AC 2009-96: WOMEN ENGINEERS IN ADVANCED ACADEMIC POSITIONS (WEAAP)

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Women Engineers in Advanced Academic Positions (WEAAP): Effecting Change in Higher Education

Abstract

Contemporary issues plaguing higher education and inhibiting the growth of engineering colleges are numerous and vast in scope. The survival of engineering programs across the nation require concerted efforts toward creative thinking and innovative solutions. The higher education community most likely to develop such solutions is comprised of in positions of executive administration. WEAAP, or Women Engineers in Advanced Academic Positions, was a workshop convened not only to address these concerns, but also to consider how issues of bias affecting women in engineering play a role in undermining the success of engineering colleges as a whole. The following paper provides an initial report of this gathering, expanding on the framing and defining of the problems colleges of engineering face, and on the strategies exchanged to address them. While this content is not exhaustive, it does provide groundwork for further study, and provides a comprehensive understanding of the aims and objectives of the WEAAP network.

Introduction

Numerous challenges loom for higher education these days, with many affecting colleges of engineering uniquely. Even as engineering colleges within our nation's universities become major units for industrial and global engagement, they face difficulties of decreased state appropriations, rising salaries, competition for enrollment, low K-12 interest in engineering, capped tuition and pressure to expand alternative funding sources. Financial constraints intersect with equity issues, particularly for engineering colleges: recruiting and retaining women in undergraduate and graduate engineering programs remains an enormously difficult task, and the continuing isolation experienced by women in non-life-science engineering and technology professions across sectors of academe, government and industry complicates and jeopardizes the success and sustainable future of the engineering education.

The efforts of organizations and programs such as ADVANCE, WELI, WEPAN, and SWE and other professional societies have supported the career advancement of women and have even facilitated the growing number of engineering women in higher education administration. Opportunities for the women in such positions to convene and share research and solutions to collectively address some of these issues, however, have remained limited. The Women Engineers in Advanced Academic Positions (WEAAP) workshop "Effecting Change in Higher Education," funded by the National Science Foundation and convened in January 2008, provided an opportunity for these deans, vice presidents and provosts to network, brainstorm, and focus on complex local, national and global issues of engineering education.

This paper reports and expands on the findings of the initial WEAAP gathering, and on WEAAP's objectives to offer the greater engineering and academic community insight into the multiple perspectives and comprehensive problem-solving emerging out of the workshop. While many conclusions resulted from the discussion and will be elaborated on further in this paper, one issue emerged as a priority: the need for a network and virtual organization for professional

engineering women in all sectors and across institutions to be designed, implemented and funded. This network and organization should be established as a partnership and with the support of other organizations, including SWE and ASEE. Once established, the organization should develop and promote the identified activities, including the creation of a think tank that operates as a brain trust on key issues such as economic models for higher education and Colleges of Engineering as part of the economic engine of states, regions and nations, develops leadership in Colleges of Engineering for our campuses, supports the graduate environment for women engineering students, refocuses on the professional school model for Colleges of Engineering, trains faculty and students for entrepreneurship and creates cross-sector collaborations.

The construction of such a network, and the objectives and visions WEAAP participants foresee for the network, represent a culmination of the issues and solutions most emphasized at the workshop. While the greater impact of the workshop will manifest as its membership and identity evolve, WEAAP participants continue to take leadership and determine for the future how the emergent strategies summarized above, and below, can or should be brought to bear on our efforts to ensure the flourishing of engineering programs nationwide.

Description of the workshop

Workshop Aims

The workshop, running from January 7-9, 2008, was convened with the underlying consideration that colleges of engineering can become the focus of personal, industrial and global engagement. Hoping to promote dialog and knowledge exchange to foster this potential, three specific issues were cited: the on-going difficulty in recruiting women into undergraduate and graduate education in many fields of engineering, the continuing isolation experienced by women in non-life-science engineering and technology professions in all sectors (academe, government and industry), and the change for public universities regarding decreased state appropriations, rising salaries, capped tuition and the resultant drive toward alternative funding sources.

Within this context, foundational aims for the conference emerged:

- The initiation and facilitation of an effective dialog for engineering women in advanced administrative positions across the country.
- Discussion – among those who are first-hand observes and players – of important issues of diversity in higher education that have great impact on the current and future success of engineering colleges.
- The generation and sharing of innovative practices, solutions, and partnerships that can be disseminated and applied to academic leadership at all institutions.

Workshop participants

In bringing together women administrators from 17 US states and Canada (see Appendix C for Participant List), the WEAAP workshop offered an extensively diverse perspective for its issue-driven agenda. Over 45 women in higher education administration were identified through exhaustive networking. All were invited to participate, and 23 were able to attend. Institutions represented included 18 public and 7 private institutions, ranging in enrollment from 2,300 to 50,000 (Table 2) with great variation of graduate and undergraduate programs, demographics, research expenditures, and costs (Tables 3, 4 and 5). Details used to derive information summarized in these tables is presented in Appendix D.

Workshop organization

The workshop was organized into topic segments, each with two focused panels (Table 1). The panel topics are identified and developed in material presented as Appendix B to this report.

Each workshop attendee was assigned to a panel and invited to pre-prepare a white paper that would served as a personal statement about both her experiences and perspectives on the issues related to her assigned panel. Each panel lasted two hours, and began with an overview by an assigned moderator, followed by a statement of personal views by the other panel discussants. The subject was then opened up for input and discussions from other attendees, further generating varied perspectives on the single-issue focus. Lunch, dinners, receptions and concluding activities provided opportunities for informal networking and continued discussion. Questions and discussions of future aspirations resulted in identification of potential formalized actions and tactics to be considered for continued progress regarding the roles of women and engineering in leadership of higher education. Appendix A contains the Workshop Agenda.

Table 1: Topic and Panel Descriptions

Topic 1: Women in Engineering Undergraduate and Graduate Students	Panel 1a: Undergraduate Students Panel 1b: Graduate Students
Topic 2: Women Engineering Professionals in Academe, Government and Industry	Panel 2a: Women Engineering Faculty Panel 2b: Women in Engineering Cross Sector and Cross Discipline Partnerships
Topic 3: Higher Education Administration: Impact on Engineering Colleges	Panel 3a: Role of Colleges of Engineering on Campus Panel 3b: Fiscal Reality

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Table 2: WEAAP Participant Institution Enrollment Information[3]

	Low End	High End
Total Enrollment	2,124	51,234
% Graduate Students - whole university	0%	67%
Engineering Undergraduate Students as % of Total Undergraduate Students	2%	70%
% Women Among Engineering Undergraduate Students	10%	30%
Engineering Graduate Students as % of Total Graduate Students	5%	76%
% Women Among Engineering Undergraduates	14%	33%
% Graduate Students Among Engineering Students (excluding Undergraduate Schools)	13%	42%

Table 3: WEAAP Participant Institution Faculty Information.

	Low End	High End
Number of Tenured and Tenure-Track (T/TT) Engineering Faculty	24	412
% non-T/TT Full-time Engineering Faculty	2%	19%
Number of Women in Engineering T/TT Positions	1	48
% Women in Engineering T/TT Positions	3%	25%
Total Engineering Students Per T/TT Engineering Faculty	6.2	28.4
Total Engineering Students per Full-Time Engineering Faculty	6	29.7

[3] American Society for Engineering Education (2005). "Profiles of Engineering Colleges."

Table 4: WEAAP Participant Institution Research Information.

	Low End	High End
Total T/T + Research Engineering Faculty	24	607
Total AY 05-06 Research Funding ($M)	$3.72	$203.68
Industry Grant Funding ($M) AY05-06	$0.12	$20.83
% Industry Grant Funding AY05-06	0	18%
Average Grant Funding per (T/TT + Full-Time Research) Engineering Faculty	$62,838	$503,985

Table 5: WEAAP Participant Institutions Cost Information.

	Low End	High End
Undergraduate In-State Tuition and Fees	$3,206	$34,730
Graduate In-State Tuition and Fees	$3,391	$33,672
Ratio of Graduate to Undergraduate Tuition and Fees for In-state Students	0.72	2.13

Despite their different experiences, attendees expressed a surprising number of common concerns centering on feelings of struggle. While these administrators are devoted to advancing women within engineering and engineering education, maintaining that this will positively impact the field at large, they also recognize that the distracting realities a difficult political and economic climate create inhibits the growth of programs dedicated to funding or focusing on such advancement.

Workshop findings, outcomes, key ideas

Besides being asked to participate as a panel discussant and to prepare and share metrics reflecting trends both national and local to their own institutions, workshop attendees were asked to summarize their issues and action items for each panel segment. These included questions on key ideas taken from the panel and discussion, including prioritizations, actions attendees would take home for work and planning, metrics and trends attendees were interested in tracking into the future, and any related questions in need of further exploration. While the resultant list of discussion points is not exhaustive, it does represent the commonly emphasized and prioritized themes of the workshop. In the body of the report, the recommended action items for each panel are presented along with key identified metrics pertinent to the panel topic. In addition, areas of inquiry for which further study is warranted are identified.

Topic 1: Women in engineering undergraduate and graduate programs

This panel pair explored the environment in colleges of engineering for women students. Engineering Bachelor's degrees awarded to women declined in both AY 2004-05 and AY 2005-06, and Master's degrees declined in AY 2005-06. Enrollments indicate that these declining trends will continue. Although the numbers of doctoral degrees awarded to women have continued to increase, the limited increase in the doctoral enrollment of women (2 to 3%) in fall 2005 indicates that the increasing degree trend will end in just a few years.[4]

To closely examine considerations regarding reasons for this decline, changes needed to combat failed recruitment and retention efforts, and strategies for success in growing colleges of engineering holistically, panel members were asked to report on trends in enrollment and retention at their institutions and how these issues are being addressed. Finally, panel discussants were asked what critical factors need to be addressed at the national level to effect change.

