

# Achieving and Sustaining Gender Balance in an Undergraduate Teaching Institution

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*Abstract* --- Recruiting and retaining women in the STEM faculty ranks has been a national priority for many years. Recent research, sponsored by the NSF ADVANCE program, was performed mostly by doctoral institutions. However, for small undergraduate universities, the resulting challenges and decision frameworks are likely to be different. The prevalent recommendations need to be re-evaluated and re-interpreted for relevance and applicability.

Multiple change agents have been identified, but it is believed that the departmental climate most strongly correlates with successful institutional transformation. The primary success factor is a set of formalized processes in: (1) teaching, scholarship and service, (2) mentoring, and (3) leadership. A secondary factor is a faculty support infrastructure capable of fostering collaborations and reducing isolation. A third factor is an introspective capability that broadens the understanding of the issues affecting women ultimately expressed in the form of better policies and procedures.

There is a strong connection between gender progress on the faculty side and improving the pipeline of female students. To effectively intervene on the supply side, it is important to have networking, mentoring and role modeling processes that match student demographics and global sociological conditions. In the case of our University, this requires recruiting, developing and retaining faculty whose principal focus is undergraduate education which is challenging in STEM fields where the traditional emphasis is on research.

Curricular evolution in doctoral institutions is typically driven by emerging trends and technological opportunities while the needs of regional industries and local programs are more influential among primarily undergraduate institutions. As advanced degrees become a professional requirement, baccalaureate graduates will be expected to pursue advanced studies early in their career. Hence, more undergraduate STEM programs will serve as feeders to doctoral institutions. The future supply of graduate students and ultimately faculty will become more dependent on these teaching universities.

This paper describes our specific efforts and successes in the context of an undergraduate teaching institution. We have demonstrated that even with limited resources and no external funding, it is possible to improve the community culture and climate. Tangible strategies and initiatives aimed at improving the climate are presented: (1) administrative leadership

commitment, (2) grants and endowments, (3) faculty development resources, (4) workshops that mirror industry successes, (5) early and mid-career planning, and (6) recruiting and retention of female faculty.

*Keywords*- gender balance; female faculty; recruiting; student retention

## I. INTRODUCTION

Recruiting and retaining women in the science, technology, engineering and mathematics (STEM) faculty ranks has been a US national priority for many years [1]-[9]. Recent research, sponsored by the NSF ADVANCE program, was performed mostly by doctoral institutions [10]. However, for small undergraduate universities, the resulting challenges and decision frameworks are likely to be different. The prevalent recommendations need to be re-evaluated and re-interpreted for relevance and applicability.

Our University is a small private undergraduate institution conveniently located among a vibrant array of high technology companies. A key strategic objective of the University is managed growth and improved retention by fostering unique and distinctive programs. The five-year academic strategic plan of the University is to sustain an academic community of scholars who embrace its mission. One element of this strategy is to increase STEM faculty diversity.

The STEM disciplines are primarily concentrated in Engineering and Arts & Sciences (A&S). Engineering supports ten while A&S has seven STEM-related programs with enrollments of about 500 and 170 students, respectively. These programs vary widely in size/demographics and gender diversity (student as well as faculty). The STEM matrix in Table I shows program enrollment and gender mix for the fall 2009 semester.

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challenge in STEM fields where the traditional emphasis is on research.

TABLE I. STEM PROGRAM MATRIX

STEM Program Matrix AY 2009-10

Degree	Engineering Programs	Enrollment /Female/%
Bachelor of Science	Acoustical Engineering	34/06/17
	Biomedical Engineering	38/13/34
	Civil Engineering	66/07/11
	Computer Engineering	34/02/06
	Computer Engineering Tech.	24/06/25
	Electrical Engineering	53/01/02
	Electronic Engineering Tech.	30/02/07
	Environmental Engineering	04/02/50
	Mechanical Engineering	140/17/12
	Mechanical Engineering Tech.	52/07/13
	Arts & Sciences Programs	Enrollment /Female/%
	Biology	74/48/65
	Chemistry	23/05/22
	Computer Science	38/03/08
	Mathematics	14/03/21
Physics	08/00/00	

