

The Power of External Mentors for Women Pursuing Academic Careers in Engineering and Science: Stories of MentorNet ACE and its Protégés and Mentors

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Abstract—“Finding my way through the completion of my doctorate and the start of my faculty career was challenging, but it was made more successful and more pleasant by the consistent mentorship I received.”

“My relationship with my mentor ... has helped me with career altering decisions from a female perspective that I did not feel I could discuss with my male advisor and teachers.”

“Why did I volunteer to be a mentor? ... How to be successful as a PhD student and in the faculty job search shouldn't be a secret, but there is so little information on how to be successful, and having a book to read isn't the same as being able to ask questions of someone supportive and neutral willing to help guide you. What do I get from it on a day to day basis? I get to rethink how I do things, and what I would do.”

While mentoring is frequently cited as a highly critical element of success for women in engineering and science, structured mentoring involving external mentors for those pursuing academic careers in these fields is relatively new. This paper considers the benefits of building cross-institutional mentoring networks to advance academic career progress for women in science and engineering.

The MentorNet Academic Career E-mentoring (ACE) program, matching graduate students, postdoctoral scholars, and early career faculty members in engineering and science fields pursuing academic careers with tenured faculty members external to their home institutions for structured e-mentoring relationships, involved 480 pairs of mentors and protégés during its first three years.

Introduction

“MentorNet was right on time! I discovered MentorNet while I was in my second year of my master's degree work, and the online mentoring service was just what I was looking for at a time when I was considering not completing my program. Due to the lack of female engineering faculty members at my institution, I was unable to seek out help through that avenue. The MentorNet matching process was easy and provided me with just the mentor I was searching for.

“I was paired with Dr. Daniels-Race, a faculty member at Louisiana State University. Although she was not in the same engineering discipline, she was able to give me excellent advice and convinced me to finish up my program since I was extremely close to completing the program.

“Throughout the mentoring relationship, we discussed many topics ranging from pursuing a Ph.D., switching schools/programs, academia vs. industry, and work-life balance. These topics were very beneficial and I learned a lot. My mentor was very insightful and it was great hearing about her experiences as a grad student and a young professor starting out.

“I was motivated by our conversation to continue on after receiving my master’s degree to pursue my doctorate at a different institution. While adjusting to a new school, my mentor introduced me to *her* mentor, and I was very fortunate to establish an informal mentoring relationship with this professor also.

“I found my MentorNet relationship to be very beneficial for me. It was a wonderful experience to have – it helped me through my masters program and assisted my motivation. My mentor and I still keep in contact. She is always willing to discuss any issues. I hope that in the future I could serve as a mentor to other young women in engineering seeking advanced degrees.”

The above set of reflections offers the self-reported story by Carnegie Mellon University Ph.D. candidate Arielle Drummond, about her experiences in MentorNet’s Academic Career E-mentoring pilot program. Another report of an experience as a MentorNet academic career protégé comes from Katherine J. Kuchenbecker, Ph.D., previously a graduate student at Stanford University and now Assistant Professor of Mechanical Engineering and Applied Mechanics at the University of Pennsylvania:

“When I consider my academic career over the last two years, I can trace much of my success back to a single recommendation that one of my best friends offered to me in a moment of difficulty: ‘Sign up for a MentorNet mentor.’ I was a Ph.D. student slowly nearing the end of my degree, hoping to become a faculty member, but I didn’t know how to steer my way through that morass. I was so surprised to find that a fleet of tenured faculty members across disciplines had signed up to e-mentor students like me, that one of them would be willing to correspond regularly with me about anything and everything related to finishing my thesis, applying for faculty positions, and shaping my future to meet my dreams. January 31, 2005 was a good day. It’s the day I joined the MentorNet community and looked for a faculty mentor match. It’s the day the system matched me with Dr. Elisa H. Barney Smith, Associate Professor and Associate Chair of Electrical and Computer Engineering at Boise State University. Over the last two years, she has sent me over fifty emails, each one offering insights, experience, and most importantly support. Finding my way through the completion of my doctorate and the start of my faculty career was challenging, but it was made more successful and more pleasant by the consistent mentorship I received. I am indebted to both Elisa and MentorNet for this aid, and I hope this resource can continue to be available to others like me. The recommendation to ‘sign up for a MentorNet mentor’ is my most common refrain when a friend of mine comes to me at a difficult or uncertain point in his or her academic career.”

What motivates busy faculty members to consider taking on yet another protégé, and particularly one outside their own department and institution? Dr. Kuchenbecker's MentorNet mentor, Elisa H. Barney Smith, Ph.D., Associate Professor and Associate Chair of the Department of Electrical and Computer Engineering at Boise State University, reflects:

"You would think that a PhD candidate from a university like Stanford should know it all and have a career all lined up. What could a professor at a primarily undergraduate metropolitan university be able to offer her, especially when she is a Mechanical Engineer and I am an Electrical Engineer? And with all the demands that are placed on faculty, why add on another commitment that won't get you credit towards career advancement and promotion when you could put the extra time into research?

