Assessment of Activities:

1. **Retreats, work groups, and site visits**
   Process Assessment: Record of attendance at ADVANCE related programs with the intention that one-third of tenure-track faculty and all departmental and college administrators in participating disciplines will participate in at least one ADVANCE related program over the five-year period.
2. **Travel to or interaction with other ADVANCE project sites, or peers with successful programs addressing gender in S&E**
   Process Assessment: Record of participation by project staff, department heads, and faculty.
3. **Focus groups and qualitative interviews with faculty women in S&E**
   Process Assessment: Record of participation by faculty women in focus groups or qualitative interviews and record of how the results are used in project-related activities.
4. **Review of policies and programs**
   Process Assessment: Summary of policies and programs in place that affect the gender climate. Recommendations for policy revision to the administrators responsible for their implementation.

Program Element 2: Empowering Women as Leaders and Scholars

Measurable Outcome: A significant increase in the percentage of women in visible positions as academic and technical leaders and as senior scholars in engineering and the sciences.

Project Activities

1. Two half-time placements per year for women to serve in key administrative or technical leadership roles. Men who propose a gender equity focus to the assignment are also eligible.
2. Competitive research grant support for projects within VTICT priorities, designed to increase productivity and competitiveness of female PIs in sciences and engineering.

3. Faculty Success program.
4. Named lecture series to bring visibility to work by women in S&E.
5. A flexible work/life fund to meet varied needs for women faculty members.

While many of the strategies in this program element are primarily directed at empowering individual women faculty members, there are institutional and environmental changes we expect to occur as well. Advancing women in academic and technical leadership roles is of primary importance at Virginia Tech. Of 20 academic departments in engineering and sciences at Virginia Tech, none is chaired by a woman. Leadership of the College of Engineering, however, includes three women, an associate dean and two assistant deans, two of whom are African American. The proportion of women directors among university, college, and department-level research centers is noted in Table 2.

Table 2: Academic and Technical Leadership

	Total Number of Departments/Centers	Number of Women Directors in S&E Departments or Centers
S&E Academic Departments	20	0
University Research Centers	22	0
Departmental or College Research Centers	97	2

The Virginia Tech ADVANCE program will offer women the opportunity to develop leadership skills and to enhance their visibility in the university through half-time placements in key administrative or technical leadership roles. Administrative placements will be negotiated based on need and interest, but are expected to include roles within either or both deans' offices, the Research Division, initiatives reporting to the Provost, or other key assignments. Placements to enhance technical leadership may include helping create the Virginia Tech Institute for Critical Technologies (VTICT), or providing leadership within one of the university's major research centers. Men will be eligible to apply for this program if their proposal includes a gender equity focus. Depending on need and interest, we will also provide training on campus for women who want to enhance their administrative/leadership skills and/or support their participation in one of the excellent institutes offered by Harvard or at Bryn Mawr. In addition to the obvious benefit to individual women, we expect these leadership placements to have an impact on the areas where they serve and to infuse gender equity considerations in our infrastructure and operations.

ADVANCE funds will provide several modest research grants aimed at increasing the productivity and competitiveness of female PIs in the sciences and engineering. Support for projects related to the critical technologies emphasized by the newly-emerging VTICT will be encouraged to leverage resources and institutional priorities. The Work Group will coordinate a review process including both external and internal reviewers to ensure the quality of these proposals.

Virginia Tech has several departmental mentoring models to draw on, but no systematic program to assure faculty development and success throughout the engineering and science departments. ADVANCE activities will include exploration and implementation of Faculty Success initiatives for both women and men, including traditional mentoring, peer mentoring which we have used successfully with several groups of women in the sciences (Lederman, La Berge & Zallen, 1994), and other strategies to create communities of scholars. Exemplary departments will be recognized and presented with an ADVANCE Award for Excellence. Developing a culture of faculty development and success in these fields would have significant benefit for both male and female faculty members.

A named lecture series, annually supporting a visiting scholar in engineering and one in the sciences, will be established. This strategy addresses several program objectives – the guest lectures create opportunities for women scholars at Virginia Tech to interact and create a sense of community as part of a major campus event; the scholars provide successful female role models to doctoral students and junior faculty; and male faculty and administrators are introduced to women scientists and scholars from outside the institution, enlarging their views of who is doing interesting research.

