

---

# On Belay: Peer-Mentoring and Adventure Education for Women Faculty in Engineering

---

NAOMI C. CHESLER  
*Department of Biomedical Engineering  
University of Wisconsin—Madison*

PEG BOYLE SINGLE  
*Department of Education  
University of Vermont*

BORJANA MIKIC  
*Picker Engineering Program  
Smith College*

## ABSTRACT

This paper reports on an intervention program designed to cultivate effective peer mentoring among a small group of women engineering faculty members from different academic institutions. Adventure education, comprised of linked intellectual and physical challenges in an outdoor setting, was chosen as the vehicle to transform the group into a highly functioning team. Based on a qualitative analysis of post-workshop essays, the intervention resulted in informational, psychosocial, and instrumental mentoring benefits that could serve to support and enhance the participants' academic careers. This paper provides a blueprint for the design of similar workshops for groups that could benefit from additional peer-mentoring and networking opportunities in the engineering academy.

## I. INTRODUCTION

The under-representation of women in the engineering workforce nationwide is well known [1]. One strategy for improving the diversity in the engineering professions is to create a more diverse environment in the engineering academy. In 2001, only 8.9% of the tenured or tenure-track faculty members were female: 17.5% of the assistant professors, 11.1% of the associate professors, and 4.4% of the full professors were women [2].

Reasons for the disproportionate absence of women from engineering faculty positions are multifaceted, and often unintended. The MIT report [3] revealed that their women science faculty received smaller office and laboratory space, fewer internal funds per sponsorship dollar or publication, and fewer opportunities for networking and mentoring opportunities than their men science faculty. Wenneras and Wold [4] found that after controlling for quality of a research grant application and applicant competence, women's appli-

cations were scored lower than the men's applications by the equivalent of "three extra papers in *Nature* or *Science*" (p. 342). Women faculty members often report lower levels of social support and fewer intra- and inter-departmental professional interactions than their male counterparts [5]. Finally, there are few women in positions of academic leadership who can act as role models for women faculty members. As of January 2003, there were fourteen female deans of engineering at colleges and universities in the United States [6].

Mentoring is a useful and popular method for addressing the accumulated disadvantages that women face. While there are important variations across racial and class groupings, socialized gender differences between women and men have significant implications for the design of mentoring programs [7]. In particular, programs that foster peer mentoring and community building may be more likely to meet the needs of women faculty than traditional, hierarchical mentoring relationships [7]. Providing role models to women is also likely to have a significant positive impact on career advancement [8, 9]. Finally, adventure education, as a format for intervention, has been shown to quickly develop interpersonal connections and a sense of community. Indeed, a meta-analytic review of research on adventure education suggests that results are more positive and longer-lasting than for other forms of intervention, and that the format is especially beneficial for adult learners and for women [10].

Thus, we developed an intervention workshop to provide opportunities for networking, mentoring and access to role models for untenured women faculty members. As a unique characteristic, we developed this workshop within the framework of adventure education. Our programmatic goals were to (1) develop participants' communication and leadership skills, (2) initiate supportive peer-mentoring relationships among participants, and (3) provide access to a senior and successful role model. Our hope is that deliberately constructed intervention programs such as this will be a positive influence on women's professional development, retention and advancement in the engineering academy, and that the benefits for women faculty will translate into similar benefits for women students in engineering disciplines. The results presented here indicate progress toward these goals and could be a blueprint for the design of similar programs.

## II. METHODS

### A. Participants and Recruitment

Untenured but tenure-track women faculty members from the New England region were invited to apply for acceptance into the workshop. Notices were sent to the deans of twenty-four colleges and universities listed in the Northeast Regional Dean's Council

and e-mail postings were distributed on electronic mailing lists. Primary criteria for selection included obtaining matching travel money from their institutions, being in a tenure-track position in a traditional engineering department (i.e., not engineering technology), and working at an academic institution in New England. A secondary criterion included being part of a pair of applicants from other regions (to allow for dissemination and growth to other regions), and diversity in terms of race/ethnicity. In total, fourteen untenured women engineering faculty members participated. Their academic experience ranged from entering their first to fifth years, with the majority of the participants having been in their current position for two to three years (Figure 1). Their fields of expertise included chemical (two participants), mechanical (two), biomedical (three), environmental (three), electrical (one), systems (one) and general (one) engineering, as well as materials sciences (one). Most of the participants came from institutions classified by the Carnegie Classifications as extensive doctoral/research universities (eight participants); next most common were participants from liberal arts baccalaureate colleges (three); and one each came from master's colleges and universities (one), intensive doctoral/research universities (one), and baccalaureate colleges—general (one). Several had been awarded federal funding for their research and education activities including the National Science Foundation CAREER award.