"So why did I volunteer to be a mentor? I can remember going through my PhD. I had a few stressful times when results weren't coming, but thankfully they weren't as bad as those my friends described. Three of us 'girls' would meet for lunch most every day and talk about everything, often with a larger mixed-gender group of friends. If we didn't have each other to do group therapy, we wouldn't have gotten through. Then came the job search. I had very little information on what to do. Much of what I did do was based on lucky guesswork. I did put together a successful application package and came away with 6 interviews and 3 offers, but if I had had some of the information that I now know as a professor, there are many things that I would have done differently both for my PhD in general and for the job search. How to be successful as a PhD student and in the faculty job search shouldn't be a secret, but there is so little information on how to be successful, and having a book to read isn't the same as being able to ask questions of someone supportive and neutral willing to help guide you.

"What do I get from serving as a MentorNet mentor on a day-to-day basis? I get to rethink how I do things, and what I would do. I'm not searching for a new job right now, but the chances that I will eventually are there, so while giving Katherine and others advice on the job search, I have time to reflect and rethink what I would put in my application package. When we discuss research and making research plans, I again get to reflect and think about my research and making distinct steps rather than just continuing day-to-day on the momentum that has been building. MentorNet is great with its biweekly discussion topics. Not all are topics that we choose to discuss, but all apply equally well to faculty and to grad students. In many ways it is similar to how you learn a subject better when you go back to teach it after having been through it once. As a mentor, I have the motivation and the structure to go back and reflect on many things that are valuable to my career as well. And when you get lucky and get a mentoring relationship like I had with Katherine, seeing her be so successful and confident with her career path more than makes it worth the little time that the mentoring process requires.

"As I look through candidates applying for jobs in our department, and have phone interviews with them, we have several who may be great people and good technically, but several of them sabotage themselves by doing little things they shouldn't. I feel so badly for them and wish that we could tell them what they specifically did wrong that got them removed from our candidates list, but doing that would have all sorts of repercussions with our HR department. Through serving as a MentorNet mentor, I can tell a few promising PhD candidates ahead of time not to make these mistakes."

The **underrepresentation** of women in science and engineering, both in industry and in higher education, has negative implications for the future technical work force, for equal opportunity, for individuals, and for the disciplines and professions themselves. In academic science and engineering, women comprise less than 20% of faculty positions in 4-year colleges and only approximately 22% of full-time senior faculty appointments in life sciences (National Science Foundation 2000), despite that field being the scientific and engineering field graduating the highest percentage of women at all levels for many years (excluding psychology and the social sciences) (National Science Foundation 2002). In a number of other fields, the percentages of women faculty are much lower, leading to scenarios in which women studying engineering frequently never are taught by even one female professor. Though women enter the study of science and engineering just as or better prepared than their male counterparts, they are more likely to switch to other areas of study (Strenta, Elliott et al. 1994; Seymour 1997). On average, women who switch out of these fields have higher achievement than the men who remain.

Among the demonstrated educational **obstacles** to women's persistence in these fields are an academic climate where engineers and scientists are typically seen as male, where few women students have relationships with or even know women engineers and scientists (Char 1997; Leslie 1998; Yauch 1999), and classroom environments that are competitive and unwelcoming to women (Crawford 1990; Tobias 1990). As women enter graduate school and faculty positions, they face difficulties such as subtle and outright systematic discrimination (Massachusetts Institute of Technology 1999), competing family and career demands (particularly as women approach tenure), and feelings of isolation as they encounter fewer and fewer women colleagues (Ambrose 2001; Thom 2001). The situation leads to too few role models for would-be women faculty in engineering and the sciences, thus perpetuating the problem for future generations.

Mentoring is a frequently employed strategy for the retention and advancement of women in engineering and science. Whether or not such individuals are labeled "mentors," nearly everyone has one or more mentors in the form of more experienced guides and advisors as they grow and develop as individuals and professionals (Amon and McMichael 1995). Among other benefits, mentoring helps make explicit the tacit knowledge of a discipline and its professional culture, and with this knowledge, individuals are more likely to be successful. Both protégés and mentors learn from mentoring relationships (Zachary 2000). Well-deployed mentoring can also be highly effective in supporting systemic change and in creating positive, productive, equitable learning environments (Clutterbuck 2001).

In contrast to the obstacles for academic women in engineering and science, noted above, mentoring, deliberate encouragement, and affiliation with a community have been shown to enhance women's retention, self-efficacy, confidence, and likelihood of remaining in these fields (Cunningham, Pavone et al. 1996; Goodman, Cunningham et al. 2002). For women of color, mentoring has been suggested to be the only significant predictor of success (Faison 1995). Mentoring can also serve to counter the idea that science and engineering are not friendly to women and people of color, and is key to recruiting and retaining women and minorities in science, technology, engineering and mathematics fields (Shah 2001). A well-accepted strategy to improve retention of women students in science and engineering in higher education,

mentoring helps expose students to the opportunities in their fields, offers guidance and advice based on experience, and provides support, encouragement, and access to professional networks for further career development (AWIS 1993). Mentoring offers one-on-one attention and assistance in “de-coding” less obvious cultural and structural elements of a field, and allows students access to an impartial advisor who can provide personalized support and information (Thom 2001).