Panel 1a: Undergraduate students

Moderated by Pamela Eibeck, Dean of Engineering at Texas Tech University, this panel also included Cherrice Traver, Dean of Engineering at Union College, and Candis Claiborn, Dean of the College of Engineering and Architecture at Washington State University. They focused primarily on issues of recruitment and retention of engineering students in general, but also examined the challenges in attracting women undergraduate students to colleges of engineering. The changing nature of the student population, now with a female majority and a majority of students that attend more than one higher-educational institution[5], the rigidity of the engineering curriculum and its lack of appeal to women are becoming larger factors in impeding college students from selecting engineering as a major.

In elaborating on the issues and expectations of contemporary undergraduates as well as the declining trends in enrollment and interest, panelists added context to the metrics, fueling some of the following findings and points of interest.

Key recommended action items

Change the image of engineering. We need to change the image of engineering to one the public and the students embrace as a career of choice[6]. At the core of recruitment challenges is the image of engineering as place for asocial guys who like to work alone on their math and science problems. Outreach efforts that integrate culturally relevant engineering applications into K-12 curricula or promote the role of engineering in helping people and the environment can help attract women to engineering. Identify and applaud our best and most innovative engineering educators.

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[4] Synopsis of report No. 0507A, from Inside Engineering Education. Retrieved from www.engtrends.com. October 7, 2007.

[3] C. Adelman, "Answers in the Tool Box: Academic Intensity, Attendance Patterns and Bachelor's Degree Attainment" Department of Education, Office of Educational Research and Improvement, 1999.

[6] "Changing the Conversation," 2008, National Academy Press, Committee on Public Understanding of Engineering Messages, **http://books.nap.edu/catalog.php?record_id=12187**

Create a culture in engineering colleges that welcomes women. Successful female engineering majors have typically "fit in with the guys". Until faculty and student peers welcome women along with their femininity, symbolized by the sorority girl wearing pink, capable young women will continue to reject engineering rather than redefine or reject their sense of self.

Integrate successful retention models. Some retention efforts were identified as having positive impacts including cohort registration, mentoring, living-learning communities, high-quality academic advising services, undergraduate research opportunities, bridge programs, and gender-segregated sections of science or math. Such opportunities should be identified, assessed, and exported as best practice.

Provide greater flexibility in the engineering curriculum. Recognizing that more students want breadth in their undergraduate education, and that many transfer into Colleges of Engineering and/or may arrive less prepared to study engineering, the curriculum needs to be less dense and more flexible. Changes to the curriculum should include reducing the number of required courses and reducing the prerequisite chain and encouraging diversity of learning opportunities. We should continue to develop the evolving concept of international engineering programs, and continue to consider 3-year degree possibilities.

Diversify educational opportunities for engineers. Women, as well as men, are attracted to programs with visible positive impacts on society, such as bioengineering or environmental engineering, as well as interdisciplinary programs. Attractive breadth for engineering programs include gaining more business or entrepreneurship knowledge, integration of engineering with liberal arts programs, or expanding international study experiences. We need to make Engineering the degree of choice to engage the important issues of the present and the future.

Consider a 5-year path to a professional degree. The possibility shifting the professional degree to the masters level was discussed both in the context of allowing the undergraduate degree greater flexibility and the current NCEES recommendation that engineering licensure require 30 additional credit hours after the bachelors degree. This elicited mixed reactions. Concerns were expressed that students would be less attracted to engineering if it required two degrees for professional opportunities requiring more time and cost. Some suggested that industry would be opposed to such a change – we need to find out.

Expand the career path options with a degree from an engineering college. Just as there are many career paths within the medical field (physician, nurse, physical therapist, physicians assistant to name a few), engineering colleges should provide an analogous breadth of career paths associated with technology such as engineer, K-12 educator, engineering technologist, sales/marketing, high-tech entrepreneur, pre-medicine, pre-law, etc. The advantage to such an approach is that it provides a variety of jumping off points from a foundational education in engineering and technology. However, this represents a significant departure from the current situation in which each institution tends to support only a degree in engineering or technology appropriate for people aspiring to practice engineering or to go to graduate school. Few engineering schools introduce engineering and technology minors for nonmajors and virtually none have degree programs for engineering-related careers.

Develop effective partnerships with county/community colleges. The reality is that many more students begin their career in higher education with one or more years matriculating at a county or community college. We need to work to make the 2-year degree seamless with the 4-year engineering degree. If we do this, we will be able to enhance the success of transfer students interested in pursuing engineering as a profession.

Achieve a zero net loss of engineering majors. Most engineering colleges lose engineering majors between the freshman and junior year, with few, if any, students transferring into engineering colleges from other majors or from other educational institutions. We must continue our efforts to make engineering attractive to all college students by offering freshman courses to the university-wide population and we need to supply training for faculty in the more effective and innovative use of technology in education.

Drop the pipeline metaphor. The "engineering pipeline" metaphor elicits an image that the path to engineering has only one entry point, typically in junior high school. Even worse is the metaphor of the "leaky pipe" in which there are only losses and no additions to the population of future engineers. In such a model, it is far too easy to view the formation of young engineers as a process of creating appropriate hurdles for them to leap or screens to pass through. If we adopt an alternative metaphor, such as a "sponge", the porous nature of entering or leaving engineering is evoked and encourages solutions that attract and prepare people for engineering at multiple stages during their education as well as for re-entry to the profession. Transportation metaphors are also useful: highways have on- and off-ramps; trains permit passengers to both embark and disembark at various stations, etc. Moving away from the pipeline metaphor places added responsibility on engineering curriculum development to construct solid cases and rationale for the attributes, skills and knowledge that are required for young engineers and to identify alternate paths for developing them.

<u>Key metrics</u>

The following metrics should be maintained longitudinally at the national level. Analysis of this data can reveal the success of efforts to attract a larger number and more diverse group of high school and college students into engineering.

- The number of women and men receiving BS, MS and PhD degrees in engineering.
- The fraction of all bachelor's degrees (BA and BS) that are in engineering.
- The fraction of entering freshmen identifying engineering as a desired major.
- The six-year graduation rate of students in engineering.
- The number of college-level students transferring into engineering after their first year of higher education.
- The number of students who transferred into 4-year Engineering programs following completion of 2-year programs at county or community colleges.
- The average total credit hours required for engineering degrees.
- The fraction of total credit hours in science, math and engineering courses required to obtain an engineering degree.

In addition, we need metrics to be developed associated with the following:

- Exit interviews to develop information on where students go if they leave Engineering before receiving their degree.
- Develop information on where students go after obtaining their BS degrees in Engineering
- Develop methodology that measures the flexibility available and taken in Engineering degree programs.
- Develop a way of measuring pedagogical innovation and its impact on retention.
- Develop information on how many Engineering students have an undergraduate research experience and better understand how to assess the outcomes from these experiences.

Areas needing further study

- What would be the intended and unintended consequences of a 5-year path to the first accredited professional engineering degree? What is industry's assessment of the impact of a 5-year path to the MS as the first professional degree? How would it affect salaries or job opportunities for "pre-professional" BS degree recipients and MS engineering degree recipients? Would the longer path to an accredited degree impact student interest in engineering?

- What are engineering education trends in other developed nations? It was stated that the number of engineering degrees in other developed nations follows similar trends to those in the United States. If this is the case, especially in nations with strong K-12 math and science preparation, what implications does this have on why young people in the US and other developed nations choose not to become engineers? How should the U.S. accreditation and graduate admissions processes consider a 3-year degree program in wide use in the E.U.?

- How can the effectiveness of retention efforts be determined? Significant amount of time and resources are expended on retention activities. Can the impacts of retention activities and other experiences be disaggregated to identify best practices in retention programming as well as predict their impact on student retention? How does the use of cohorts relate to student success in or out of the classroom?

- What influences the career choices of high school and college students? How can engineering professionals and educators influence the interest in engineering as a career, and how does this influence differ across the fields of engineering[7]? We need to obtain a better understanding of why students do not choose or actually reject the study of some fields of engineering in particular. We need more information on career paths available and taken by those who hold Engineering degrees.

- What metrics should be developed to identify "star" faculty? For both undergraduate and graduate programs, we can do much more to identify best practices regarding education, research and the integration of research and education?

[7] M. Ohland et al., 2008, "Persistence, Engagement and Migration in Engineering Programs," Journal of Engineering Education.

Panel 1b: Graduate students

Moderator Delcie Durham, Associate Provost and Dean of the Graduate School at University of South Florida, Deidre Meldrum, Dean of Engineering at Arizona State University and Linda Abriola, Dean of Engineering at Tufts University, offered a closer look at trends and issues within graduate engineering programs, both nationwide and among their own student and faculty populations. Though similarities exist between recruitment and retention efforts in both graduate and undergraduate engineering programs (problems with engineering's "image" and public perception, rigidity of curriculum and narrow paths constructed for students), differences were identified and centered more specifically around the role of faculty in either maintaining or combating current problems:

- ***Multidisciplinarity and interdisciplinarity must be considered assets***. Many students applying to engineering graduate programs do not have the profile or background traditional for or even expected by graduate admissions. Both recruiters and those involved in admissions should be encouraged to look at student candidates more holistically, rather than focusing just on GRE scores or traditional engineering undergraduate programs. Interdisciplinary programs within graduate schools, including those that incorporate a global focus or enhance students' employability, also may draw more graduate students and women graduate students in particular. Building and growing interdisciplinary or multidisciplinary programs may also enhance industry collaboration and funding opportunities for students and colleges.