In addition to the fourteen participants, a senior woman engineer and dean of engineering at an intensive doctoral/research university was invited. The dean's accomplishments in engineering research, commitment to mentoring, and track record of supporting women junior faculty were critical to her selection as a role model for the group.

### B. Intervention Format

Outward Bound Professional was chosen to facilitate the workshop. The facilitators and basic structure selected were based on their Leadership Program for Professional Women. This program uses increasingly difficult individual and team exercises and physical challenges to develop communication skills, teamwork, self- and group-assessment and change in the participants individually and for the group.

After introductions and general orientation, activities on the first day included team-building exercises, development of a

group mission and a short hike. To illustrate the team-building exercises, the group was asked to construct a complex rope bridge and use it to cross a river safely in a given period of time. The challenge was that no one had all the information necessary to complete the task. Instead, each team member received instructions for one aspect of the task representing a specific and unique expertise that was necessary for task completion (e.g., a type of knot). One team member was given the larger perspective, but no detailed information. Furthermore, team members could not show one another their instructions. Thus, teamwork and communication was necessary to complete the task. After this activity, as with all others, the group engaged in a discussion of and reflection upon the activity, in particular on the goals, roles, procedures and interactions that evolved.

At the end of the day, the senior speaker addressed the group, and answered questions about the tenure process and the process of personal decision-making that goes into pursuing an academic career while maintaining balance between an academic career and a personal life.

The second day built on the activities of the first with additional team and individual challenges. For example, participants confronted a "high ropes course," which is a complex network of logs and ropes constructed thirty feet above the ground over which participants must traverse while on belay. Note, "on belay" is a mountaineering term that refers to being physically supported in a harness via a rope harnessed to another person. In this challenge, individual achievement was encouraged through support that was both physical (through the belayer) and psychosocial (from all the members). The psychosocial support included verbal encouragement as well as information about the next step in a course if the participant could not see it. In the evening, the facilitators presented a social styles workshop, where individuals identified their preferred style with two variables in each of two dimensions: communication and orientation. After self-identification (Figure 2), each social style group had a breakout session to discuss their commonalities, strengths and weaknesses. These reflections were then shared with the group as a whole.

The final day, an early hike was followed by two challenges that again required physical and psychosocial reliance on other participants.

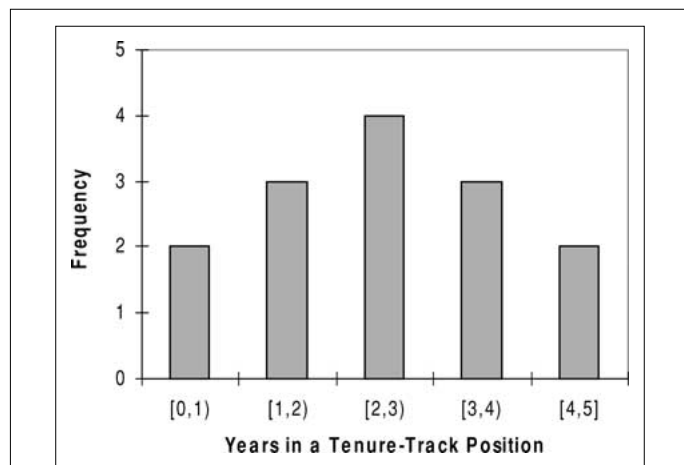


Figure 1. Number of participants by years of experience in a tenure-track position. Parentheses inclusive, brackets exclusive.