Mentoring has also been shown to be an effective tool for faculty and graduate students (Boice 1992; AWIS 1993; Boice 1993; Boyle and Boice 1998; Boyle and Boice 1998a). This recognition has led many institutions to create faculty and graduate student mentoring programs on their campus, including some programs specifically for women faculty. Some professional societies and associations have created mentoring programs to encourage women to pursue academic careers in science and engineering; the Computer Research Association’s Committee on the Status of Women in Computing Research’s (CRA-W) Distributed Mentor Project (<http://www.cra.org/Activities/craw/dmp/>) is one example; this program matches women undergraduates in the computing sciences with female mentors for a summer of research at the mentor’s institution. Furthermore, networks for informal mentoring for women in academic science and engineering such as the Committee for the Advancement of Women Chemists (COACH) (<http://coach.uoregon.edu/>) have also been developed. Women graduate students and faculty in science and engineering may also receive mentoring informally, or not at all. One reason mentoring programs are initiated is because women and people of color are less likely to be included in informal mentoring than are white males, who comprise the majority of senior leaders in higher education, including faculty. In informal mentoring relationships, individuals are very likely to choose someone like themselves, and frequently do not label the relationship “mentoring,” but these relationship nonetheless take on the characteristics of mentoring relationships (Catalyst 2001).

The power of mentoring is sometimes poorly understood, and mentoring is not always effectively practiced (Zachary 2000); in particular, many well-meaning individuals have constructed mentoring programs without adequate knowledge and resources, leading some participants to conclude “mentoring doesn’t work” or “mentoring programs don’t work.” While not every single mentoring relationship within a constructed program may end up being successful or valuable, there is ample evidence that mentoring programs provide considerable benefit to many participants (Murray 1991; Philip and Hendry 2000; Clutterbuck 2001; MentorNet Research Project 2002). At its weakest, mentoring is viewed as a somewhat offhand strategy to address deficits, providing some needed encouragement and advising of weaker and less confident individuals. At its strongest, however, mentoring is understood as a powerful learning process, which assures the intergenerational transfer of knowledge and “know-how” on an ongoing basis throughout one’s life (Zachary 2000; Clutterbuck 2001). When mentoring is understood as a serious and powerful learning process, complete with the need to establish learning objectives, measures, and discipline to achieve results, its potential can be realized (Zachary 2000).

Structured mentoring programs provide matching, training, coaching, and facilitation for mentoring relationships (Murray 1991). Such programs are different from naturally occurring mentoring, where a mentor and protégé form their own relationship, without the benefit or

intervention of a program. Structured mentoring programs, with training of mentors and protégés and facilitation or “coaching” of the relationships increase the likelihood of satisfying mentoring relationships (Brainard 1994; Boyle and Boice 1998; Zachary 2000; Clutterbuck 2001).

E-mentoring (also sometimes called telementoring or cyber-mentoring) is mentoring conducted primarily or exclusively via email. It builds on the Internet as social technology that connects and affiliates people (Winter 1996). Email has the obvious advantages of convenience, efficiency, asynchronicity and facilitating distance communication. But mentoring via email and related electronic communications technologies also enables thoughtful, deliberate communication, provides a useful record of that communication, can use the power of writing as a reflective learning tool and as a strategy for socialization into a professional culture (Ivanic 1997), and limits status differences that might otherwise inhibit communication between protégés and mentors (Sproull 1992). In addition, the restricted channel of communication provided through email communications helps build relationships, especially for those who feel isolated (Smith 1988).

About MentorNet

MentorNet (www.MentorNet.net), the *E-Mentoring Network for Diversity in Engineering and Science*, was founded in 1997; its mission is to further the progress of women and others underrepresented in scientific and technical fields through a dynamic, technology-supported mentoring network and to advance individuals and society by developing a global, diversified, expanded and talented workforce. Since 1998, nearly 19,000 undergraduate and graduate students, postdoctoral scholars and early career faculty in engineering and related sciences fields, at more than 200 colleges and universities across the U.S., and in several other nations, have been matched in structured, one-on-one, email-based mentoring relationships with male¹ and female scientific and technical professionals working in industry and government. MentorNet’s innovative, award-winning² e-mentoring network has provided innovation for mentoring along four dimensions:

1. The testing and evaluation of the use of email as a medium for beneficial mentoring relationships between students in engineering and science and professionals in these fields,
2. The development of a technology-based infrastructure to support the necessary programmatic mentoring relationships on a very large scale with efficiencies,
3. The development of a multi-institutional partnership to collaborate on the development and implementation of a cross-organizational mentoring network, and
4. The deliberate engagement of mentors *external* mentors for engineering and science students, postdoctoral scholars, and early career faculty, designed to complement the

¹ MentorNet intentionally encourages men as well as women to serve as mentors, for several reasons: 1) there are too few women to meet the need, 2) women are already more frequently called upon to serve mentoring functions to help develop the future generations of scientists and engineers, and even more importantly, 3) through serving as mentors, men can gain improved understanding of the obstacles women encounter and a vested interest in helping to change practices and policies that impede women’s full participation in the professions, thus enhancing systemic change. The preferences of protégés to be matched with a mentor of a particular gender, however, will be accommodated.

² In 2001, MentorNet was awarded the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring.

mentoring provided by internal mentors, such as advisors and supervisors at the protégés' home institutions.