- ***Enhance industry collaboration and professional degrees***. Prospective graduate students often perceive the lengthy time-to-degree and the rigid "path" for degree completion as limiting to their futures. Several discussants referenced the alternative options industry collaboration may provide, e.g., the Professional PhD, wherein graduate students would spend a more abbreviated period within the classroom and enter the field while being "co-mentored" by academe and industry to complete dissertation or research projects.

- ***Address impacts of climate issues on graduate students and education***. Increasing the "visibility" of women faculty and fostering faculty-student interaction may help retain women graduate students. Developing cohorts, for both study and community building, may also provide networking and greater "visibility", aiding in retention efforts.

<u>Key Recommended Action Items</u>

- Develop programs that make more use of women in industry and alumna to counteract isolation and connect into a network. Make similar usage of advisory committees in departments and colleges.
- Conduct graduate student climate assessments.
- Conduct exit interviews for each woman who leaves with or without her Engineering degree.
- Set up mentoring networks that extend beyond the college and campus communities.

- Develop better information, and include sensitivity training, for faculty about becoming better advisors and supervisors.
- Extend cohort environments throughout the graduate experience, and learn how to assess these environments and their potential to enhance student success.

Key Metrics

- What is the involvement of domestic women in our engineering graduate programs, and does the amount (number and percentage) vary across engineering disciplines?
- We need to know:
    - The overall distribution of College of Engineering faculty and students by ethnic groups, country of origin – who are we, and how is our distribution changing over time.
    - How to assess faculty abilities as advisors, and establish metrics regarding expectations and "star advisor" status.
    - The climate for interdisciplinary environment and culture on campuses, and how it can be best assessed and used by potential students to identify a college of choice for graduate study.
    - The involvement of industry and alumni in career path development.
    - Degree completion rates, time to degree, length of time with research or teaching assistant support through degree completion, and information about funding gaps if completion is delayed but support runs out.

Areas Needing Further Study

- How can we understand the environment and culture experienced by women in graduate study? We have studied undergraduate and faculty much more often than graduate life, and we need to assess each campus and identify problems, concerns and best practices.
- How do we gauge the success of post-doctorate programs and experiences? We need to do more to understand and communicate how to offer a successful post-doctorate experience, and how to recognize one when it is offered.
- What are the real career paths of women in engineering? Not all have "traditional" starts, and not many go straight through without stopping or pausing.
- We need more information on the career aspirations of women in engineering graduate programs.
- Interdisciplinary/multidisciplinary activities and relationships – how can they be effective for women?
- Research doctorates versus professional doctorates – how can we support the different professional careers that meet different needs for women?
- How should we be addressing climate issues: positive visibility, faculty relationships with women graduate students, developing cohorts.
- How should we be identifying "star" faculty – those who welcome diversity ad are great mentors and supervisors? How do we capture their qualities and skills? We need to reward them.
- There are time-to-degree issues for women. We need to find out more about this and about what other obstacles there are and how to address these.

Interests in further research included the common interest in tracking female PhD students' career paths. As one attendee wrote in her participant observation notes, "What might draw women to industry? To academe? What can we do to track these movements to generate and study data?" Additionally, questions of mentoring factored heavily into issue areas in need of further and future consideration: how might we assess faculty mentoring and advising of graduate students? How can we track whether good mentoring impacts "time to finish" degree programs?

Topic 2: Women in engineering professionals in academe, government and industry

This panel pair explored the environment for women faculty in engineering colleges, the roles of industry (personal, interpersonal, institutional), and external professional interactions on stature in academe and career development.

2a: Women engineering faculty

According to the 2006 National Research Council Report, "To Recruit and Advance: Women Students and Faculty in US Science and Engineering,"[8] four challenges confront female faculty: 1) lower tenure and promotion rates; 2) longer time to promotion; 3) lower retention rates; and 4) lower job satisfaction. The report states that these challenges diminish the probability that female faculty will remain at a university, lower the efficiency and productivity of faculty, and make an academic career less satisfying. In preparing to discuss these national statistics and their own institutions' data, panel discussants for this topic were asked what critical factors need to be addressed on the national level to effect change and how these issues are addressed on their respective campuses. Moderated by Cheryl Schrader, Dean of Engineering at Boise State University, this panel also included Mariesa Crow, former Dean of the School of Materials, Energy and Earth Resources at the Missouri University of Science and Technology (formerly the University of Missouri, Rolla), Faye Boudreaux-Bartels, Electrical and Computer Engineering chair at University of Rhode Island, Susan Blanchard, Founding Director of the U.A. Whitaker School of Engineering at Florida Gulf Coast University, and Linda Lucas, School of Engineering Dean at the University of Alabama, Birmingham. Their suggestions addressing these critical factors included the following:

- ***The importance of a chair's commitment to diversity is critical.*** Good leadership that progresses toward and understands the importance of diversity, both within the department and campus-wide, can have a tremendous impact on campus culture. Introducing a climate aspect to performance reviews for deans and department chairs may improve accountability and address the issue more specifically. Implementing training for search and hiring committees, supported by administration, may also improve efforts to diversify faculty and address climate issues.

[8] National Research Council (2006). To Recruit and Advance: Women Students and Faculty in US Science and Engineering, National Academies Press. Washington, D.C. http://books.nap.edu/catalog.php?record_id=11624

- ***Women leave academe for positions in other sectors at a higher rate than men – why****?* Based on statistics provided by a number of institutions, women leave academe at twice the frequency as their male counterparts. There is a need to determine why that is, as motivation and other critical factors are often lost in statistics. A holistic examination of mentoring throughout the career, including mentoring training and the involvement of graduate students in mentoring practices may help deter this attrition.

- ***Reexamination of promotion and tenure process needs to occur***. Women's paths may be non-traditional and include a greater incidence of collaborative or interdisciplinary research. These, along with activities like mentoring and committee memberships, should be factored into the promotion and tenure process to better reflect the contributions of women faculty and their career advancement.

Participant notes revealed a need for metrics explaining "where women with PhDs are going." Questions of how to find retention data on hiring cohorts with regard to gender and ethnicity, how to track or chart the willingness of faculty (both male and female) to take advantage of work-life balance policies and the impact those choices have on careers, and how to "separate out" trends in engineering from those in the sciences were also important to attendees. Broader questions related to this issue area asked why the percentage of women engineers is greater among ethnic minorities, whether part-time, tenure-track appointments are workable and where they may be available, and why there are so few women at the department chair level nationwide.

Key Recommended Action Items

- The chair is an incredibly important person for diversity success. Strong training and coaching efforts are warranted for the department chair regarding management, diversity and mentoring training – integrated into formal and informal performance and promotion review, and potentially including the use of external evaluation to bring best practice and evaluate climate.
- Bring back a program like the NSF POWRE (Professional Opportunities for Women in Research and Education) program – may use for skill developments, connections with industry.
- Develop information resources and identify best practice regarding part-time tenure-track for early, middle and late faculty careers.
- Build virtual networks for women on campus, link to women at other campuses and in other sectors.
- Charge an office (or establish an office) with work equity monitoring that will continue to monitor workload and resource assignments on campus.
- Provide training opportunities for women interested in moving into chair positions, continue and expand the work of WELI (**http://www.weli.eng.iastate.edu/**) and professional society activities.
- Consider an NSF program that is for senior women faculty to develop quality lectures and be invited to campuses across the nation to present, work with women on campus, with department chairs and deans, and perhaps also to assess and offer insights on campus climate regarding diversity.

- Consider connecting smaller schools to collaborate and provide mentoring for women and training for faculty and leadership.

Key metrics

- We need metrics for career satisfaction, including identification of isolation vs a sense of community
- We need more exit interview information so we understand and can quantitatively represent why women leave academe, and who leave academic leadership positions.
- Disaggregate data so that engineering can be considered separately and distinctly from sciences.
- Maintain and disseminate data on women who move into chair positions.
- We need data and success rates on recruiting to develop metrics regarding diverse interview pools and diversity-welcoming processes.
- We need longitudinal data and metrics on success and usage of different dual career hiring policies.

Areas needing further study

- How willing are faculty (both male and female) to take advantage of our more flexible work/life policies? Find out what policies are most used, and most effective.
- How can/should sabbatical programs and residencies in industry be used successfully to also provide mentoring and leadership experience? Are there diversity and gender issues with sabbaticals that should be realized and addressed?
- We need more longitudinal studies about the career paths taken by women engineering faculty, before and after they received their PhDs.
- We need more and continued attention to workload and resource assignments at more schools – information that will allow development of understanding and metrics.
- We need to understand and to develop longitudinal metrics on how much interdisciplinary work is going on in colleges of engineering, and how collaboration is valued at performance and promotion reviews.

2b: Women in engineering cross sector and cross discipline partnerships

Cross sector partnerships stimulate new ideas and provide opportunities for concerted problem solving across sectors. In addition, cross sector partnerships increase the opportunities and effectiveness of women engineers, and promote satisfaction and total career growth.[9] To take on today's challenges, engineers must not only master a traditional discipline but also establish connections between disciplines, initiate efforts to leverage those connections and collaborate with other engineers and experts from business, the sciences, law, medicine and public policy. Moderator Zulma Toro-Ramos, Engineering Dean at Wichita State University, joined Sallie

[9] Nelson, P.P. (2006). Presentation made to participants of the Partnership for Women of Industry/Government/ Academe. New Jersey Institute of Technology. May 10, 2006.
http://www.njit.edu/academics/provost/openpartnership/index.php

Keller-McNulty, Rice University's Engineering Dean, Karen Whitehead, Provost at South Dakota School of Mines and Technology, and Priscilla Nelson, Provost at New Jersey Institute of Technology in considering the opportunities, benefits and challenges in developing partnerships between women engineers in academia, industry and government. Each panel discussant was asked to share whether engineering faculty at her institution collaborate with experts in other engineering disciplines as well as across disciplines within academe (e.g. in fields of science, law, public policy), and how permeability between sectors might be facilitated on a national level:

- ***Multidisciplinary and cross-sector research and studies need to be facilitated, recognized, mentored and rewarded***. Concerns about promotion and tenure processes or department approval of cross-sector or cross-discipline partnerships should not remain obstacles to innovative programs which may enhance both recruitment and funding opportunities.[10]

- ***Women may play a key role in facilitating and enabling cross-discipline and cross-sector partnerships***. As greater numbers of women are involved in interdisciplinary work and greater numbers of women may be leaving academe for careers in industry, their potential to facilitate cross-sector partnerships may be the key to broadening programs involving increased permeability and networking.