II. ADVANCE RESEARCH FINDINGS

The National Science Foundation’s (NSF) Advancement of Women in Academic Science and Engineering Careers (ADVANCE) program is a national strategy designed to broaden participation in the STEM workforce [10]. The long-term goal is to advance the status of women in academic science and engineering, and NSF more specifically describes its objective as:

“...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. ADVANCE encourages institutions of higher education and the broader science, STEM community, including professional societies and other STEM-related not-for-profit organizations, to address various aspects of STEM academic culture and institutional structure that may differentially affect women faculty and academic administrators. Since 2001, the NSF has invested over \$130M to support ADVANCE projects at more than one-hundred institutions of higher education and STEM-related not-for-profit organizations...”

There are over 3,500 higher-education institutions in the United States, most of which offer one or more STEM programs. NSF contracts have historically been concentrated in the Top 100 research universities. Table II shows

ADVANCE funding which mirrors this trend with the exception of 2003 where a majority of the awards were directed towards Tier 3 institutions. In three of the four cohort years, Top 100 universities were predominant.

TABLE II. NSF ADVANCE AWARDS

University or College	Ranking	UGs
Hunter College	Masters – North, 51	16 k
Univ. of Colorado	National, 79	26 k
Georgia Institute of Tech.	National, 35	12 k
Univ. of Michigan	National, 25	25 k
New Mexico State	National, 4 <sup>th</sup> tier	13 k
Univ. of Puerto Rico	-	
Univ. of California	National, 44	21 k
Univ. of Washington	National, 42	28 k
Univ. of Wisconsin	National, 38	30 k
Case Western Reserve	National, 41	4 k
Univ. of Montana	National, 3 <sup>rd</sup> tier	10 k
Columbia Univ.	National, 3	7 k
Univ. of Rhode Island	National, 3 <sup>rd</sup> tier	12 k
Univ. of Alabama	National, 3 <sup>rd</sup> tier	11 k
Univ. of Texas	National, 4 <sup>th</sup> tier	17 k
Kansas State Univ.	National, 124	19 k
Utah State Univ.	National, 3 <sup>rd</sup> tier	13 k
Univ. of Maryland	National, 3 <sup>rd</sup> tier	9 k
Virginia Tech	National, 71	22 k
Brown Univ.	National, 14	6 k
California State Poly.	Masters – West, 31	19 k
Cornell Univ.	National, 12	14 k
Iowa State Univ.	National, 85	20 k
Rensselaer Poly. Institute	National, 44	5 k
University of Arizona	National, 96	28 k
University of Illinois	National, 3 <sup>rd</sup> tier	15 k
Univ. of North Carolina	National, 4 <sup>th</sup> tier	17 k
William Marsh Rice Univ.		
Michigan State Univ.	National, 1 <sup>st</sup> , 71	36 k
North Dakota State Univ. Fargo	National, 3 <sup>rd</sup> tier	10 k
Northeastern Univ.	National, 1 <sup>st</sup> , 96	12 k
Ohio State Univ. Research Foundation		
Purdue Univ.		
Rutgers Univ.	National, 1 <sup>st</sup> , 64	27 k
Univ. of Nebraska Lincoln		
Washington State Univ.	National, 1 <sup>st</sup> , 116	20 k
Wright State Univ.	National, 4 <sup>th</sup> tier	12k

The principal strategic activities undertaken by the ADVANCE institutions were to: (1) improve workplace climate, (2) attract and retain female faculty/students, (3) transform departments, (4) stimulate partnerships in scholarship and teaching, (5) measure and report progress and (6) promote advocacy and active research collaboration. A

comparison of the projects reveals many similarities across the spectrum of awardees structured along the following lines:

- Comprehensive self-study
- Basic research on gender topics
- Visiting scholars
- Coaching constituencies
- Best practices training from industry
- Focused workshops and conferences
- Policy and procedure modification
- Collaborative research incentives
- Networking, mentoring and role modeling
- Department transformation
- Position funding (ADVANCE chairs)
- Leadership development
- In-house gender equity endowments
- Interventions for faculty
- Balance work-life issues
- Recruiting initiatives

While multiple change agents were identified, the departmental climate is believed to most strongly correlate with successful institutional transformation. The leading departmental success factor is a set of formalized processes in: (1) teaching, scholarship and service, (2) mentoring, and (3) leadership. A secondary factor is a faculty support infrastructure capable of fostering collaborations and reducing isolation. The third factor is an introspective capability that broadens the understanding of issues affecting women ultimately expressed in the form of better policies and procedures.