MentorNet's centralized infrastructure is designed to serve a large number of colleges and universities, corporations, professional societies, and government labs and agencies, and their respective students, employees, and members, all interested in advancing diversity in engineering and related sciences through mentoring. These organizations provide financial support for MentorNet operations, and help to recruit prospective participants. MentorNet uses research and evaluation in its design, continual quality improvement, and to assess preliminary outcomes. Prior to 2003, MentorNet concentrated its efforts on mentoring between students and professionals working in industry and government as a complement to academic mentoring. In 2003, through an ADVANCE Leadership grant from the National Science Foundation, we modified and extended MentorNet's capacity in order to advance women³ in academic careers in engineering and related sciences, including planning and implementing a pilot program to link graduate students and pre-tenure faculty with tenured faculty in one-on-one e-mentoring relationships.

MentorNet's One-on-One program pairs protégés and mentors for structured mentoring relationships conducted via email and designed to last eight months at a time. Designated MentorNet liaisons within colleges and universities, corporations, government sites and professional societies inform professionals and students of the opportunity to participate in this MentorNet program, directing them to the MentorNet web site (www.MentorNet.net). Prospective participants may obtain full information, complete online profiles, and access training materials including tutorials from MentorNet's web site. MentorNet has developed and refined software programs and related systems to enable bi-directional matching of protégés and mentors based on backgrounds, interests, and expressed preferences entered into a database via the online profiles. Program staff members provide direction and coaching to develop and sustain these e-mentoring relationships, using MentorNet's customized training and coaching curricula. These curricula have been developed based on research related to mentoring, student and early academic career experiences in engineering and science, and electronic communications. All participants are asked to complete online surveys at the end of the year to inform evaluation. To complement and enhance the One-on-One e-mentoring program, MentorNet also offers a community experience to its participants including such features as a monthly electronic newsletter and a series of online topic-based discussion groups focused on life/work balance, gender issues, diversity issues, job search, and similar themes. MentorNet's online community members may participate in these functions alone and/or in the One-on-One Mentoring Program.

The Development of MentorNet's Academic Career E-mentoring (ACE) Program

MentorNet's goal for the ACE pilot program was to lay the groundwork and build the infrastructure for what could grow to be an extensive academic e-mentoring network increasing the likelihood that participating protégés will successfully pursue academic careers. Our

³ Although the ACE program was focused on the needs of women considering/entering careers in higher education, the program did not exclude men from participating. Furthermore, in 2005, MentorNet, originally "The E-Mentoring Network for Women in Engineering and Science" broadened its mission to serve women and others underrepresented in engineering and the related sciences.

objectives were to build a set of systems to link tenured faculty with graduate students, postdoctoral fellows, and untenured tenure track faculty in productive online, ongoing discussions to enable valuable professional development through mentoring. While effective mentoring is adapted to the individual needs of the protégé, mentoring generally involves exchange of valuable information, encouragement, advice, role modeling, and networking. We anticipated the mentoring needs of academic women in engineering and science, at different stages of their career preparation and progress, building on the research and empirical literature, and with the wise counsel of an advisory committee.⁴ Specialized mentoring training and coaching curricula were developed and implemented for graduate students and early career faculty pursuing academic careers, and their mentors.

Electronic-mediated mentoring programs for those interested in, and pursuing, academic careers are still in a stage of infancy, with respect to understanding whether such a format works in support of effective mentoring, what constitute best practices and what are limitations of such endeavors, and issues of both scalability and sustainability for these programs. In addition, the development of MentorNet ACE enabled us to examine the impact of mentors from outside an individual's academic institution on career decision-making for women interested in, and pursuing, faculty careers in engineering and science.

The development of MentorNet ACE was informed by and accelerated as a result of an existing collaboration between MentorNet and WEPAN's Faculty for the Future project (www.facultyforthefuture.org). During the first year of the ACE pilot program, we focused on matching graduate students and postdoctoral scholars with tenured faculty mentors. In the fall of 2004, as planned, the program expanded to provide the unique service of e-mentoring for untenured, tenure-track faculty. During the course of the pilot program, MentorNet's existing discussion suggestions (biweekly emails sent to protégés and mentors) for graduate students interested in industry careers were modified to be appropriate for those graduate students and postdoctoral scholars interested in academic careers. Related mentor and protégé coaching curricula were developed for the mentoring dyads in which the protégé was a tenure-track faculty member.

We also developed additional online discussion groups geared towards those interested in or pursuing academic careers, and added web site resources providing information with relevance to those interested in or pursuing academic careers.

In planning the ACE pilot program, we established a target goal to match 100 protégé-mentor pairs in the first two years of the program. During those two years, 232 e-mentoring relationships were established, more than twice the goal. 51 graduate students or postdoctoral scholars were matched with tenured faculty in the first year, and 181 protégés and mentors in the second year of the program. By the end of the third year (August 2006), 480 pairs of mentors and protégés had been matched in this program.

⁴ We are grateful to the members of the MentorNet Academic Career E-mentoring Advisory Committee: Susan Ambrose (Carnegie Mellon University), Denice D. Denton (University of Washington, University of California, Santa Cruz), Patricia P. Jones (Stanford University), Anne MacLachlan (University of California, Berkeley), Carolyn W. Meyers (North Carolina Agricultural and Technical State University), and Richard M. Reis (Stanford University) for their generous and sage wisdom in advising those developing the ACE program.