- ***Interdisciplinary institutes, newly created or already existing, can be used to support and facilitate cross-sector collaboration.*** Outreach programs and networking events involving interdisciplinary institutes bring researchers and potential collaborators together. "Residence" programs or "visiting" partnerships and exchanges between academe and industry may also increase visibility and funding.

- ***Isolation for STEM professionals continues in all sectors***. A web-based information resource would promote networking across sectors, providing personal and professional connectivity and career enhancement.

Interest in following funding for research coming from industry, numbers of PhD graduates entering US industry, numbers of faculty sabbaticals in industry and the numbers of cross-discipline and cross-sector partnerships surfaced within participant notes and observations completed in response to this panel's segment. Additional concerns of how to deal with tenure and promotion processes regarding partnerships, how to structure IP agreements in promoting partnerships and how cross-disciplinary and cross-sector leadership is measured and rewarded were also expressed in follow up notes and conversations.

<u>Key recommended action items:</u>

- Convene a national dialog on the value proposition for tenure, to encourage academe to value success and effort in cross-sector and interdisciplinary activities.

[10] "To Thrive and prosper: Hiring, Supporting and Tenuring Interdisciplinary Scholars." **http://www.pkal.org/documents/Pfirman_et-al_To-thrive-and-prosper.pdf**).

- Establish and promote funding programs that are focused on women in cross-sector research and education projects – women professionals moving both ways across the sector boundaries.
- Support the development of effective virtual networks for women on campus, and to link to women at other campuses and in other sectors – needed because many women are still isolated and need support to make connections. This is particularly important for women faculty at smaller engineering schools.
- Identify the "star" women from faculties and industries who know how to make cross-sector connections and set up an "executive mentoring corps" that can mentor those interested in pursuing such research connections.
- Convene campus events and institutes that can serve as portals for cross-sector interactions and networking.
- Identify impediments and best practices for joint faculty appointments, and implement encouraging metrics for promoting and valuing such efforts in academe.
- Institute enhanced positions for colleagues in industry (e.g. "Professor of Practice") that will encourage them to become more strongly engaged and participating in academic activities.
- Where possible, include EPSCoR in setting up effective academe-industry engagement programs.
- Create programs that will incentivize industries that interact with academe.

Key Metrics

- We need metrics about cross-sector research efforts – by institution and across the nation. Note that most listings of academic research partnerships with industry are notoriously incomplete if not wrong.
- We need more exit interview information so we understand and can quantitatively represent why women leave academe and go to industry, and what they find when they get there. Follow development of career satisfaction and/or dissatisfaction.
- We need to be able to more effectively and convincingly measure the impact of academic activity in research and technology transfer on economic development.
- We need metrics that define what is considered a successful cross-sector and cross-disciplinary partnership for a women engineer in academia and other sectors but also for the general public.

Areas needing further study

- How has academic-industry activity and investment changed over time at different institutions?
- We need to be able to identify best practice and understand how to value and promote cross-sector activities.
- How should faculty sabbaticals and in-residence programs be best used for career growth and to strengthen involvement with industry?

- We need to better understand how to structure success in Intellectual Property agreements to promote partnerships.
- We need to understand and identify the actions and programs that will lower the risk of women migrating out of academic faculty positions.

Topic 3: Higher education administration: impact on engineering colleges

Our universities are under increasing financial stress and must operate in a global and multi-cultural world, and engineering colleges within our universities are increasingly pressured to contribute more to the overall success of their institutions. Panel discussants convened to address this topic were therefore asked to consider climates of Colleges of Engineering (CoEs) regarding operations inside the university as well as those external to the institution.

Prior to the 1960s, CoEs functioned as professional schools. Not all faculty members held terminal degrees; research was primarily linked into real-world problem solution, applied in close involvement with industry. From the 1960s through the 1990s, CoEs became academic schools, and faculty held terminal degrees and tenured positions. Increasingly, the faculty grew to have a majority of non-US born professors, often with less experience with industry. The losses in state funding reflect a transition from public perception of education as a private good with only personal value-added. The technology revolution meanwhile increased costs for universities, and industry salaries drove competitive salaries in academe.

Currently, CoEs by and large continue to hold the academic-scholarly model as the primary basis for career advancement in academe. However, universities are moving toward different business models for operations, including increasing use of non-tenure track, full-time instructors to deliver curricula. With state funding continuing to decrease, changing demographics, and with tuition caps and salaries increasing, the future success of the business of higher education is unclear.

This scenario causes new pressures that fall full force on engineering colleges and tenured and tenure-track faculty. New faculty hires faced with unreasonable expectations may continue to experience reduced career satisfaction and withdraw from academe completely.

Panels addressing these issues examined how CoEs can develop partnerships with other colleges within the institution so that a holistic and cohesive effort is made to navigate the higher education transformation underway.

3a. Role of Colleges of Engineering on campus

Panel discussants, including moderator Mary Roth, Associate Provost at Lafayette College, Laura Huenneke, Dean of Engineering at Northern Arizona University, Mary Good, Founding Dean of the College of Information Science and Systems Engineering at University of Arkansas, Little Rock, Cristina Amon, Dean of Engineering at the University of Toronto, and Jane Ammons, associate dean of engineering at the Georgia Institute of Technology, were asked how

they perceived or experienced a changing role for colleges of engineering on campus and whether this included increased pressure to develop interdisciplinary research and education, faculty productivity, industry engagement and learning and outcomes assessment. A culmination of their responses includes the following:

- ***Acknowledge that faculty members are risk averse.*** As many CoEs perceive themselves to be "stand alone" institutions, faculty members may have developed resistance to integration efforts or holistic changes. Reluctance to reach out, partner with or depend on other colleges within the institution creates barriers to advancement opportunities and may strain the role that the CoE plays system-wide.

- ***Identify and articulate contributions of the CoEs to economic development***. Cross-sector partnerships within industry and government can enhance visibility in this area. Generating data assessing how CoEs impact and improve state- or nation-wide economic development may also facilitate stronger partnerships within institutions.

- ***Identify and articulate contributions of engineering colleges to university missions***. Reach a greater understanding of the roles colleges within the institution's system play; assess how coursework, advisement, funding can be assessed and accessed collaboratively through cross-discipline partnerships. Lack of communication between departments and colleges results in disengagement, mistrust and hostile environments.

- ***Develop new models of promotion and tenure***. Varied models are needed to reflect new programs, growing interdisciplinarity and the need for faculty focus on partnerships within academe and across sectors. Resistance of these considerations may deter faculty outreach and partnership.

As a significant portion of the discussion following this panel segment focused on connecting engineering colleges with state- and nation-wide economic development, participant questions regarding metrics revealed considerations for how to measure the contributions of academe to economy. A need for tracking where undergraduate and graduate students go once their program is complete, as well as tracking faculty workloads and resource allocations was also expressed. Finally, participant notes and observations also indicated a need to understand the next ("millennial") generation of faculty and what to expect in terms of planning for resultant differences in communication and approach.

<u>Key recommended action items</u>

- Establish important national awards for engineering education, technology transfer success, and cross-sector collaborations (e.g., NAE, professional societies).
- Conduct activities focused on:
    - Valuing and reward cross-college and cross-disciplinary contributions in performance and promotion reviews.
    - Building leadership in CoEs on campus.
    - Making research profitable for CoEs and the universities.

    - Establishing large-scale industry partnering, including internationalization, and involving partnerships with Schools of Business and/or Management.
- Convene the nation-wide discussion on the rewards system in CoEs. What would changing from an academic college to a professional college mean?
- Develop a campus-wide program aimed to train and build a cohort of all deans, based on mutual respect.
- Incentivize faculty to develop innovative and relevant courses and degree programs, and strategically reinvest in successful programs.
- Identify and analyze unused capacities and expenses involved in increasing enrollments so that growth can be strategic, however painful.
- Link engineering deans groups (including those through professional societies) with Deans groups in other disciplines – establish peer group diversity on campus and across campuses. Great ideas don't originate only inside the mind of an engineering dean!
- Modify the GOALI, SBIR/STTR programs to focus use on building connections with industry, and for cross-disciplinary R&D.
- Expand state, federal, and industry programs that incentivize university research across campuses and regions to come together
- Introduce classes in entrepreneurship and business into the engineering curriculum (and for students in other colleges, too).
- Act to establish and enhance internship programs, and especially involve women students and faculty. These opportunities generate excitement and commitment (both ways), and engage industry in a way that will involve faculty as well if we do it right.
- Establish cross-sector fellowships or residency programs for women in industry and academe.
- CoEs need to take the lead on campus program assessment and accountability issues.
- Export the best CoE ideas (e.g., research experiences for undergraduates, senior capstone courses, integrated graduate research) across campus.
- We need to understand pragmatically how the cost and price of higher education is changing, and we need to convince the faculty that they need to understand at least the rudiments so they won't be part of the problem, even if they decide not to be part of the solution.
- We need to change our language used in CoEs – from "best and brightest" to inclusive language that enhances access and dialog, changing how others perceive us from competitive (win-lose) to collaborative. Engineering should be inviting engagement across campus, driving CoEs to systems and integration rather than to traditional engineering disciplinary silos.
- We need to develop new innovations in engineering curricula that bring broader and relevant subjects into our curricula including: globalism, business and entrepreneurialism, interdisciplinarity, and tied connections to engineering's roles in the local and regional economy.
- Create new degree concepts (e.g., a 2- or 3-year undergraduate engineering degree as an entry bridge to medical school; M. Engineering degrees that demonstrate project-based masters; new concepts in executive degrees involving or led by CoEs.