The balance between personal and professional lives is a major issue for women in the sciences (National Research Council, 2001). Grant funds will be used to provide flexible resources for women faculty facing temporary and pressing family or other personal issues. For example, the funds might be used for a graduate assistant to maintain research and teaching momentum following birth of a child or during a period of intense care for elderly parents. We recognize that due to changing gender roles and responsibilities, men may have similar needs and would be eligible to apply for these funds in dual-career situations.

We have proposed multiple strategies here to empower women at varying stages of their careers, enhancing their capabilities and productivity as technical and administrative leaders and as scholars. But our intent here is also to build a sense of agency for change among women faculty so that their personal and professional development is leveraged to promote institutional change. We expect to do this in part by bringing women in the sciences and engineering together at many points during the project to reflect on issues of common concern and strategies for improvement, by encouraging individual women and men to use their positions and their work to address issues of concern to women in general, and to maximize the self- and institutional reflection that sets the context for these strategies.

Outcome Assessments:[1] (a) A comparison of the number and percentage of women in designated academic and technical leadership positions before the project and for each year of the project, with the intention of demonstrating a statistically significant increase in the women in leadership roles for participating units overall by the end of the five-year period. (b) Tracking the progress of each female faculty member over the five-year period with the intention of demonstrating their retention and advancement.

Process Assessment of Activities: While the overall outcome for this objective will be assessed as described above, the integrity of the project activities will be documented and their immediate impact will be assessed in the following ways. Each of the lists below includes both the ways that the activities will be assessed and also (where appropriate) the expected findings of these process assessments, such as the number of participants or the direction of impact statements. Where activities are evaluated by participants during the course of the ADVANCE project, the results of those evaluations will be fed back into project planning.

Administrative and technical leadership placements

- Record of placements (at least 6 over the five-year period)
- Participant evaluations of the impact of these placements on their professional development (showing positive impact)
- The long-term measure, extending beyond the life of the grant, will be increased representation of women in leadership roles in research centers, departments, and college and university administration

Research Grant Suppport

- Record of grants awarded (one or more each year)
- Recipient evaluations of impact of ADVANCE project funds in increasing their competitiveness for major research grants (showing positive impact)
- Long-term measure is the record of external grant submissions and awards by recipients of this ADVANCE grant for three years following the ADVANCE award

Faculty Success Program

- Record of participation in faculty success programs
- Description of models to promote faculty success

[1] Here and elsewhere throughout this proposal, anticipated outcomes are expressed in terms of percentages. This is for two reasons. First, the project itself will sometimes increase the total number of positions available (expanding the pie, so to speak). Second, the current budget issues and the university's restructuring make it unclear what the total number of positions in a discipline might be. While we would hope to increase the absolute number of women in these positions, the overall total of positions may shrink to the point that an absolute increase is not possible. Even in this case, however, the ADVANCE project should assure that the presence of women in these roles will grow, when measured as a percentage of the total new hires and total faculty for example.

- Impact evaluations from participants (showing positive impact)

Named Lecture Series

- Documentation of scholars' visits (at least two scholars per year over four years, including research presentation and interactions with students and faculty)

Flexible Work/Life Fund

- Record of grants to Work/Life Fund recipients
- Participant evaluations of the effect of this strategy in sustaining her productivity (showing positive impact)

Program Element 3: Increasing the Representation of Women and Building a Critical Mass

Measurable Outcome: A significant increase in the percentage of women faculty in S&E at Virginia Tech.

Project Activities:

1. Intensive work with search committees to develop more skill and success in recruiting women
2. Visits to other campuses and conferences to make connections
3. Hosting potential faculty members in advance of degree completion

Over the last several years, Virginia Tech has taken a systematic look at its hiring processes and decided there was a need for change. A study of the process and outcomes for tenure-track searches conducted during 1997 revealed that many search committees had few if any women and minorities serving on them, despite guidelines that stated such an expectation, and that outcomes of these searches did little to help the institution reach its goal of diversifying the faculty. The College of Arts & Sciences subsequently took on this issue and developed a pilot process for searches in the college which involved close involvement by the dean and the dean's staff. During 2001-02, we took elements of that pilot and shared best practices with search committees in other colleges, training about 150 people over several sessions. Virginia Tech is rewriting the faculty search manual for the university and creating an on-line interaction and reporting process.