Although any student who visited MentorNet's web site could find the option to participate in the MentorNet ACE program, we did not do any concentrated outreach to prospective protégés for the ACE program as it became apparent early on that protégé demand for the program was surpassing the rate at which mentors were signing up. We did inform representatives at participating colleges and universities about the development of the ACE program, and encouraged them especially to publicize this program to any tenured faculty who might be willing to volunteer to serve as mentors. Due to an abundance of would-be protégés, and despite the program's growth, insufficient tenured faculty mentors to meet the demand, MentorNet's current practice remains to continue to publicize the program among MentorNet's campus partners, but to focus the outreach efforts for the initiative on mentor recruiting.

Considerable effort was placed on recruiting mentors, which had always been anticipated to be a challenge. After a year of experience with the ACE program, including some formative evaluation and on the basis of advice from the Advisory Committee, revisions were made to the existing mentor recruiting materials in January 2004 to provide documented evidence of and highlight the relatively small amount of time necessary to participate (knowing that tenured faculty have great demands on their time) and the fact that there was great student demand for the program.

As the MentorNet ACE project continues now as an integrated aspect of MentorNet's One-on-One Program, mentor recruiting remains a main focus of the project. Data collected from faculty mentors participating in the program to date verifies that an approach based on personal contact (i.e. in person or by phone or email) from trusted colleagues is most effective, and that it requires time for word-of-mouth to spread about the program.

As MentorNet moves forward with the MentorNet Academic Career E-mentoring program, the program has been integrated into MentorNet's One-on-One program. In 2006-07, MentorNet updated its web site and internal systems to effect this change. One of the significant improvements has been to eliminate the need to choose between "Industry" and "Academic" programs at the beginning of the registration process. Instead, protégés may simply choose their mentor by their work sector and/or job level.

To complement existing training materials, two new sets of protégé and mentor training tutorials were developed for those participants in the 'Academic' track. One set is designed for mentors and protégés when the protégé is a graduate student or postdoctoral scholar. The other set is for pairs in which the protégé is an early career faculty member. Both sets consist of 4 (each) case study style tutorials designed to help the participant explore different scenarios they may encounter within the mentoring process. Each case study takes the reader through a scenario, similar to what s/he may encounter in the mentoring relationship and poses a question at the end for how to would handle the particular situation with the protégé/mentor. The participant is given two choices and guided through a description of the implications of each choice.

For faculty mentors, the four themes of the tutorials are:

- 1) When to choose self-disclosure versus general advice to guide a protégé.
- 2) When a protégé asks about your workplace experiences regarding potentially controversial topics, when to respond about official policy versus personal observations about practice.

- 3) When a protégé comes with a problem, whether to work through problem with the protégé and let that individual decide on the best option, or work through the problem with the protégé, with the mentor offering an opinion about what course of action to pursue.
- 4) How to handle situations when your protégé asks for advice on a topic you have little experience with and little time to investigate.

For protégés on the academic career path, the themes are:

- 1) How to decide when to follow your mentor's advice or take a different route.
- 2) How to handle self-disclosure about personal situations, or keeping the relationship strictly about school or work.
- 3) What to do when you feel too busy to write to your mentor but time is growing between communications.
- 4) When and of whom to ask advice about difficult topics such as how an academic career can fit with having a family.

Mentors and protégés are welcome to review the training tutorials at any time, and as often as they choose. Participants are not required to go through the tutorials.

MentorNet ACE Results and Findings

Evaluation of the MentorNet Academic Career E-mentoring Program involved analysis and reporting on data collected through the profiles of participants and through surveys of mentors and protégés at the conclusion of their eight-month-long relationships, as well as a series of interviews with mentors and protégés. A follow-up survey for all participants in the first year of the program assessed career progress and long-term effects of the mentoring experience.

During the period the pilot program was evaluated (August 1, 2003 to February 2, 2005), there were 420 prospective protégés, the vast majority (94%) of whom were female. Most would-be protégés were graduate students (66% doctoral students and 18% masters students), while 12% were postdoctoral scholars. During the second year of the pilot program, pre-tenure tenure-track faculty members were able to participate as protégés for the first time; they comprised 4% of the total applicant pool (or 15% of the second year's applicant pool). Most applicants were either White (46%) or Asian/Asian-American (33%), while 6% were African/African-American, 5% were Hispanic/Latina(o), and 2% were multiracial. 53% identified themselves as citizens of the United States, while 46% indicated citizenship of another country.

Protégés from diverse engineering, technology, and scientific disciplines made up the applicant pool. The largest numbers were working in several engineering fields, the biological sciences or a biology-related field, computer science, physics, and chemistry.

Protégés came from more than 50 different academic institutions. The most frequently mentioned were:

Massachusetts Institute of Technology (n=36)
Cambridge University, England (n=33)
University of Wisconsin (n=24)
University of California, San Francisco (n=20)
Johns Hopkins University (n=16)

Michigan State University (n=14).

The online profile includes a section that asks protégés to rate the relative importance of ten issues they may face on the path toward a faculty position. The importance of each issue provides an overview of what protégés are most concerned about, and what could be helpful in focusing each individual mentoring relationship. The issues of greatest importance to protégés were: academic and career development issues, general support, and faculty job knowledge.

MentorNet also asked what protégés sought by applying for a MentorNet mentor. MentorNet asked “What do you hope to gain via MentorNet’s ACE e-mentoring program that you do not expect to learn in other ways?” and provided space for an open-ended response. There were 48 respondents who took time to write a response to that question, and they articulated the topics they hoped their e-mentor would discuss with them. The topics are listed below with illustrative quotes.