- As CoEs become more innovative and entrepreneurial, attention is needed for quality student advising – either train faculty or hire special advising staff. This is particularly important to not lose ground regarding diversity goals.

Key Metrics

- We need metrics to understand the role of market forces on who looks to engineering for a career.
- We need metrics to demonstrate the importance of academe as part of the economic engine in the state or region. How are we part of the economic development locally, regionally and nationally? We need to identify, articulate, benchmark and assess.
- There is often too much focus on Intellectual Property and R&D in arguing for economic impact. How can we capture the value imparted by higher education in terms of graduates and trained workforce?
- We need better data on the student/faculty ratios and student success information by gender and ethnicity.
- We need to develop benchmarking and metrics to track success in CoE engagements with larger campus (e.g., involvement in assessment initiatives).
- With budget issues so prominent, we need reliable metrics to understand the $/student FTE and $/FTE faculty in different engineering degree programs and across campus.

Areas needing further study

- What new ways can be developed to understand faculty expectations and workload (including changing modes of curriculum delivery) that include penetration of instruction by contract instructors?
- As CoEs become more collaborative on campus, we need metrics to benchmark our changing roles on campus beyond the CoE – leadership and partnership.
- Can we develop more holistic representations that will help us to understand and portray demands on faculty time and to establish broader and more meaningful understanding about productivity?
- As the millennial generation arrives into faculty ranks, we need to understand more about who the next generation of faculty will be, and begin planning for the difference.
- We need to understand how to help faculty be more efficient without sacrificing quality and career satisfaction, and while staying current and relevant. We need changes in the risk and reward systems.
- How has the explosion in development and application of computational modeling and simulation across nearly all disciplines effected change in industry and job markets? What do these changes imply as feedback into higher education? This is a leadership area for CoEs.

3b. Fiscal reality

A recent report from The Council of Higher Education Management Associations[11] identifies certain drivers of change that universities will need to respond to administratively. Panel discussants for this topic were asked how some of these drivers, noted below, impact Colleges of Engineering.

- Private, state, and federal support is decreasing, and research funding is increasingly competitive.
- The cost of providing an education is increasing, particularly regarding technological needs for competitive learning environments.
- There is growing pressure both to stabilize tuition and to respond to greater financial need among students.
- More institutions are becoming tuition-driven, leading to increased competition among institutions and increased global competition for international students.
- Student demographics are changing significantly.
- Budgets are driving more institutions to increase the numbers of courses delivered by contract employees (e.g., lecturers, adjunct faculty).

This final panel, moderated by Ilene Busch-Vishniac, Provost at McMaster University, also included Priscilla Nelson, Provost at the New Jersey Institute of Technology, Chris Maziar, Senior Associate Provost at Notre Dame, and Janie Fouke, Provost at the University of Florida. Responses to these questions of impact included the following action items and observations:

- ***Enrollment growth and research expenditure rarely produce significant net growth***. With continued reductions in state support and growing dependency on tuition income, universities must review institution missions (teaching, research, service and maintenance costs) to prioritize expenditures. Encouraging the sharing of labs and equipment on campus and with research partners, centralizing support services, and expanding low cost instructional formats (e.g. distance learning) can relieve budgetary constraints.

- ***Provide greater opportunities for strategic planning***. Consider the use of a university "central bank" that departments can seek loans from to encourage strategic planning and innovative risks.

- ***Increase revenue, decrease expenditures***. "Think creatively" to increase revenue using existing resources or those which may incur minimal costs (e.g. 100% utilization of campus during summer and winter sessions; offer alternative credentialing including certificates and modular graduate degree programs).
- ***Work to enhance and broaden industry partnerships***. Seek program opportunities and funding from industry to support collaborative research and education, and to enable two-way access to specialized staff and equipment.

[11] Goldstein, P.J. (2006). The Future of Higher Education: A View from CHEMA. The Council for Higher Education Management Associations, Washington, D.C.

- ***Strive for a balance between tenure and contract teaching faculty.*** It is important that we maintain our strategic support for both education and research missions.
- ***Develop educational partnerships with other US and international universities.*** This will enable delivery of quality courses and diverse and relevant degree programs with little cost increase beyond the technology costs to support distance and hybrid course delivery (e.g., **http://www.k-state.edu/media/nuclear/big12.html**). Note that revenue sharing needs to be worked out carefully and clearly, based on building relationships among the partners.

Discussions and participant observations following this panel focused on expenditure and revenue data. Attendees cited the need to track data both within their own institutions and nationwide, and to seek out comparative analyses of budgets and funding nationwide. Attendees also considered the tracking of state investments compared to revenue generation and thorough investigation of state budgets essential to a better overview of expenditure management and budgetary strategies.

Key recommended action items

- Train leaders at every level to understand budget constraints and drivers, and for effective planning to manage financial and human resources without loss in quality. Consider broad use of cost-center approaches and other ways to incentivize entrepreneurial activities (a reference list on fiscal approaches is included in this report as Appendix H).
- Explore innovation in domestic and international corporate/professional education and training.
- Create and market innovative degree options that engage relevant societal issues in an international context.
- Explore new course delivery concepts – run these as experiments but evaluate outcomes as good engineers should.
- Create favored industry research partnerships, offering access to specialized staff and equipment.
- Pursue sponsored research for profit: patents, licensing, venture funding and start-ups. Make research profitable rather than break even (at best) as things are now. However, take care as universities effectively change from non-profit to profit status (IRS).
- Offer credentialing beyond standard degrees (e.g., professional, executive, certificate).
- Increase T/TT faculty teaching loads in terms of student credit hours delivered, using technology and student/adjunct support effectively to handle more students with quality but with decreased cost per credit hour.
- Decrease costs by strategic increases in the use of non-tenure-track contract faculty. However, take proactive steps to involve students in research projects undertaken by tenure-track faculty to maintain the commitment to integration of research and education.
- Increase efficiency and profits by using courses from other universities, and exporting your courses to other universities.
- Institute more joint-institution degree programs (e.g., nuclear engineering in Big 12 schools).
- Consider developing “pipeline partnerships” and “favored school status’, forming a system of “minor league” feeders to “major league” schools. Is this corporate model for

universities of the future (perhaps with franchising?) with both domestic and international "members" of the league a viable model?
- Create/implement shared expense courses (use of labs, etc.) with government and industry.
- Make effective case for long-term "greening" of higher education to produce sustainable campuses.
- Train faculty, chairs and deans to be effective managers and leaders in academe.

Key metrics

- Identify approaches and metrics that help federal decision makers to act appropriately once they really understand how higher education is a main driver of the economic engine.
- Track state investments in higher education compared to revenue generation (and not just from tuition) – create economic engine models.
- Make economic models for regions – more important economically than using a state as the area for integration. Especially important for urban campuses in multi-city areas, often extending across state lines (e.g., NJ/NJ/Connecticut, Philadelphia area, Washington DC and MD, VA).
- Develop good databases and metrics that will track industry R&D activities with universities – and identify best practice for partnerships and managing IP.
- Separate state and federal earmarks, pass-through grants or contracts, etc. from faculty-initiated competitive research. Tell a transparent story about research in academe.
- The HEPI (Higher Education Price Index) is increasing faster than the CPI, but the HEPI needs to be reformulated to account for changes in productivity.
- For enhanced understanding on campus and with the public, we need the following for our campuses and for assessment across the nation:
    - Student/faculty ratios for tenure and contract teaching faculty, and by gender and ethnicity.
    - Research expenditures/tenured FTE faculty member.
    - Instructional delivery costs per student credit hour.

Areas needing further study

- What are new strategies that can be developed to balance tenure and contract teaching on campus?
- How can we help states obtain a better understanding of budgetary management for higher education? We need to conduct a thorough investigation of state budgets and funding algorithms (including student support) across the country.
- The success of funding sources in achieving breakthroughs may well depend on the sustainability of the funding resource. We need to analyze and make a very strong case for the importance of longer-term research commitments and needed significant increases in funding for NSF and NIH.
- The prospect of a 3-year engineering BS degree is not likely to fade away; so the U.S. needs to fully consider the impact of this degree on U.S education and the engineering professions.

- Keep working at new ways to use evolving IT capabilities to increase both efficiency and quality of course delivery.
- With the growth of county/community college enrollment, universities need to collaborate on course content and curricula so that students get what they need for successful transfer. This could ultimately lead to universities offering only 2-year completion degrees and graduate programs. Is this what we want or believe is needed?
- Publics need to get VERY serious about corporate giving. What will it take to make win-win relationships that are considered integral to the future of the university and the corporation?
- What do alumni want from their alma mater? We need to establish better win-win long-term career relationships with alumni – bond them effectively life-long to the university and make the university responsive to changing needs of alumni.
- How can academe make the interface with industry and government more seamless and smooth, including simpler, clearer IP understandings?
- What are the "stable" budget models for universities in the future? We cannot all keep growing our enrollment to balance our budget - the demographics are against us. Can a zero-based budgeting approach be effective?
- We need to establish metrics for profitability, quality and productivity to be applied across campuses and across the nation, and to identify successes and best practices.