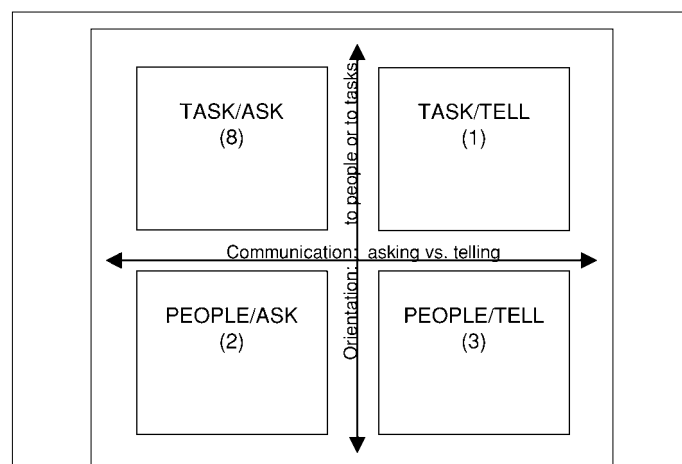


Figure 2. Four social styles represented by four quadrants defined by communication style and orientation to people or tasks. Numbers in parentheses indicate number of participants self-identifying in that quadrant.

The first was a rock climbing challenge where participants climbed a steep rock face on belay. The final challenge of the weekend was a team-based exercise where the group simulated a rescue down the side of a thirty-foot cliff. This challenge built on all the previous ones where limited information, the identification of roles, and the meting out of tasks were used as vehicles to illustrate and build leadership, communication and teamwork. The challenge required the involvement and investment of all the participants through coordination, the identification of appropriate roles for all participants and consensus building. The workshop ended with a reflection on the final group challenge, the entire workshop, and dialogue about future goals.

### III. RESULTS

#### A. Evaluation Methodology

Qualitative formative evaluation principles were used to evaluate the program. These methods are suited for use with small groups of people where the intervention is being used for the first time with a new population [11]. The primary assessment data included participants' written reflections on the workshop and the authors' participant observations of its constituent elements and small group discussions [12, 13]. A post-hoc design was used to code and analyze participants' reflective self-reports and the authors' observations [14–16]. The deductive coding frame was based on *a priori* expectations of three kinds of mentoring benefits: informational, psychosocial and instrumental. Participants' reflections were examined for evidence related to each of these benefit categories.

#### B. Results

Most participants cited specific skills gained through the workshop that were deemed likely to influence their daily lives, reported overcoming initial skepticism about community development in a three-day format, and expressed strong commitment to maintaining this peer-community upon their return to the workplace. Par-

ticipant comments also revealed the merit of inviting a senior woman in the engineering academy to speak to the group about her experiences. Interestingly, the adventure education format may have been critical to the success of the community-building experienced in this workshop.

Several themes emerged in the analysis of the reflection essays and were consistent throughout. The first theme reflected a participant's increased understanding of the information necessary for successful professional development within an academic career. Using taxonomy from the mentoring literature [17], we called this category *Informational Benefits*. The second category reflected aspects of heightened self-awareness or increased self-confidence and an awareness of "not being alone." Also using a mentoring taxonomy, we refer to this category as *Psychosocial Benefits*. Finally, the third category reflects a commitment to mentor others and share the benefits of the workshop with a broader community; this category was denoted *Instrumental Benefits*.

Excerpts from participant reflections are grouped according to the three categories of psychosocial, informational, and instrumental benefits (Tables 1–3) and are discussed below. Comments on the presence of a senior role model and the particular impact of adventure education (Table 4) follow. We also present preliminary evidence of post-workshop peer mentoring.

**1) Informational Benefits:** The three main benefits of the program described within the category of informational benefits were increased confidence in writing, the benefits of consensus-style management, and more realistic perceptions of professional risks (Table 1).

Participants appeared to appreciate the opportunity to discuss their writing and their writing habits freely. In particular, a diagnostic writing fluency survey we administered (from [18]) provided them with a new outlook on their academic writing. Opportunities to engage in conflict resolution, which incorporated multiple perspectives and resulted in consensus-building also appear to have been significant to the participants. We speculate that a confrontational style of