MentorNet ACE benefits desired by protégés were found to be of the following eight kinds:

1. Ideas for successfully navigating the path from graduate student to faculty member.
“I’m hoping to gain skills that will help me secure a post doc that will help me land a faculty position. I’m hoping to learn what things to look for and ask about in a post doc in order to put me on the path to a faculty position.”
2. Female faculty members to serve as a role model [sometimes because there were no women faculty in students’ graduate school programs].
“I guess what I am looking for is someone female to look up to, someone who’s been there and shown that it can be done.”
3. Objective and honest answers to questions
Student is seeking “a more balanced perspective of academic life. Going through a Ph.D. program only gives you the perspective from a graduate student’s point of view. Oftentimes it is difficult to transcend that ‘position’ and get a rational and realistic perspective from current ‘teachers and mentors’ because they don’t see you as ‘equal’.”
“I am hoping to get a perspective ‘from the outside’ on my progress and strategy.”
4. Perspectives students believe they cannot get elsewhere,
“Additional insights from a female perspective that is non-biased to the institution that I am currently at.”
5. Support, encouragement, and advice that is ongoing rather than one or two conversations a term.
A student cited the desire for “a chance to have an ongoing relationship with a female professor rather than just a one-time session and the chance to ask questions in a low pressure comfortable setting.”
6. Understanding of issues in entering academia, including the culture.

“Insight into what a career in academia demands, less in terms of intellectual abilities than in terms of the culture of academic departments.”

“Guidance through the politics and system would be most welcome....”

7. Insights for personal life, including how to balance academia and having a spouse and/or family.

“Up until now, the advice has been to sacrifice my life, mind and soul to it [becoming a professor]. I wish to know if there is anybody out there with a less extreme experience.”

8. Source of contacts and networking for finding their first faculty position.

“I would like to gain perspective from someone who’s at a different type of institution which may be more like my eventual workplace. I am currently at a research-intensive university but I would prefer to teach at a smaller college which emphasizes quality in teaching as well as research.”

“I hope to gain valuable contacts outside my department....”

During the same two-year period, there were 167 mentor volunteers. Of those mentors, 60% were female and most (71%) were White. Asian/Asian-Americans represented 14% of the mentors, while 4% were African/African-American and Hispanic/Latina(o) and 2% identified themselves as Multiracial. The vast majority of mentors (90%) were citizens of the United States.

Tenured faculty e-mentors were also asked to rate the same ten issues, but the question posed to them was how comfortable they felt discussing the issue with their protégé. Mentors reported that they were most comfortable providing general support and advice about academic career development and faculty jobs. Many mentors were also comfortable discussing research issues, self-confidence, and balancing work and family. Most were not comfortable discussing issues related to race/ethnicity or sexual orientation.

Protégés who completed “End of Relationship” (EOR) surveys came from 42 colleges and universities across the United States and one university in England which had the largest number of EOR survey respondents (n=10). The academic institutions in the United States with the greatest number of students completing surveys were: MIT (n=7); Pennsylvania State University (n=6); and the University of California, San Francisco (n=7.)

The two fields of study most represented in the EOR sample are computer science (17 protégés) and biology-related disciplines (18 protégés), such as microbiology, neuroscience, and biomedical engineering. There are twelve protégés preparing for academic careers in Physics, seven in mechanical engineering, six in electrical engineering, six in chemical engineering, and six in agricultural science. Other disciplines include mathematics, geology, astronomy, and environmental engineering.

Protégés most frequently cited career/family balance, time management, and teaching as topics for which their mentors provided the most helpful advice. Among those protégés interested in learning more about grant-writing, one-third indicated they did not learn about this topic from their mentor.

For most protégés and mentors, their MentorNet mentoring relationship was not a time-consuming activity. Protégés and mentors were asked how much time they spent per week reading and writing emails to their MentorNet mentor. Almost two-thirds (64%) of protégés responded that they spent less than 15 minutes per week. The majority of mentors (56%) spent 15 minutes per week or less communicating with their protégés. The majority of mentors who responded wrote to their protégés either once/month (31%) or twice/month (31%), although 26% wrote less frequently and 12% more frequently. Based on the interview data, it was important to protégés that they and their mentors communicated from the outset about the expectations for frequency of writing. If the protégé's expectations were not met, then the mentoring relationship was seen as less effective.

By the conclusion of the MentorNet relationship, almost half the protégés (45%) feel very certain they will pursue a faculty position. This includes the five early career faculty members who answered this question, and a fairly even distribution among the doctoral and postdoctoral scholar respondents as well as the five masters' degree students. 40% of ACE protégés were somewhat uncertain whether they will seek a faculty position, and 14% were very uncertain. Tenured faculty mentors were less optimistic that protégés were going to pursue faculty careers. About half the protégés were completely or very confident in their ability to succeed as faculty members, and most of the others were moderately confident.

Protégés' satisfaction with their mentoring experience is demonstrated by their strong desire for their university to keep the MentorNet program available for students:

- 87% said they want their university to continue to make MentorNet available to graduate students.
- 78% indicated they believed that by offering MentorNet, their university shows it cares about supporting and encouraging women in their field.
- 65% have recommended MentorNet to other potential protégés.