Conclusions

The women participating in WEAAP focused on addressing issues of diversity and the ways these interact with and relate to the difficulties facing colleges of engineering as a whole. While many of the issues raised in conversation at WEAAP were neither new nor revolutionary, the space and platform provided was, and therein lies the potential for WEAAP to add constructive opportunities to the improvement of American engineering colleges' futures. Completing a series of informal evaluations, many of the attendees expressed that the atmosphere of trust generated by participants and facilitators created an environment with tremendous potential. Several participants felt that the specific set of common and shared experiences among workshop attendees allowed for an uninhibited flow of ideas and solutions: the willingness of these administrators to be open about their own institution's issues and the excitement generated from collaborating and brainstorming over common problems begs repeating and holds tremendous potential in the face of the current and future difficulties confronting colleges of engineering.

WEAAP: Overall Outcomes/Actions

In wrap-up sessions and closing remarks, attendees expressed enthusiastic interest in formalizing a network of women engineers in advanced academic positions. Though ideas about objectives and structure varied and will continue to evolve as this network is formed, participants agreed that as a group, WEAAP can harness the power achieved by administrators to effect change nationwide. Contemplation of benefits to network formation included data sharing, investigation of issues in higher education that have not been extensively explored, and perhaps more importantly, support. As one attendee stated, when moving into higher education executive administration, one often finds "immediate reactions of distrust" creating atmospheres adverse to brainstorming, collaboration, and combined efforts. Offering a new platform of trust, shared circumstance and "brainstorming space," WEAAP can continue to generate further and more focused investigations of the issues impeding the success and growth of engineering colleges across the nation.

#1 Priority Network – A virtual organization for professional engineering women in all sectors and across institutions needs to be designed, implemented and funded. The agent for the proposal should include WEAAP invitees, and several organizations including SWE (Society of Women Engineers), WEPAN (Women in Engineering Program Advocates Network), MentorNet, ASEE (American Society for Engineering Education), and other professional societies. Support for the network should be long-term and sustainable, and involve industry and government participation.

Once an effective network is created and maintained, then the following actions can be initiated and coordinated with priority:

1) **Operate a think tank** – Establishing a think tank – a brain trust addressing key issues that can generate dialogue, editorials and white papers on important and often difficult topics.
    a. Fiscal crisis – We need to convene a major study considering the economics of higher education, generating real facts to have government, foundations and

organizations, industry and the public understand the crisis and their potential roles in stabilizing higher education.

b. How can we demonstrate that Colleges of Engineering are or have potential to become part of the engine that drives economic and state/national development?

2) **Leadership practices** – Enhancing efforts of WELI, stabilizing WELI with respect to WEPAN, SWE, and other organizations can aid in developing management and leadership excellence in Colleges of Engineering.

3) **Support the graduate environment for women students –** This marginalized, isolated and vulnerable group needs to be supported. How do we move forward more proactively to do so?

4) **Professional schools/degrees** – We need to convene across engineering to discuss refocusing from academic to professional school models, and consider impacts on promotion and tenure, budgets, etc.

5) **Entrepreneurism knowledge** – "Executive corps", workshops, training are needed to increase the participation of women faculty (and women in industry) in entrepreneurism, business, patents, licensing and technology transfer and product development.[12]

6) **Relevance** – We need a focused campaign that addresses perceptions of the public, students, and government about engineering as a career, and that promotes understanding of engineering's relevancy in relation to major issues and varied career paths (e.g., sustainability, entrepreneurship).

7) **New metaphors** – We need to develop metaphors other than "pipeline", that better reflect the reality of engineering, career development, and higher education (e.g., access, alternative entry, partnerships with county and/or community colleges, etc.), and to develop new metrics appropriate for the new metaphors.

8) **Interdisciplinarity** – We would benefit from development of a resource that accumulates best practices for advancement of diversity through interdisciplinary and collaborative programs.

9) **International activities** – Face facts – Colleges of Engineering and the profession need to be better at engaging international institutions, colleagues and students. But we also must understand how the globalization of engineering may present different challenges regarding diversity and minority participation. We need to convene a discussion in which best practices and difficulties are addressed.

10) **Cross-sector collaborations** – Convene meetings and other events that bring women in different sectors together to address the potential for improved participation of women in

[12] e.g., A. James Clark School of Engineering. Retrieved from **http://www.eng.umd.edu/future/index.html** October 7, 2007.

collaborative academic/industry research and development, leading to effective technology transfer and product realization. Plan funding programs that provide support for women engineers to be "Fellows in Residence" in their opposite sector (e.g., women faculty in residence in industry during a summer).

Final Comments

All of the attendees concurred that moving into administration was an important and worthwhile decision overall. There are good reasons for every woman in a faculty position to consider making such a career move, even if it is only temporary and done in service to her disciplinary community on campus. However, the attendees noted that not every day is bright in administration, and that there are caveats, lessons to be learned and baggage to stumble over all along the way toward your goals.

The attendees were invited to contribute to a growing list of reasons for moving into a full-time administrative position, and a separate list of negatives or impediments associated with taking on a full-time administrative position. These full listings were assembled and returned to the attendees for them to participate in a Delphi process to vote and identify the Top 10 reasons for moving into administration, and the Top 10 impediments. The result of the vote is recorded in Tables 6 and 7 below, as the final word from the workshop organizers.

Strong interest in the thoughts of the highly accomplished WEAAP attendees remains. The WEAAP organizers will continue to distribute and report on workshop findings, and invites the ensuing dialog that will facilitate the growth and building of a substantial network.

Table 6. Top 10 reasons (3-way tie for the bottom 3 listed)

1	You can contribute to and take lead in big picture thinking, policy development.
2	You can be instrumental in changing the image of engineering and of academic careers.
3	You can act to make the administration, academics and faculty more flexible and welcoming of change – organization, curriculum, career development.
4	You will be an implicit role model, greater impact and visibility.
5	You can advance interdisciplinarity on campus – intellectually and through faculty governance and P&T on campus.
6	You can bring diversity to the decision table and make gender issues visible.
7	You can act to enhance the success of diversity in recruitment and retention.
8	You can broaden your knowledge beyond your discipline.
9	You will get a higher salary, prestige and perks.
10	You will not be bored – no two days are the same and there are challenges everywhere. If you are tired of your own thoughts – you will have many "clients" to listen to.
	You will represent your profession and university to external constituents, and in the process, you will meet fascinating and very successful people.
	You can make new personal and institutional connections and partnerships – extending to cross-sector and international arenas.

Table 7. Top 10 Impediments

1	The time commitment will be enormous in most experience, and less of your time is your own.
2	You will be distanced from your discipline and research, it is harder to stay involved in your scholarship.
3	You'll be even more isolated than you were as a faculty member.
4	You may have to change institutions to advance (with mobility/family potential difficulties).
5	Not everyone will love you, and people will start saying critical things behind your back – you will need to grow a thick skin.
	Many aspects of your family life will often have to take a back seat to everything else. You are expected to attend sports events, eat out, host activities – expect to eat well, not see a grocery store for weeks on end, and gain weight.
7	Everyone will have high (and sometimes unreasonable) expectations of you – administrative positions are increasingly high pressure and high stress.
8	You will have to deal with uncomfortable (and sometimes nasty) personnel matters, including grievances.
9	Budget problems are yours (not someone else's).
10	You may well get stalled in your academic career – don't try it without being a Full Professor (or higher).
	You serve at the pleasure of your superior, and can be asked to step down for all sorts of reasons.

Appendix A: WEAAP Agenda

Monday, January 7, 2008

6:00 p.m. – 10 p.m.	Reception at Hampton Inn - 2nd Floor

Tuesday, January 8, 2008

7:30 am	Bus Pick-up from Hampton Inn to NJIT Conference location – Eberhardt Hall Room 112
7:45 am – 9:00 am	Breakfast, Welcome and Networking Eberhardt Hall - University Club
9:00 am - 10:30 am	Panel 1A
10:30 am – 10:45 am	BREAK
10:45 am – 12:15 pm	Panel 1B
12:15 pm – 1:45 pm	Lunch – University Club
1:45 pm – 3:15 pm	Panel 2A
3:15 pm – 3:30 pm	BREAK
3:30 pm – 5:00 pm	Panel 2B
5:30 p.m. - 6:30 pm	Reception – ATRIM
6:30 pm – 8:30 pm	Dinner – Atrium
8:45 pm	Bus back to Hampton Inn

Wednesday, January 9, 2008

7:00 am – 7:30 am	Checkout from Hampton Inn and load luggage on bus
7:30 am	Bus departs from Hampton to NJIT Eberhardt Hall room 112
7:45 am – 9:00 am	Breakfast and Networking Eberhardt Hall - University Club
9:00 am - 10:30 am	Panel 3A
10:30 am – 10:45 am	BREAK
10:45 am – 12:15 pm	Panel 3B
12:15 pm – 1:15 pm	Lunch – University Club
1:15 pm - 3:00 pm	Workshop Closure/Wrap-up
3:00 pm	Bus departs for airport
	Early departures before 3:00 pm – let NJIT know to arrange transport

Appendix B Panel descriptions for the WEAAP workshop

Topic 1: Women in engineering undergraduate and graduate programs

This panel pair will explore the environment in our Colleges of Engineering for women students. Engineering bachelor's degrees awarded to women declined in both AY2004-05 and AY2005-06 and master's degrees declined in AY2005-06. Enrollments indicate that these declining trends will continue. Although the numbers of doctoral degrees awarded to women have continued to increase, the limited increase in the doctoral enrollment of women (2.3%) in fall 2005 indicates that the increasing degree trend will end in just a few years.