Recruitment of underrepresented groups works best when it is personal and done over the long term, not just in the context of a search for one specific position where narrowly prescribed job qualifications may eliminate interesting women and minority candidates. This is time-consuming work. Project funds will be used to provide incentives, such as release time or summer stipend, to faculty members deeply involved in more aggressive search strategies. Faculty members will also be encouraged to visit other campuses to give talks and make connections with women and minority doctoral students and post-docs in the pipeline. Some of these will then be invited to campus while they are still in training so that we can begin to recruit them as potential faculty hires. Work Group members and other university representatives will seek out and attend conferences for minority-serving doctoral programs, such as the one hosted by the Southern Region Education Board, the McKnight Foundation, or the Society for Advancement of Chicanos and Native Americans in Science to build similar relationships with minority women in the pipeline. We will develop links to organizations and caucuses serving women and minorities and develop specialized expertise around recruitment of women. Based on our experience with these strategies, we will develop a manual and set of tools for search committees in S&E disciplines to increase their effectiveness in identifying and recruiting women and faculty of color.

While the best opportunity to hire women in the sciences and engineering may be at the junior level, we will make a concerted effort to identify and recruit one or more senior level hires who can provide role models for women with less experience. Invitations to senior scholars to provide the named lecture in engineering or science (Program Element 2) may be a very effective way to initiate a successful recruitment of a senior faculty member.

It is critical to make the task for faculty search committees more manageable in terms of workload and more effective and accountable in terms of actual results. While we have on several occasions been very effective in using web tools to identify potential candidates, conducting targeted searches, and pursuing candidates of interest with personal calls and attention, ultimately leading to appointment of several women in engineering and in sciences, we need to make these practices part of every search. While the goal of this program element is to recruit and hire more women faculty members in the fields where there are currently so

few, we expect that retention of these new recruits will depend on the success of efforts to improve the climate for women as addressed in other aspects of the ADVANCE project.

Outcome Measure: A comparison of the number and percentage of women faculty in participating departments before the project and for each year of the project, with the intention of demonstrating a statistically significant increase in the women faculty over the course of the project.

Process Assessment of Activities:

1. **Intensive work with search committees**
   Process Assessment: A web site and manual or similar tools documenting recruitment resources for faculty searches in the sciences and engineering.
2. **Visits to other campuses and to conferences**
   Process Assessment: Documentation of recruitment trips (at least five) by project staff, department heads, and faculty. Tracking of women identified through visits and conferences to determine if they were eventually offered a position and the outcome of that offer.
3. **Department strategies for faculty recruitment**
   Process Assessment: Portfolio of the best examples of recruitment strategies conducted by departments as a result of ADVANCE-funded initiatives.

Program Element 4: Advancing Women into Faculty Careers

Measurable Outcome: A significant increase in the percentage of women in engineering and the sciences who choose faculty careers.

Project Activities:

1. Establish a program for preparing the future professoriate
2. Expand the Dissertation Year/Postdoctoral Fellowship Program for Academic Diversity

Increasing the number of doctoral-prepared women scientists and engineers for faculty positions is an important complementary priority since our success in building a critical mass of women on the faculty is a function in part of availability. The new Vice Provost for Graduate Studies and Dean of the Graduate School plans to put in place a program for preparing the future professoriate, which will provide opportunities for doctoral students to learn about and realistically prepare for faculty careers. The ADVANCE project provides a complementary focus for these efforts, providing modest support for activities and research directed toward women doctoral students in the sciences and engineering. As an additional commitment, the Graduate School has pledged two assistantships plus tuition waivers annually for women doctoral students in an underrepresented science or engineering discipline. The assistantships will be assigned to women faculty members as a way to increase the synergy among ADVANCE-related goals and activities.