Protégés felt the mentoring experience was useful and their mentor was effective. Close to 75% reported they had effective mentoring experiences:

- 77% of protégés found the e-mails with their mentor were greatly useful.
- 74% were satisfied with their mentor.
- 71% agreed their mentor has been effective.
- 73% agreed their MentorNet experience was well worth their time.
- 68% agreed MentorNet filled a gap in their support system.
- 65% agreed their mentor was a good match for them.
- 64% found their mentors provided support and encouragement on an ongoing basis.

Two in three protégés (n=61) indicated their expectations for their e-mentoring experience were met or exceeded, 22% (21) did not feel their expectations were met, and 12% (n=11) did not have an opinion. The positive responses came from protégés who felt their mentor was a good match for them, someone who was able and willing to answer questions, and they appreciated the convenience of e-mail and the discussion suggestions. The following comments are illustrative:

“Good match. I wanted a mentor from a smaller school, focused on education not research. Email contact is easy to keep up with, unlike phone calls or meetings, you can write any time. Good discussion topics – I would not have thought of all the issues that MentorNet suggested.”

“The mentor made an incredible difference in my professional career by emphasizing the importance of going to meetings to discuss my research with other specialists. I was not getting this support in my current academic/government environment. The mentor was also interested in my career long term.....He was objective in his mentoring advice, whereas my current academic/government research environment had a conflict of interest.”

“This is the FIRST time I’ve been able to ‘talk’ with another woman about balancing family and an academic career. It means so much to finally have some info from someone who’s actually doing the sort of things (with career and family) that I would to do someday. I’ve had many good male mentors, but somehow, no matter how great they are, there is something they just can’t give me.”

Protégés whose expectations were not met typically reported this result for one of three reasons: 1) the mentor did not make time to keep up a meaningful mentoring relationship; 2) the protégé and the mentor both became too busy and lost touch; or 3) the mentor and protégé match did not work, due to areas of specialty, lack of “chemistry,” or mentor inability to discuss topics of most concern to protégé. The following comments are illustrative of these protégés’ concerns:

“My mentor didn't respond to some of my emails and seems generally busy so has not really been in touch and I stopped sending emails to him. The low scores on this survey represent the fact that we've not been in touch much now.”

“My mentor was not from my field (minor problem); our communication did not occur on a regular basis (major problem) – this was the fault of both parties involved. It was perhaps unfortunate that I was seeking knowledge to further my career rather than advice on my current stage of study. Perhaps MentorNet is more useful to those who have little or less idea of how science in academia/industry operates.”

“We communicated a couple of times right after we were first matched (June). The professor took the time to write two long and interesting e-mails. He made several helpful comments and showed he was truly interested in the success of women and minorities. Unfortunately, after two e-mails he was traveling for a month and I was busy studying for qualifying exams, so neither of us continued to e-mail.”

Interview and qualitative data reveal that protégés chose MentorNet because they value frank opinions and advice from a tenured faculty mentor who is not in their academic department or institution. Protégés can ask any question, without fear of asking “stupid” questions or somehow negatively affecting their educational experience.

- 81% reported their mentor gave them objective and honest answers to their questions
- 65% said their mentor tells them what it is really like to be a faculty member, both the positive and negative aspects.
- 61 % indicated their mentor makes them feel: “Yes, I can do this.”

- 51% learned more about career/family balance.
- 48% discussed the challenges and rewards of being a woman in their field in academia.

MentorNet's program features were found to be helpful. Nearly three in four protégés found the emails with their mentor and the matching process useful to a great extent. Half the respondents also found the discussion suggestions that MentorNet provides to protégés (to help protégés ask questions or explore issues in their emails with their mentor) were very useful. Other features, such as the resume database and E-Forum, were used by many fewer respondents and were not found to be as useful as the other program features.

Protégés learned from their mentors that other people struggle in graduate school but still have successful faculty careers. Some research shows women experience the “imposter syndrome,” thinking they are not as smart as their peers or are not strong enough to overcome the challenges along the path to an academic career in engineering or science. Having the assurance that one can get less than stellar grades in a course or find graduate studies difficult, and still move on to a tenured position is very helpful in encouraging persistence.

The MentorNet ACE mentoring experience also helped protégés become more motivated to become faculty members, and to be more confident that they can succeed in doing so. Other ways mentors were reported to be helpful were in helping protégés clarify their goals, understand the value of having multiple mentors to suit different purposes, and learn strategies to pursue a tenured position without sacrificing family/personal relationships.

Based on data from the 95 responses to the EOR questions about protégé plans for the next year, the vast majority will be continuing on their path toward an academic career. Most will be continuing their education, including some who will be completing their dissertation and six who will be looking for postdoctoral positions. Fourteen respondents will be applying for faculty positions, and four of these individuals will also be applying for positions in industry. None of the protégés said they were leaving a scientific, technology, or engineering field.

When protégés were asked how they would characterize the success of their mentoring relationship, 26 (28%) reported it was highly successful, 30 (32%) indicated it was successful, 27 (29%) thought it somewhat successful, and 11 (12%) felt it was unsuccessful.