Now that the projects for Cohort 1 are completed, researchers are beginning to assess the degree of transformation that has been and will continue to be achieved. Transformations of this sort are likely to occur over a span greater than five years [11]. To be sustained, some level of institutionalized funding will be required. The issue of sustainability was addressed by Litzler *et al* [12], where seven of the nine colleges and universities that received funding in 2001 were surveyed. The purpose of the work was to gauge the degree of institutionalization as measured by the presence of stable funding to continue one or more successful ADVANCE project elements. The three main findings were: (1) leadership change at the top decreased the likelihood of success, (2) there was no direct correlation to the level of state funding, and (3) transformation occurred in degrees based on support, duration, diffusion, and advocacy. From our perspective, the most interesting point was the success of state universities in the mid-range of financial assistance. Those in the lower and upper scales were unable to establish and maintain internal efforts. For small undergraduate teaching institutions, it appears that funding constraints may block

progress even in the presence of perceived value and support at the top.

### III. INTERNAL RECRUITING EFFORTS

On the engineering side of STEM programs at our University, there are currently 23 full-time faculty teaching core technical courses. In 2005, there were three female faculty members, one in each of three departments. One was tenured and had achieved the rank of full professor. Two others were assistant professors and on tenure-track. The total number of faculty has remained relatively constant since 2005 and is not projected to increase. In support of the University's mission, values and strategic plan, the focus in STEM faculty diversity is to recruit and retain women as new positions and vacancies arise.

Since 2005, six faculty searches have taken place to fill open engineering positions. In three cases, we were successful in recruiting a female. To date, all three have been retained as assistant professors and are progressing on tenure-track. Consequently, in the last five years, the number and percentage of female engineering faculty has doubled from 3 (13%) to 6 (26%). Meanwhile, of the two incumbent female faculty members, one has been tenured and promoted to the rank of associate professor. She was also appointed department chair, while the other is eligible for tenure and promotion this academic year. Table III summarizes our recent progress in improving gender balance within the engineering faculty ranks.

TABLE III. FACULTY RANK GENDER PROGRESS

Engineering Faculty		
23 total faculty in civil, electrical & mechanical engineering		
Female Faculty	Academic Yr.	
	2005-06	
	No.	%
Tenured/tenure-track	1/2	4/8
Rank: Assistant/Associate/Full	2/0/1	8/0/4
Chair: Civil/Electrical/Mechanical	0/0/0	0%
2009-10		
Tenured/tenure-track	3/6	13/26
Rank: Assistant/Associate/Full	4/1/1	17/4/4
Chair: Civil/Electrical/Mechanical	0/0/1	33%

In recruiting six faculty from 2005-09, the Provost's Office assisted the departments by paying for additional ads to increase the number of women applicants. While the gender mix of the overall candidate pool is not known, women were

finalists and granted campus interviews in five of six cases. It appears that the percentage of women who applied was higher than their representation in the national undergraduate ranks. The growth in doctoral graduates in recent years has been attributed to temporary visa holders, many of whom choose to remain in the US, including many women. This increases the female candidate pool and enables faster progress towards gender balance. Of the last six female hires dating back to 1992, five were international Ph.D. graduates who received their terminal degree domestically.

In the last six faculty searches since 2005, the committees chose one or more women as finalists five times. It is interesting to note that in none of the cases was a woman ranked first. However, as the leading candidates dropped out, the women rose to the top and some were ultimately hired. In one case, a promising female ended up second to another and would not have received an offer. The Provost's Office agreed to create an additional position to seize the opportunity.

Given this recent success in adding female faculty, our capacity to leverage their presence in student recruiting has been strengthened. We have experienced the impact of women as active role models in open house events, orientations and advising. Beginning in 2006, the number and percentage of women undergraduates entering the College has steadily increased with the most improvement in biomedical, civil and mechanical engineering. In prior years, female enrollment was flat.