Writing Skills	The diagnostic [writing] survey handed out convinced me that perfectionism was slowing me down when approaching new manuscripts or essays. I now feel more confident in my writing skills and ability to put a piece of writing together more quickly.
	Writing has been a chore for me, but thinking about it as a sales pitch or advertising to the world about what cool stuff I've done, now that was an eye-opener.
Management Skills	I was very pleased with the way we were able to talk things out, which provided me with one more valuable lesson on the importance of listening to all voices and building consensus.
	[I] wonder whether we don't often drive so hard to decisions and resolutions that we forget to take the time to consider the needs of every member of the team. Put into operational terms, I think this suggests that time spent ... building consensus is time well spent.
	We reached consensus... There was a 'win-win'. I don't think I've ever been part of this type of decision-making process.
Re-evaluation of Risk	I learned ... the distinction between perceived vs. real risk.
	The best part was the time to reflect, alone and as a group, about key aspects of how we as individuals interact with our roles as professors. How we handle risk and conflict and how we plan for our lives, our careers and the academy.
	What will I do differently? ... Re-evaluate the rules; ... Re-evaluate perceived risks; ... Build consensus; ... Give myself a break.

Table 1. Informational benefits self-reports (representative).

Increased Confidence	I take away from this experience a profoundly expanded sense of possibility, restored confidence in myself as well as others, a support network that has seen me in my most trying hour, and a set of tools for an upward spiral of self-improvement that I hope will be ongoing.
	One thing I did get out was a little more self-confidence. ... I learned iterative attempts at achieving a goal.
Loss of Isolation	Just knowing that I'm not alone is very comforting. Knowing that there are people I can vent to without feeling on guard provides me with a great sense of security.
	The early group-building exercises were very effective at bringing me out from my sense of isolation.
Heightened Perspective	There are many times when I don't think I know as much as I should about concepts I teach... What I need to realize is that similar to the rope bridge building [exercise], everyone has a different 'piece of paper' in life that enables them to excel in some areas but maybe not others. This is why collaboration is as important for us in our professional lives as it was for us in building the rope bridge.
	I know that I need to take some peaceful time to myself for quiet reflection about the things that are important in life to put everything in perspective.
Community and Trust	After the introduction on the first night, I believed that this would be a pleasant experience but that we would find our differences too much to overcome [and so we would not be able] to build an atmosphere of trust and acceptance in three short days. I was wrong.
	I secretly assumed that the depth of personal involvement with other human beings necessary for a true friendship could develop only over years not days. It also seemed to me that despite our similar jobs and our commonality as women working in male-dominated fields, we as individuals had very little in common. ... The experience during the final challenge has changed my thinking.
	I have participated in numerous other workshops/events where one of the goals was to build community... Although I found these workshops beneficial in other ways, I did not feel that they were successful in community building. I am amazed to have walked away from this workshop feeling like I belong to this group.

**Table 2. Psychosocial benefits self-reports (representative).**

Commitment to Others	I am motivated to continue to spend some time each week on some type of mentoring or support activity with other female engineering faculty.
	The experience was renewing to my ... energy for mentoring and [building] workplace teamwork.
	It feels wonderful to be part of a community that I know I can call upon if I need advice or solace, and with whom I can share my successes knowing that you actually do care to hear them. It feels even better knowing that I would do whatever is in my power to help any one of you.

**Table 3. Instrumental benefits self-reports (representative).**

Outward Bound	Physical health is probably second in importance to mental health. The Outward Bound experience was a physically rewarding experience.
	Each challenge slowly built in intensity and meaning, as I grew more aware of the connections between the tangible physical, mental and social challenge of the activity, to the intangible personal and workplace struggles of female engineering faculty. ... This growing awareness was reinforced in the group reflections after each activity.
	I was able to use the Outward Bound process to reflect upon what happened for me that morning [on the high ropes course] and what I could do differently. ... I ... resolved to make some changes. ... Indeed, my second experience [rock climbing] was very different. I amazed myself...

**Table 4. Adventure education benefits self-reports (representative).**

decision-making is more common in academe and in engineering in general and, thus, the consensus-building was a positive change. Participants also reported gaining a more realistic perception of professional risk-taking.

2) **Psychosocial Benefits:** The four benefits within the category of psychosocial benefits that emerged were increased confidence, loss of isolation, improved (i.e., more realistic) perspective on their personal and professional environments, and increased community and trust (Table 2). In particular, the participants commented on how the tangible experience of having a support network influenced their personal self-confidence and self-perception of ability. As a corollary to self-confidence, the participants wrote that the intervention helped to diminish the isolation that they experience in their jobs. In addition to these two benefits, participants experienced a heightened, and improved, sense of perspective on their jobs and an increased sense of community and trust.