Panels

1a. Undergraduate Students

- Are you experiencing similar trends in enrollment and retention at your institution?
- How are you addressing this issue on your campus? (e.g. curriculum, pedagogy, academic and social climate, student leadership, funding, undergraduate research, programs, policies)
- What critical factors need to be addressed on the national level to effect change?
- Other questions invited.

1b. Graduate Students

- Are you experiencing similar trends in enrollment and retention at your institution?
- How are you addressing this issue on your campus? (e.g. curriculum, pedagogy, academic and social climate, student leadership, funding, undergraduate research, programs, policies)
- What critical factors need to be addressed on the national level to effect change?
- Other questions invited.

Panel	Moderator	Panelists	
1a: Undergraduates	Pam Eibeck, Texas Tech	Cherrice Traver	Union College
		Candis Claiborn	Washington State University
1b: Graduate Students	Delcie Durham, U. South Florida	Deirdre Meldrum	Arizona State University
		Linda Abriola	Tufts University

TOPIC 2: Women engineering professionals in academe, government and industry

This panel pair will explore the environment of our Colleges of Engineering for women faculty, on roles of industry (personal, interpersonal, institutional), and external professional interactions on stature in academe and career development.

Panels

2a. Women Engineering Faculty
According to the 2006 National Research Council Report, *To Recruit and Advance: Women Students and Faculty in US Science and Engineering*, four challenges confront female faculty. They are: 1) lower tenure and promotion rates; 2) longer time to promotion, 3) lower retention rates, and 4) lower job satisfaction. The report states that these challenges diminish the probability that female faculty will remain at a university, lower the efficiency and productivity of faculty, and make an academic career less satisfying.

- Are you experiencing this phenomenon at your institution?
- How are you addressing this issue on your campus?
- What critical factors need to be addressed on the national level to effect change?

2b. Women in Engineering Cross Sector and Cross Discipline Partnerships
Cross sector partnerships stimulate new ideas and problem solving across sectors; increase the opportunities and effectiveness of women engineers; and promote satisfaction and total career growth. To take on today's challenges, engineers must not only master a traditional discipline but also establish connections between disciplines, initiate efforts to leverage those connections and collaborate with other engineers and experts from business, the sciences, law, medicine and public policy.

- What are the opportunities, benefits and challenges to develop partnerships between women engineers in academia, industry and government?
- Do engineering faculty at your institution collaborate with experts in other engineering disciplines as well as across disciplines within academe in fields of science, law, medicine and public policy?
- Are you facilitating this strategy at your institution?
- How can this permeability between sectors and disciplines be facilitated on a national level?

2a: Women Engineering Faculty	Cheryl Schrader, Boise State	Mariesa Crow	University of Missouri, Rolla or Missouri Science and Technology
		Faye Boudreaux-Bartels	University of Rhode Island
		Susan Blanchard	Florida Gulf Coast University
		Linda Lucas	University of Alabama, Birmingham

2b: Cross-Sector and Cross-Discipline	Zulma Toro-Ramos, Wichita State University	Sallie Keller-McNulty	Rice University
		Karen Whitehead	South Dakota School of Mines and Technology
		Priscilla Nelson	New Jersey Institute of Technology

TOPIC 3: Higher education administration: impact on engineering colleges

This topic will consider the climates for our Colleges of Engineering regarding operations inside the university and also external to the university institution. The instigation is that our universities are under increasing financial stress, universities must operate in a global and multi-cultural world, and Colleges of Engineering are under increasing stress to contribute more to the success of universities.

Pre-1960's, Colleges of Engineering functioned as professional schools. Not all faculty held terminal degrees; research was primarily linked into real world problem solution, applied in close involvement with industry. From the 1960's through the 1990's, Colleges of Engineering became academic schools, and faculty held terminal degrees and tenured positions. Increasingly, the faculty grew to have a majority of non-US born professors, often with less experience with industry. The losses in state funding reflect a transition from public perception of education as a private good with only personal value-added. The technology revolution meanwhile increased costs for universities, and industry salaries drove competitive salaries in academe.

Into the 2000's, Colleges of Engineering by and large continue to hold to the academic, scholarly model for the colleges as the primary basis for career advancement in academe. However, universities are moving toward different business models for operations including increasing use of non-tenure track full-time instructors to deliver the curricula. With state funding continuing to decrease, and with tuition caps and salaries increasing – the future success of the business of higher education is not clear.

This scenario causes new pressures that fall full force on Colleges of Engineering and tenured and tenure-track faculty, especially on new faculty hires for whom we may have unreasonable expectations, resulting in reduced career satisfaction and faculty leaving the sector. These panels will examine how Colleges of Engineering can develop on campus as the partners other colleges need to enable all to contribute to the higher education transformation underway, and to do so with enhanced career satisfaction.

Panels

3a. Role of Colleges of Engineering on Campus

- How have you perceived or experienced a changing role for Colleges of Engineering on campus, including increased pressure for interdisciplinary research and education, faculty productivity, industry engagement (research, applications, continuing education), and learning and outcomes assessment?

3b. Fiscal Reality

A recent report from The Council of Higher Education Management Associations[i] identifies certain drivers of change that universities will need to respond to administratively. Some of these drivers are noted below. How do these drivers impact Colleges of Engineering?

- Private, state and federal support is decreasing, and research funding is ever more competitive.
- The cost of providing an education is increasing, particularly regarding technological needs for competitive learning environments.
- There is growing pressure both to stabilize tuition and to respond to greater financial need among students.
- More institutions becoming tuition-driven, leading to increased competition among institutions and increasing global competition for international students.
- Student demographics are changing significantly (e.g., more foreign born students, Hispanics, Asians, no growth in the total number of students in traditional institutions).

3a: Colleges of Engineering on Campus	Mary Roth, Lafayette College	Cristina Amon	University of Toronto
		Laura Huenneke	Northern Arizona University
		Mary Good	University of Arkansas, Little Rock
		Jane Ammons	Georgia Institute of Technology
3b: Fiscal Reality	Ilene Busch-Vishniac, McMaster University	Chris Maziar	Notre Dame
		Janie Fouke	University of Florida
		Priscilla Nelson	New Jersey Institute of Technology

Final Discussion Questions

- Shall we form and maintain a Network for Women Engineers in Higher Education Administration?
- How can you be most effective influencing policy and practice at your institution? Can this Network benefit you in your role?
- How can this Network of women engineers who are in advanced academic positions influence policy and practice in the academic community?
- Is there a personal benefit to establish and maintain this Network of women engineers who are in advanced academic positions?
- If so, what are the objectives of the Network?
- What is the most effective and least time consuming structure of such a Network?

Appendix C WEAAP Participant List

Linda Abriola, Tufts University	Linda.Abriola@tufts.edu
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Mary Juhas, National Science Foundation	mjuhas@nsf.gov
Deborah Jackson, National Science Foundation	djackson@nsf.gov

Appendix D: Detail Tables

Table D.1 Enrollment

Name	Institution	Public or Private	Fall 2006 Total Enrollment				Fall 2006 Engineering Enrollment									
							Undergraduate				Graduate				%Grad Among ENG Students	% ENG Among All Students
			Total (w/o professional)	UG	Grad	%Grad	FT ENG UG	Women FT ENG UG	ENG UG as % of Total UG	% Women Among ENG UG	Total ENG Graduate	Women FT ENG Grad	ENG Grad as % of Total Grad	% Women Among ENG Grad		
Candis Claiborn	Washington State University	Public	22,874	19,554	3,320	17%	1,608	179	8%	11%	426	95	13%	22%	21%	9%
Cherrice Traver	Union College	Private	2,212	2,212		0%	265	34	12%	13%					0%	12%
Cheryl Schrader	Boise State University	Public	17,803	16,017	1,786	11%	871	101	5%	12%	131	28	7%	21%	13%	6%
Christine Maziar	Notre Dame	Private	10,325	8,427	1,898	23%	783	191	9%	24%	393	94	21%	24%	33%	11%
Cristina Amon	University of Toronto	Public	45,114	59,866	12,628	21%	4,094	855	7%	21%	1,297	280	10%	22%	23%	8%
Deirdre Meldrum	Arizona State University	Public	51,234	41,815	9,419	23%	3,204	579	8%	18%	1,603	353	17%	22%	33%	9%
Delcie Durham	U. of South Florida	Public	41,592	34,077	7,515	22%	2,033	313	6%	15%	675	174	9%	26%	25%	7%
Faye Boudreaux-Bartels	University of Rhode Island	Public	14,506	11,875	2,631	22%	862	128	7%	15%	181	43	7%	24%	17%	7%
Ilene Busch-Vishniac	McMaster University	Private														
Jane Ammons	Georgia Institute of Technology	Public	17,935	12,360	5,575	45%	6,891	1,451	56%	21%	3,360	667	60%	20%	33%	57%
Janie Fouke	University of Florida	Public	46,549	35,110	11,439	33%	4,573	929	13%	20%	2,205	452	19%	20%	33%	15%
Karen Whitehead	South Dakota School of Mines and Technology	Public	2,124	1,870	254	14%	1,139	176	61%	15%	163	34	64%	21%	13%	61%
Laura Huenneke	Northern Arizona University	Public	20,562	14,526	6,036	42%	831	122	6%	15%	24	1	0%	4%	0%	4%
Linda Abriola	Tufts University	Private	7,971	4,994	2,977	60%	709	212	14%	30%	493	162	17%	33%	41%	15%
Linda Lucas	U. of Alabama, Birmingham	Public	15,586	11,284	4,302	38%	514	119	5%	23%	223	65	5%	29%	30%	5%
Mariesa Crow	University of Missouri, Rolla (MST)	Public	5,858	4,515	1,343	30%	3,158	575	70%	18%	1,019	212	76%	21%	24%	71%
Mary Good	University of Arkansas, Little Rock	Public	11,555	9,400	2,155	23%	185	22	2%	12%					0%	2%
Mary Roth	Lafayette College	Private	2,381	2,381		0%	494	124	21%	25%	0	0			0%	21%
Pamela Eibeck	Texas Tech	Public	27,294	22,851	4,443	19%	2,519	274	11%	11%	553	100	12%	18%	18%	11%
Priscilla Nelson	New Jersey Institute of Technology	Public	7,670	5,450	2,220	41%	1,622	275	30%	17%	1,171	309	53%	26%	42%	36%
Sallie Keller-McNulty	Rice University	Private	5,008	2,995	2,013	67%	774	230	26%	30%	512	131	25%	26%	40%	26%
Susan Blanchard	Florida Gulf Coast University	Public	7,757	6,962	795	11%										
Zulma Toro-Ramos	Wichita State University	Public	14,298	11,203	3,095	28%	643	96	6%	15%	560	76	18%	14%	47%	8%