For more than a decade, the university has supported a program for advanced doctoral students from underrepresented groups for a research/mentoring experience at Virginia Tech. Originally conceived as a summer experience for four fellows per year, the program has more recently offered an academic-year fellowship for two participants who spend the year completing their dissertations, teaching one course, and interacting with faculty and the university community in a pre-faculty mentoring experience. The program has been a useful strategy in the recruitment of faculty of color. ADVANCE project funds will expand this program to add two postdoctoral fellowship opportunities per year for women in underrepresented fields in S&E. The fellowships will support research in the critical technology areas associated with VTICT as a first priority. A mentoring team will be created for each fellow to encourage the maximum professional development during the postdoctoral experience. Specific attention will be given to recruiting applicants of color for the fellowships.

As part of the named lecture series, visiting senior scholars will meet with doctoral students and post doctoral fellows. These visits will allow them to talk openly with successful women academics about how they have built a satisfying life and dealt with the perceived difficulty in finding a balance between professional and personal commitments. This is one of a number of socialization issues that institutions need to address if doctoral students are to choose a faculty career and make a successful transition (Austin, 2002).

Outcome Assessment: A comparison of the number and percentage of women graduate students and post doctoral fellows in participating departments before the project and for each year of the project who intend to pursue faculty careers, with the intention of demonstrating a statistically significant increase in the women faculty candidates over the course of the project.

Process Assessment of Activities:

Future Professoriate Program

- Record of participation in seminars, assessment, and individualized experiences designed to prepare women for faculty careers in S&E (at least 80 participants over five years)
- Reflections of participants on the change in their goals and expectations over the course of the program (showing positive impact of ADVANCE programs)

Dissertation Year/Postdoctoral Fellowship Program

- Record of participation in the program (at least six over the five-year period, with at least two of these joining the faculty at Virginia Tech)
- Participant evaluations of the value of this program in preparing them for successful transition to a faculty career (showing positive impact)
- Longer term, fellows will be tracked to document subsequent career moves, including offers of employment at Virginia Tech.

Five Years After the ADVANCE Program

After their noontime run, Gail strides back to the building with Phil, Carl, and Sherri. She agrees to run with them tomorrow and heads to her office, where a cadre of graduate students has gathered with questions about their research. One of the students is Melissa, a Ph.D. candidate with aspirations to become a professor. Gail's afternoon quickly becomes a series of meetings: graduate students, faculty from her research center, more graduate students. In the meetings with the other faculty, Gail looks each of them directly in the eye. She has earned her position as head of the research center. Not only does she know that she has earned the position, but the other faculty know it as well. Before turning off the lights for the day, she pulls out her notes for tomorrow's lecture for one last look. Although she knows the material, she wants one more review. When a student poses a question tomorrow, she will be ready.

Strategies for expanding participation of women from minority groups

Currently there are three Hispanic women, two Asian women, and four African American women on the faculties of the participating colleges. Increasing minority participation in the science and engineering pipeline has been a major institutional focus over the last decade. We have developed effective collaborations with regional high schools and HBCUs (historically black colleges and universities), written grants for state, federal and corporate support for research experiences and retention initiatives for minority students, hired a graduate recruiter, and organized activities related to minority graduate student recruitment. (Please see the appendix for some of these initiatives.) We will build on these connections to enhance the recruitment of women of color to graduate school, postdoctoral positions, and faculty positions at Virginia Tech. We will participate in conferences for minority-serving doctoral programs to make connections and increase our ability to recruit women of color in all disciplines, particularly those in S&E.

A fundamental principle of Virginia Tech's ADVANCE program is that every activity must be infused with an awareness of and commitment to increasing the participation of women of color. It is our intention to actively engage minority women through all program elements.

Performance plan and methodology

Specific outcomes and process measures are included with the program element descriptions above. The plan for implementation of major project activities is below:

Program Elements/ Activities	**Year One**	**Year Two**	**Year Three**	**Year Four**	**Year Five**
Project Administration					
Hire staff					
Purchase equipment					
Set up office					
Institutionalizing Change					
Retreats					
Consultation/visit with best practice sites					
Workgroups					
Evaluation of extant policies and programs					
Self study/Assessment					
Empowering Women as Leaders and Scholars					
Technical or admin leadership placements					
Seminar series					
Research support					
Flexible work/life fund					
Faculty success initiatives					
Increasing the Representation of Women and Building a Critical Mass					
Training & support for search committees					
Visits to other campuses					
Seminars by potential faculty					
Minority Conferences					
Advancing Women into Faculty Careers					
Future Professiorate Program					
Visiting Scholars					
Post-doc fellowships					

Management /Administrative Structure:

Achieving the broad and ambitious goals outlined in the proposal will require involvement of a significant number of faculty and administrators willing to think through the most effective ways to create and sustain change within the context of the participating colleges and disciplines.