3) **Instrumental Benefits:** Instrumental benefits, as mentioned earlier, refer to the benefits associated with promoting others through increased professional opportunities. Where the participants expressed instrumental benefits, it mostly appeared in the form of commitments or pledges to support younger colleagues and peers (both women and men) at the participants' home institutions. Providing opportunities for others often leads to an improved sense of self-worth by "giving back" to the community. As demonstrated by the comments shown in Table 3, informational, psychosocial benefits, and instrumental benefits are often experienced together.

4) **Senior Role Model:** Most reflective essays did not specifically comment on the value of including a senior faculty member/role model. Nonetheless, the advertised presence of a senior woman in the field affected participants' decisions to apply. One participant included this sentiment in her reflection essay: "I was very interested in hearing from the advertised 'senior woman faculty,' who could surely provide some interesting tips and perhaps become a networking resource." Informal conversations initiated by the authors confirmed that this was the majority viewpoint. Overall, the presence of the female engineering dean and the sharing of her personal story were reported as "inspiring," "a great example" and extremely valuable according to the attendees (from informal discussions not recorded). The focus of questions on the timing of her personal life choices were indicative of the concern participants have in their own lives regarding these choices. The significance of her presence continued after the workshop as evidenced by continuing and frequent e-mail exchanges.

5) **Adventure Education:** An unexpected theme that emerged in the reflection essays was related to the adventure education aspect of the program (Table 4). In particular, the Outward Bound approach was effective in renewing personal energy with physical activity, modeling effective ways of dealing with workplace challenges, and creating a supportive community through team challenges.

6) **Post-Workshop Peer Mentoring:** One year after the workshop's end, at least five groups of participants at different institutions have met and reconnected in person, facilitated either by professional or personal opportunities. During this same time period, e-mail communication among all participants, facilitated by an e-list, has been frequent (more than five per week on average). The content of these e-mails has addressed professional as well as personal concerns. Specifically, exchange of course

materials such as syllabi and problem sets have been discussed; personal updates, photos, reflections and other information have been shared.

## IV. CONCLUSIONS

The goals of this deliberately constructed interventional program were to enhance communication and leadership skills and enable networking, peer-mentoring and role modeling for women faculty members in engineering. The tools and techniques of adventure education, as facilitated by Outward Bound, appear to have quickly and successfully achieved these goals. Based on a qualitative evaluation of post-workshop reflection essays, participants experienced short-term positive effects in the following areas: writing skills, management skills and re-evaluation of risks (informational benefits); personal confidence, decreased feelings of isolation, and greater community and trust (psychosocial benefits); and commitment to mentoring and community building (instrumental benefits). These positive experiences, as well as post-workshop electronically mediated peer mentoring, may contribute to improved retention and advancement in academe for the participating women faculty members. The long-term impact of this program on personal and professional success and satisfaction will be assessed longitudinally.

The positive, short-term benefits of this program and the relatively small number of women affected motivate the development of similar programs nationwide. The availability of local, highly-skilled adventure educators and facilities should not be an obstacle. We anticipate these results could be useful for designing a peer-mentoring and leadership program for any group of individuals with shared goals that could benefit from additional mentoring and networking opportunities in the engineering academy.

## ACKNOWLEDGMENTS

The authors gratefully acknowledge the Engineering Information Foundation for financial support of this intervention program (EIF 00.13). This material is also based upon work supported by the National Science Foundation CAREER Grant Number 9985012 (NCC).

## AUTHORS' BIOGRAPHIES

Naomi C. Chesler is an Assistant Professor of Biomedical Engineering at the University of Wisconsin-Madison. She received her B.S. in Engineering from Swarthmore College and her Ph.D. in Medical Engineering from the Harvard-MIT Division of Health Sciences and Technology. Dr. Chesler's engineering research focuses on the clinically relevant effects of mechanical forces on vascular biology during hypertensive remodeling in the systemic and pulmonary circulations; her educational action-research focuses on the needs of women students and faculty for mentoring and other interventions designed to increase advancement, retention and gender equity in the academy.

*Address:* 2146 Engineering Centers Building, 1550 Engineering Drive, University of Wisconsin, Madison, WI, 53706-1609;

telephone: 608-265-8920; fax: 608 265-9239; e-mail: chesler@engr.wisc.edu.