#### IV. INTERNAL FUNDING OPTIONS

To create a successful track record of scholarship, new engineering faculty need to establish a technical research focus including journal publications and a supporting network of peers and collaborators. Start-up packages, customarily offered by research institutions, are not provided; consequently, new faculty must aggressively pursue funding from internal and external sources. In a primarily undergraduate institution with heavy teaching loads, the most effective research strategy is to integrate and leverage grants that include course releases. To assist with the research, it is also important to cultivate a cadre of undergraduate and graduate students in a non-Ph.D. environment.

The University offers a number of internal research and pedagogical grants, fellowships and prizes. This pool of funding is an effective way for all faculty to initiate work prior to receiving support from external sources. While awards are for the most part modest and the work must be accomplished within one academic year, they have been persistent and stable line items in the budget over time. The specific internal opportunities accompanied by a brief description are listed in Table IV. A high number of female engineering grantees have received awards over the last eight years. For example, the Greenberg grant has been in place since 2001 and engineering faculty have won four times; three of the recipients were female.

TABLE IV. INTERNAL GRANTS FOR FACULTY

Internal Grant Opportunities		
Name	Female Awards	Description
Vincent B. Coffin grant	3	Offsets the loss of income for summer teaching obligations in order to have release time to engage in substantive scholarly or creative work
Summer stipend	2	Offsets the loss of income for faculty from summer teaching obligations to engage in scholarly or creative work
Faculty Center for Learning & Dev. Grant (not active)	3	Supports course re-design to make it more appealing and effective
Greenberg Junior Faculty grant	3	Supports high-quality scholarship for faculty members just beginning their careers
Belle K. Ribicoff Junior Faculty prize	0	Awarded to one junior faculty each AY. A recipient of one of the above awards from the prior 3 years is chosen as the Belle K. Ribicoff Professor for 3 years, with a stipend to pursue course development, artistry, research or scholarship
Innovations in Teaching award	1	Recognizes innovative assignments and activities that positively impact student learning
Engaged Learning Fellow	1	Supports implementation of an engaged learning strategy including but are not limited to service learning, problem-based learning, and learning communities
International Center Faculty grant	1	Supports internationalization of course content, develop a study abroad course, partake in a faculty development seminar, present a paper, or conduct research
WELFund grant	6	Supports initiatives to enhance women's education and leadership both on and off-campus by awarding grants to innovative projects designed with women or girls as the primary beneficiaries

The funding sources shown in Table IV support the community as a whole with some emphasis on tenure-track faculty. An exception is the Women's Education and Leadership Fund (WELFund) which has evolved into the primary means for advancing gender-based initiatives irrespective of academic status. Established in 2006, the purpose of WELFund is to: (1) enhance the education of women, (2) advance women as scholars and as the subject of scholarship, (3) cultivate and sustain women's leadership skills, and (4) increase awareness about women as individuals and in communities. WELFund was established as a legacy to Hartford College for Women, a single gender institution affiliated with the University of Hartford in its final years, and

the primary source of WELFund grants is the remaining endowment of this college. An eleven member board, composed of regional leaders, both women and men, establishes priorities, reviews application materials, and decides which proposals will be supported. In the nearly three years since its founding, the program has funded 62 different projects. Individual grants have ranged from \$2,000 to \$10,000, and any student, staff or faculty may apply, regardless of gender.

Faced with limited financial resources, the University community has come to rely on WELFund to enable projects in the following areas: (1) faculty research, (2) support for student research, (3) professional development, (4) STEM best practices, and (5) leadership initiatives. For example, three recent grants funded engineering research by female faculty in the areas of acoustics, transportation, and microprocessors, and each project included female undergraduate students. Thus, faculty have been able to secure a base level of support to initiate and grow research interests while simultaneously attracting female student collaborators. The obvious benefit for faculty members is to publish and present work beyond what would normally be possible (e.g., one conference per year). For most students, this is their first opportunity to participate in research, write peer-reviewed content and network with professionals in the field.