Leadership Council*:* The Leadership Council will give overall policy and management oversight to the project, assuring the involvement and support of key institutional leaders. They will help move policy changes through university governance and assure their subsequent adoption. They are also expected to give visible leadership to the project through their individual roles. Members will be:

1. University Provost and Vice President for Academic Affairs, Mark McNamee
2. Dean, College of Engineering, Malcolm McPherson (Interim Dean)
3. Dean, College of Sciences – to be represented by Lay Nam Chang, currently Interim Dean, College of Arts & Sciences
4. Vice Provost for Graduate Studies, Karen DePauw
5. Vice President for Multicultural Affairs, Benjamin Dixon
6. Director, Virginia Tech Institute for Critical Technologies
7. Associate Provost for Academic Administration, Patricia Hyer (Principal Investigator)

ADVANCE Advisory Committee: The advisory committee will be key to shaping the nature and sequencing of the ADVANCE initiatives such as the self-assessment, training components and faculty recruitment initiatives. Membership is expected to include:

1. several department heads from the two colleges
2. college-level administrators with roles relevant to the project goals
3. women faculty members from participating departments
4. the lead faculty who will head up Work Groups
5. the director of the Women's Center
6. one or more other faculty members or administrators with expertise to contribute to the project implementation

External Consultants and Evaluators: Our project will benefit from the advice of others outside the institution. Two people have committed to provide counsel and external evaluation of the project on a periodic basis:

1. Dr. Jane Ammons, ADVANCE Professor of Engineering, Georgia Tech
2. Dr. Denice Denton, Dean, College of Engineering, University of Washington

Project Personnel: Principal Investigator, Patricia Hyer, Associate Provost for Academic Administration: The project PI will give overall administrative leadership to the project, assuring the full and close involvement of the Provost's Office in achieving the project goals. Among Dr. Hyer's current responsibilities are leadership for faculty hiring, policy development related to faculty employment, and diversity issues; all of these responsibilities are closely related to ADVANCE project goals and strategies. Hyer has been engaged in improving the status of women and minorities for more than 25 years, founding women's centers at two universities, conducting and publishing research on women faculty, serving as state coordinator for advancing women in higher education administration, and acting as a lead institutional change agent on diversity issues for the last 15 years through the Provost's Office at Virginia Tech. The co-principal investigators are Nancy Love, Associate Professor of Civil and Environmental Engineering, and Karen Thole, Associate Professor of Mechanical Engineering. Drs. Love and Thole will both serve as lead faculty for two of the work groups, and both have been involved in the past with gender-related outreach in S&E. Both women lead successful research programs in their respective disciplines and are being provided sufficient resources to manage their ADVANCE duties while maintaining their research agendas. Additionally, both Dr. Love and Dr. Thole will gain valuable leadership experience through their participation in the ADVANCE program.

Project Staff: A full-time project director/administrator will be appointed to coordinate and implement ADVANCE activities. An administrative assistant and two graduate assistants will be part of the project support structure.

Coordinator of Assessment Activities: Dr. Cathryn Turrentine, Director of Planning and Assessment for the Division of Student Affairs, will oversee the assessment activities. Additional research support will be provided by the Office of Institutional Research and Planning Analysis.

Sustainability Beyond the Funding Period

The Provost has committed support for the appointment of a director and staff to carry out the project during the life of the grant and to sustain this support following the grant so that progress can continue. In addition, the university is in the needs assessment phase of its next development campaign. The deans of engineering and arts & sciences will recommend fund raising goals related to ADVANCE initiatives, as will the Vice Provost for Graduate Studies. These initiatives are expected to include one or more endowed professorships to support gender equity initiatives in science and/or engineering, fellowship support for doctoral students, and support for programs, such as the speaker series, conference travel for graduate students, and other priorities.