Peg Boyle Single is Research Associate Professor of Education at the University of Vermont. Her research examines mentoring, e-mentoring, gender equity in engineering and science and the development of effective mentoring programs. She has written articles, presented at national conferences, and given keynote addresses on these topics. Dr. Single received her Ph.D. in Social Psychology from SUNY—Stony Brook.

Address: 88 University Heights Room 107, Department of Education, University of Vermont, Burlington, VT, 05405-1736; telephone: 802-656-8533; e-mail: PegBoyle.Single@uvm.edu.

Borjana Mikic is Associate Professor in the Picker Engineering Program at Smith College. She received her B.S, M.S., and Ph.D. degrees in Mechanical Engineering from Stanford University. In her research, she studies the role of biological and mechanical factors that influence the establishment, maintenance, and restoration of biomechanical function in the skeletal tissues. Dr. Mikic teaches introductory and upper level undergraduate mechanics courses.

Address: Picker Engineering Program, Smith College, Northampton, MA, 01063; telephone: 413-585-7007; e-mail: bmikic@email.smith.edu.

## REFERENCES

- [1] *Women, Minorities and Persons with Disabilities in Science and Engineering*, National Science Foundation: Arlington, VA, 1999.
- [2] *Profiles of Engineering and Engineering Technology Colleges*, American Society of Engineering Education: Washington DC, 2001.
- [3] *MIT Report: A Study on the Status of Women Faculty in Science at MIT*, Massachusetts Institute of Technology: Cambridge, MA, 1999.
- [4] Wenneras, C., and A. Wold, "Nepotism and Sexism in Peer-Review," *Nature*, 1997, 387: pp. 341–343.
- [5] Etzkowitz, H., C. Kemelgor, and B. Uzzi, *Athena Unbound: The Advancement of Women in Science and Technology*, New York, NY: Cambridge University Press, 2000.
- [6] Layne, P., "Women Engineers as Leaders in Academe," *SWE Magazine*, 2002, 48: pp. 17–20.
- [7] Chesler, N., and M. Chesler, "Gender-Informed Mentoring Strategies for Women in Engineering: On Establishing a Caring Community," *Journal of Engineering Education*, 2002, 91(1): pp. 49–56.
- [8] Felder, R., et al., "A Longitudinal Study of Engineering Student Performance and Retention. III. Gender Differences in Student Performance and Attitude," *Journal of Engineering Education*, 1995, 84(April): pp. 151–163.
- [9] Nauta, M., D. Epperson, and J. Kahn, "A Multiple-Groups Analysis of Predictors of Higher Level Career Aspirations among Women in Mathematics, Science and Engineering Majors," *Journal of Counseling Psychology*, 1998, 45: pp. 483–496.
- [10] Hattie, J., et al., "Adventure Education and Outward Bound: Out-of-Class Experiences That Make a Lasting Difference," *Review of Educational Research*, 1997, 67: pp. 43–87.
- [11] Patton, M., *Qualitative Research and Evaluation Methods*, 3rd ed, Thousand Oaks, CA: SAGE Publications, 2002.
- [12] Atkinson, P., and M. Hammersley, *Ethnography and Participant Observation*, in *Handbook of Qualitative Research*, N. Denzin and Y. Lincoln, Editors, SAGE Publications: Thousand Oaks, CA, 1994.
- [13] Emerson, R., *Contemporary Fieldwork*, Boston, MA: Little Brown & Co, 1983.
- [14] Miles, M., and A. Huberman, *Qualitative Data Analysis*, Beverly Hills, CA: SAGE Publications, 1984.
- [15] Strauss, A., *Qualitative Analysis for Social Scientists*, New York, NY: Cambridge University Press, 1987.
- [16] Swanson, J., *Analyzing Data for Categories and Description*, in *From Practice to Grounded Theory*, C. Chenitz and J. Swanson, Editors, Addison-Wesley: Menlo Park, CA, 1986.
- [17] Kram, K.E., "Phases of the Mentor Relationship," *Academy of Management Journal*, 1983, 26: pp. 608–25.
- [18] Boice, R., *Professors as Writers: A Self-Help Guide to Productive Writing*, Stillwater, OK: New Forums Press, 1990.