In addition to seeking support for research collaborations, engineering faculty and staff have been aggressively pursuing WELFund monies for recruiting and retaining female students. One of the projects created experiential modules of various engineering specialties targeting high school girls. Each of the modules emphasized the capacity of engineers to improve lives, an effective strategy to engage female students. Another grant supported a University-magnet high school collaboration; the outcome will be a two-week summer day camp to introduce incoming high school girls to STEM fields. Further, an after-school program was implemented to discover best practices in mixed gender situations using the comparison of a single gender afterschool program. Although it is hard to measure the quantitative impact of these efforts, our appeal to female students has been enhanced, and the faculty/staff continue to energetically pursue other promising avenues.

WELFund is one of the only organizations identified in the country to provide direct financial support to faculty, staff and students. Female students received funding to create and sustain SWEET Day (Society of Women Engineers Educating for Tomorrow). SWEET Day has become a highly successful event for prospective students and their parents that encourages young women to consider engineering as a career. Workshops, informative guest speakers, and a tour of College facilities help expand the image of the engineering profession as a positive force in improving quality of life. The attractiveness of our STEM programs has been improved and participants are now more likely to apply.

A female engineering student was awarded two successive grants to support a collaborative project, "Water for Abheypur," between the University, Engineers Without Borders (EWB), and the Indian village of Abheypur. In the first project, a multidisciplinary team with two female students installed a solar powered ground water pump and tanks. The second project funded the design and implementation of a rooftop rainwater harvesting system. The system provides a source of water during the monsoon season when the solar pump is not effective. Subsequent surveys among students revealed a high level of interest and support for these projects, and what was originally an engineering effort has expanded to include sociologists from the College of Arts and Sciences and design students in the Hartford Art School.

WELFund has supported a series of associations and activities that connect women students with staff, faculty, and alumnae, providing opportunities to discuss work/life balance, health, financial acumen, and more. In addition, an outside speaker series, open to both University and high school students, invites accomplished women scientists and engineers such as Jocelyn Bell Burnell, British astrophysicist, to present their experiences in preparing for a STEM career.

In 2008-09 WELFund began a pilot program, the Laura Johnson Initiative for Women Leaders, and brought together fifteen faculty and staff for monthly professional development workshops. Its aim was to provide the knowledge, skills, and networking necessary to facilitate both career enhancement and advancement. An outgrowth of this initiative is the Leading Forward leadership program, designed by the first faculty-staff cohort to provide a similar cohort experience to female graduate students. A series of sessions explore individuals' leadership styles, goal setting, and communication strategies. Each participant is provided a mentor who is a member of the University community. Both of these programs have been designated as on-going offerings of WELFund, and will have a substantial impact on the University's culture for women.

## V. DEPARTMENT CLIMATE

As mentioned previously regarding ADVANCE findings, the department climate most strongly correlates with successful institutional transformation. The leading success factors are formalized processes in: (1) teaching, scholarship and service, (2) mentoring, and (3) leadership. The faculty authors, both department chairs, received a WELFund grant to facilitate leadership mentoring and professional development for two junior female faculty and themselves. Junior faculty were provided an opportunity to address future research, educational, and academic challenges. The senior faculty focused on academic and positional leadership activities. The grant was designed to create a more systemic approach to mentoring and to foster a supportive climate in each department.

In our College, new tenure-track professors are assigned a senior faculty as a mentor. However, mentoring for leadership

is not part of peer mentoring as we know it. The mentoring literature [13] has shown that faculty can benefit from multiple mentors; therefore, a good mentoring process should create an environment where 'giving and receiving guidance are embedded in the values and norms of the organization [14].'

New faculty members bring fresh perspectives to their respective programs, departments and colleges. They are typically well-suited to contribute in the following ways: currency in educational technology, developing new/improved courses, integrating topical threads across the curriculum and becoming a change agent. While the benefits of strong educational leadership are apparent, faculty who contribute in this area often do not receive appropriate recognition. Contrary to this practice, both junior faculty were successful in receiving internal grants to evaluate new classroom technology. The results were presented in the form of a workshop to our departments.