Table D.2 Faculty Information

Name	Institution	Public or Private	About ENG Students			About ENG Faculty					About Student/Faculty Ratios	
			UG	Grad	Total	T/TT Faculty	FT but non-T/TT Faculty	% non-T/TT FT Faculty	Number of Women in ENG T/TT	% Women in ENG T/TT Faculty	Total ENG Students Per T/TT ENG Faculty	Total ENG Students per FT ENG Faculty
Candis Claiborn	Washington State University	Public	1,608	426	2,034	105	12	10%	17	16%	19.4	17.4
Cherrice Traver	Union College	Private	265	0	265	24	5	17%	2	8%	11.0	9.1
Cheryl Schrader	Boise State University	Public	871	131	1,002	44	2	4%	11	25%	22.8	21.8
Christine Maziar	Notre Dame	Private	783	393	1,176	93	4	4%	11	12%	12.6	12.1
Cristina Amon	University of Toronto	Public	4,251	1,297	5,548	200	18	9%	22	11%	27.7	25.4
Deirdre Meldrum	Arizona State University	Public	3,204	1,603	4,807	201	20	9%	24	12%	23.9	21.8
Delcie Durham	U. of South Florida	Public	2,033	675	2,708	103	12	10%	12	12%	26.3	23.5
Faye Boudreaux-Bartels	University of Rhode Island	Public	862	181	1,043	72	8	10%	9	13%	14.5	13.0
Ilene Busch-Vishniac	McMaster University	Private	2,840	552	3,392	136	8	6%	10	7%	24.9	23.6
Jane Ammons	Georgia Institute of Technology	Public	6,891	3,360	10,251	412	7	2%	48	12%	24.9	24.5
Janie Fouke	University of Florida	Public	4,573	2,205	6,778	287	24	8%	25	9%	23.6	21.8
Karen Whitehead	South Dakota School of Mines and Technology	Public	1,139	163	1,302	65	5	7%	8	12%	20.0	18.6
Laura Huenneke	Northern Arizona University	Public	831	24	855	33	6	15%	6	18%	25.9	21.9
Linda Abriola	Tufts University	Private	709	493	1,202	65	11	14%	12	18%	18.5	15.8
Linda Lucas	U. of Alabama, Birmingham	Public	514	223	737	39	9	19%	3	8%	18.9	15.4
Mariesa Crow	University of Missouri, Rolla (MST)	Public	3,158	1,019	4,177	147	21	13%	9	6%	28.4	24.9
Mary Good	University of Arkansas, Little Rock	Public	185		185	30	1	3%	1	3%	6.2	6.0
Mary Roth	Lafayette College	Private	494	0	494	32	3	9%	7	22%	15.4	14.1
Pamela Eibeck	Texas Tech	Public	2,519	553	3,072	119	11	8%	16	13%	25.8	23.6
Priscilla Nelson	New Jersey Institute of Technology	Public	1,622	1,171	2,793	117	14	11%	10	9%	23.9	21.3
Sallie Keller-McNulty	Rice University	Private	774	512	1,286	102	12	11%	15	15%	12.6	11.3
Susan Blanchard	Florida Gulf Coast University	Public										
Zulma Toro-Ramos	Wichita State University	Public	643	560	1,203	44	1	2%	2	5%	27.3	26.7

Table D.3 Research Information

Name	Institution		About Engineering Research							
		Public	T/TT ENG Faculty	FT Research ENG Faculty	Total T/TT + Research ENG Faculty	Number of Grants	Total AY05-06 Funding ($M)	Industry Grant Funding ($M)	% Industry Grant Funding	Average Grant Funding per (T/TT+Research ENG Faculty)
Candis Claiborn	Washington State University	Public	105	26	131	454	$ 15.33	$ 0.68	4%	$ 117,023
Cherrice Traver	Union College	Private	24	0	24					
Cheryl Schrader	Boise State University	Public	44	3	47	44	$ 3.72	$ 0.12	3%	$ 79,149
Christine Maziar	Notre Dame	Private	93	0	93	298	$ 18.65	$ -	0%	$ 200,538
Cristina Amon	University of Toronto	Public	200	61	261	798	$ 59.54	$ 5.80	8%	$ 228,125
Deirdre Meldrum	Arizona State University	Public	201	36	237		$ 50.15	$ 8.94	18%	$ 211,603
Delcie Durham	U. of South Florida	Public	103	66	169					
Faye Boudreaux-Bartels	University of Rhode Island	Public	72	2	74	128	$ 4.65	$ 0.53	11%	$ 62,838
Ilene Busch-Vishniac	McMaster University	Private								
Jane Ammons	Georgia Institute of Technology	Public	412	195	607		$ 203.68	$ 6.41	3%	$ 335,552
Janie Fouke	University of Florida	Public	287	41	328	1448	$ 107.77	$ 5.41	5%	$ 328,567
Karen Whitehead	South Dakota School of Mines and Technology	Public	65	5	70	447	$ 11.25	$ 0.13	1%	$ 160,714
Laura Huenneke	Northern Arizona University	Public	33	1	34	44	$ 7.59	$ 0.30	4%	$ 223,235
Linda Abriola	Tufts University	Private	65	3	68	146	$ 10.11	$ 0.42	4%	$ 148,676
Linda Lucas	U. of Alabama, Birmingham	Public	39	4	43	149	$ 8.92	$ 0.33	4%	$ 207,442
Mariesa Crow	University of Missouri, Rolla (MST)	Public	147	30	177	1104	$ 25.87	$ 4.65	18%	$ 146,158
Mary Good	University of Arkansas, Little Rock	Public	30	2	32					
Mary Roth	Lafayette College	Private	32	0	32		$ -	$ -		$ -
Pamela Eibeck	Texas Tech	Public	119	0	119		$ 12.81	$ 1.34	10%	$ 107,647
Priscilla Nelson	New Jersey Institute of Technology	Public	117	7	124		$ 31.64	$ 3.44	11%	$ 255,161
Sallie Keller-McNulty	Rice University	Private	102	12	114	180	$ 33.20	$ 1.07	3%	$ 291,228
Susan Blanchard	Florida Gulf Coast University	Public								
Zulma Toro-Ramos	Wichita State University	Public	44	0	44		$ 13.26	$ 2.05	15%	$ 301,364

Table D.4 Cost Information

Name	Institution		Tuition and Fees Price		
		Public	In-State UG Tuition + Fees	In-State Grad Tuition + Fees	Ratio Grad/UG Tuition
Candis Claiborn	Washington State University	Public	$ 6,448	$ 7,576	1.17
Cherrice Traver	Union College	Private			
Cheryl Schrader	Boise State University	Public	$ 4,154	$ 4,944	1.19
Christine Maziar	Notre Dame	Private	$ 33,410	$ 32,800	0.98
Cristina Amon	University of Toronto	Public	$ 7,420	$ 7,006	0.94
Deirdre Meldrum	Arizona State University	Public	$ 4,689	$ 6,026	1.29
Delcie Durham	U. of South Florida	Public	$ 3,342	$ 6,048	1.81
Faye Boudreaux-Bartels	University of Rhode Island	Public	$ 8,452	$ 7,858	0.93
Ilene Busch-Vishniac	McMaster University	Private			
Jane Ammons	Georgia Institute of Technology	Public	$ 4,926	$ 5,620	1.14
Janie Fouke	University of Florida	Public	$ 3,206	$ 6,827	2.13
Karen Whitehead	South Dakota School of Mines and Technology	Public	$ 5,330	$ 4,040	0.76
Laura Huenneke	Northern Arizona University	Public	$ 4,546	$ 4,898	1.08
Linda Abriola	Tufts University	Private	$ 34,730	$ 33,672	0.97
Linda Lucas	U. of Alabama, Birmingham	Public	$ 5,362	$ 11,302	2.11
Mariesa Crow	University of Missouri, Rolla (MST)	Public	$ 9,404	$ 6,756	0.72
Mary Good	University of Arkansas, Little Rock	Public	$ 4,736	$ 5,000	1.06
Mary Roth	Lafayette College	Private	$ 31,501		
Pamela Eibeck	Texas Tech	Public	$ 6,459	$ 6,576	1.02
Priscilla Nelson	New Jersey Institute of Technology	Public	$ 10,506	$ 13,310	1.27
Sallie Keller-McNulty	Rice University	Private	$ 26,974	$ 23,938	0.89
Susan Blanchard	Florida Gulf Coast University	Public	$ 3,778	$ 6,081	1.61
Zulma Toro-Ramos	Wichita State University	Public	$ 4,681	$ 3,991	0.85