Dissemination

The project provides a number of opportunities to share our experiences and our results both internally and externally. We will create a project web site to provide access to reports and data prepared as part of the project. Project personnel will both attend and present at conferences in their disciplines as well as those

focused on gender in engineering and the sciences. The project will host a conference for women doctoral students in S&E to increase access to role models and colleagues and to provide professional development opportunities and interaction among women at various stages of their careers. We expect to share manuals, strategies, and other best practices we develop or refine with other institutions so that they might learn from our experiences and that Virginia Tech might be a model for institutions with similar profiles and cultures. In addition, by building a critical mass of female faculty we expect to be able to attract more women students to S&E majors, increasing the diversity of the S&E labor force, not only at Virginia Tech, but nationally. Improving the climate and opportunities for women at Virginia Tech will affect the expectations and attitudes of the next generation of scholars and leaders. Women and men graduate and undergraduate students will take their experiences at Virginia Tech to other institutions and workplaces, building a network of scientists and engineers infused with the values embodied in the Virginia Tech ADVANCE program and setting high expectations for the involvement of women in science and engineering occupations.

Previous Experience of Co-PIs with NSF

Dr. Love is/was PI on two NSF grants: BES 95-02450 from July 1995 - June 2001, "CAREER: The Distribution and Expression of BTX-Degrading Microorganisms in Anoxic/Aerobic Single-Sludge Biological Treatment Processes", $335,610 (includes industrial matching and REU supplements); and BES 00-86883 from September 2000 - December 2002, "Integrating Microfluidics, Materials Science and Microbiology: Biosensors for Protecting Wastewater Treatment Systems", $105,050. The objective of BES 95-02450 was to discern the impact of sequential redox treatment strategies on the biodegradation of organic xenobiotic compounds and on the structure and function of the associated activated sludge community. Research results from this work have been widely disseminated (Fettig and Love, 1997; Love et al., 1998; Love et al., 1999; Bailey and Love, 1999; Duncan et al., 2000; Ma and Love, 2001a; Ma and Love, 2001b; Bott and Love, 2001; Bott et al., 2001; Bott and Love, 2002; Love and Bott, 2002). The educational component of Dr. Love's CAREER grant also included offering a summer camp entitled Environmental Engineering Education for Girls and Teachers for K-12 female students and their teachers. This camp was designed, organized and implemented in conjunction with three K-12 teachers. Thirty-two students and four teachers participated in the program. The current project (BES 00-86883) focuses on the development of a microfluidic whole cell biosensor that links a class of chemical sources to a specific deleterious process effect through the molecular level cause. This project includes a close collaboration with the National Institute of Standards and Technology. One conference paper has resulted from this work (Wimmer et al., 2001) and two journal papers are expected.

Dr. Thole was PI on one NSF grant, entitled "CAREER: A Research and Educational Career Program: Improving Gas Turbine Technology and Increasing the Number of Women in Engineering", which was implemented at two locations: CTS-9624591 from March 1996 through December 1999 for $129,913 at the University of Wisconsin; and CTS-9996224 from January 1999 through September 2001 for $155,087 at Virginia Tech. The research tasks proposed in the CAREER grant were to develop a flow facility with a scaled-up turbine vane and to measure experimental data that can be used for benchmark studies for computational fluid dynamics simulations. The measurements that took place included a full documentation of heat transfer and flow field data both at the vane mid-span and along the vane endwall. The documentation of these measurements has led to dissemination of the data to five universities, including the international community, and three gas turbine companies who have requested this full database for comparing against their computational predictions at low and high turbulence levels. Several publications have resulted from this work (Martin and Thole, 1997; Kohli and Thole, 1997; Kohli and Thole, 1998; Radomsky and Thole, 1998; Kang et al., 1999; Lemmon et al., 1999; Kang and Thole, 2000; Radomsky and Thole, 2000a; Radomsky and Thole, 2000b). The educational tasks that were proposed and accomplished during the CAREER grant included developing a special women's section of an existing, first-year design course. This section was a large success among the women students and is continued at the University of Wisconsin. In addition, dissemination of experiences for the women's section of the first-year design class has been provided by the PI to the University of Wisconsin to allow continuation of this lab section. Note that three-quarters through the CAREER grant the PI moved from the University of Wisconsin to Virginia Tech where she currently resides.