Both junior faculty have established a research focus including a track record of publications and a network of peers and collaborators. Their challenge in the area of technical leadership is to grow research funding and a local network of academic and industrial partners. Each was successful in obtaining research funds during their first academic year. One received an external grant, in part due to the mentoring by an assigned and motivated faculty member in the same program. Such proactive and quality mentoring is not common. Ownership of tenure-track success within any department is less than desired. The likely causes are heavy teaching and service loads, exacerbated by a mentor's need to sustain their own research area. Consequently, senior faculty exhibit insufficient professional interest in junior faculty development. This is somewhat buffered at the University level by a 'new faculty' first-year orientation. However, a mentoring gap continues to exist for junior faculty and associate professors.

Most engineering faculty do not seek opportunities in academic leadership. Our two departments have collectively five positional openings and often a single faculty member holds more than one because of insufficient interest or skills. Junior faculty have become active in open house events and first-year orientation sessions, and ultimately will have to decide what role(s) to accept. For example, supported by targeted funds within the author's WELFund grant, one went to leadership training while the other attended a first-year student retention workshop.

The positional leadership challenge addressed by the faculty authors was to improve the balance of their research efforts and administrative duties. The solution was to make greater use of delegation within the departments and to set personal goals that strengthen research efforts. Subsequently, the faculty authors received a total of 6 grants/awards within one AY. In addition, a number of technical and pedagogical papers were published and all grant participants attended

multiple conferences over and above the norm, which is one per faculty member.

## VI. PRIVATE UNIVERSITY-PUBLIC PURPOSE

Curricular evolution in doctoral institutions is typically driven by emerging trends and technological opportunities while the needs of regional industries and local programs are more influential among primarily undergraduate institutions. As advanced degrees become a professional requirement, baccalaureate graduates will be expected to pursue advanced studies early in their career. Hence, more undergraduate STEM programs will serve as feeders to doctoral institutions. The future supply of graduate students and ultimately faculty will become more dependent on these teaching universities.

To this end, the University has taken steps to strategically address our emerging role in the graduate pipeline by formalizing a shared values statement 'Committed to Community':

"At the University of Hartford, we are committed to community. We are an academic community that values integrity, curiosity, creativity, excellence, responsibility, and accomplishment. Enriched by our diversity and our engagement with one another, we take pride in our shared traditions and experiences. We are dedicated to building a culture that respects all of its members and celebrates their contributions as we work together to strengthen our community [15]."

In the spirit of the above values, a presidential commission on the status of women was recently formed to expand the opportunities for all women and men on the faculty and staff. Our College is well positioned to meet the challenge with recent female faculty hires as well as a healthy array of student-oriented activities including SWEET Day, EWB and K-12 engagements. We have demonstrated that even with limited resources and no external funding, it is possible to improve the community culture and climate. The recent spike in female engineering enrollment may very well be an early indicator of future success. In some respects, the positive changes we have made may be more sustainable since these were obtained at the expense of internal resources.

## VII. CONCLUSIONS

Significant progress has been made within the engineering disciplines of our College in improving gender balance. The community has relied upon an ensemble of rather modest internal grants, awards and prizes. Given the relevance of its stated mission, the WELFund grant has become the primary vehicle for supporting many gender specific initiatives. Within the past five years, recruitment and retention of female faculty was successful. During this period, one female faculty was promoted and tenured, and the other is eligible soon. In addition, three new female faculty were successfully added, one in mechanical and two in electrical, both areas that

typically have the lowest representation compared to other engineering fields.

Meanwhile, ADVANCE grants have funded five-year transformation efforts across four cohorts totaling 38 institutions. The majority of the funding was awarded to large research universities. The projects for the first and second cohort groups have been completed, and the challenge these institutions now face is how to continue the more successful activities, especially those that require stable financial support, well into the future. Research designed to measure the degree of positive transformation achieved, as well as the level of recurring internal funding after the grant ended, is beginning to be published. It will require several more cohort cycles and years for a clear picture to emerge and be disseminated.

The scope and breadth of effort afforded by ADVANCE goes far beyond what we have been able to accomplish. Many of the best practices that have or will stem from the broader impacts cannot be implemented at our University given the internal resource constraints. It is likely that some incremental improvement in gender balance will continue to be made. In some ways, this progress may be more sustainable because the value, ownership and investment stems from within. For a truly transformational change, external resources will be needed, and preliminary work along these lines has begun. In parallel to this activity, we will continue with efforts that leverage our internal capabilities and current momentum to build on recent successes.

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