In the summer of 2006, MentorNet conducted a follow-up survey with the protégés who had participated in the first year of the program. The purpose was to explore, one year later, whether they were still on their path toward academic positions, as well as to determine what the mentoring experience meant to them and how to improve it. Of 45 participants queried, response rates were as follows:

- 17 surveys were completed
- 9 were returned with the “user unknown.”
- 3 declined participation
- 16 did not respond to the survey

For the 17 protégés who responded to the survey, the vast majority had continued on their path toward an academic career. Most were in exactly the same field or a specialty area within their

field of study. Only three of the protégés continued to maintain contact with their mentor one year later. When asked to reflect on what they learned or discovered through their MentorNet experience that continues to affect them one year later, responses were varied.

“My mentor has changed the way I approach problems. I look into a lot more options now and cope with challenges better. My mentor also changed the way I attend conferences. As a result, I have made more contacts and exchanged more ideas that I ever would have.”

“Although my MentorNet experience was brief, my mentor encouraged me to join professional organizations. He told me that joining professional organizations was one of the most important things to do as a professional.”

“My mentor shared with me a few stories about her own Ph.D. experience as well as (anonymously) those of some students in her current group/department. These tales helped me to keep the faith through difficult times.”

“My mentor was very good about sharing his experiences in academic pursuits, as well as material that could help me in recruitment.”

“My life has changed a lot. The mentoring indeed helped me building my confidence.”

“I gained some perspective on what it is like to be a faculty member at a smaller institution.”

“My mentor was particularly helpful regarding having a family and career. She adopted a child later in her career, which is an option that I had not previously considered, but now would consider.”

“Mostly the feeling that someone was kind enough to take an interest in someone else’s (my) progress and career, particularly without knowing me. It’s nice, for lack of a better word, to know that this support and goodwill is out there ...maybe more than we know.”

“I have learned that the problems I foresee for myself in physics are pretty common to women in physics (and many sciences). There is very little flexibility for women to do more than work. It is hard for me to even picture being a successful scientist and also having a family. I don’t think the number of women in science is going to improve until the field recognizes that following a different track isn’t necessarily a wrong track.”

“My mentor gave me beneficial advice that ultimately convinced me to stay in school and earn a Ph.D. She has also put me in touch with local faculty members that mentor me as well.”

Surveys showed 77% of mentors agreeing (46% strongly agreeing) that the email messages exchanged with their protégés were useful. The matching process was also viewed favorably with 73% agreeing (33% strongly agreeing) that the system was useful. For both features, about 10% did not find either very useful. The discussion suggestions were useful to a smaller percentage of mentors, i.e. 47%, including 19% who found them very useful. Almost one-third (30%) chose a neutral rating. Based on the two interview studies, it appears the reasons for these

ratings on the discussion suggestions are likely: (1) mentors did not have time to read them; and (2) most protégés talked with and/or forwarded discussion suggestions that were of interest to them.

This evaluation found that the greater the amount of time mentors spend communicating online with their protégés, the more frequently they write to protégés and participate in other MentorNet activities (such as reading discussion suggestions), the more they believe they have helped their protégés and characterize the mentoring relationship as successful. While not surprising, there were significant correlations between time/frequency of correspondence with protégés and outcome measures of the relationships, especially mentors' belief they provided support and encouragement to their protégés. There was also a significant correlation ($r = .36$) between time spent on email with the protégé, and the mentors' own expectations for the MentorNet experience being met.

Mentors were satisfied with their experience in MentorNet:

- 86% agreed that MentorNet is filling an unmet need for women in engineering and science-related fields seeking an academic career.
- 92% said they signed up for MentorNet because they wanted to support women in engineering and science.
- 82% thought that more graduate students would participate if they knew more about MentorNet benefits.
- 67% want their college/university to make MentorNet available to graduate students next year.
- 60% reported they have recommended MentorNet to other graduate students.
- 77% agreed the MentorNet experience was well worth their time.
- 54% indicated that one reason they signed up for e-mentoring was that it is a convenient way to volunteer.
- 78% joined MentorNet because they wanted to give something back
- 63% agreed that the mentoring program filled a gap in their protégé's support system.
- 59% agreed MentorNet gave them great advice on how to get the most from this mentoring experience.
- 53% agreed that expectations they had when they began e-mentoring were met or exceeded.
- 48% agreed that their protégé has a better understanding of the importance of having multiple mentors.

In looking at data characterizing mentor expectations, 25% of mentors had unmet expectations and 22% chose a neutral position. Interestingly, for mentors who were disappointed in their experience, the issues were similar to those raised by protégés: 1) protégés did not respond to their e-mails; 2) the mentor felt the match was not a good one; and 3) the e-mails from MentorNet (including discussion suggestions) seemed too numerous and became overwhelming for some.

Tenured faculty who served as mentors during the first two years of the MentorNet ACE program felt other faculty could be recruited if they knew about the program and realized the significant benefits for minimal time involvement:

- 69% agreed that more faculty members would volunteer to be mentors if they knew how MentorNet can benefit graduate students, postdoctoral scholars and early career faculty.
- 53% have asked other faculty members, whether at their academic institution or another, to become a MentorNet mentor.
- 56% of mentors heard about MentorNet from a trusted colleague or organization.
- 26% signed up for MentorNet, in part, to improve their own mentoring skills.

Mentors were not motivated to volunteer as a way to identify potential faculty for their department or institution, nor did they see their involvement MentorNet as a way to expand their own network.

Conclusion

The MentorNet Academic Career E-mentoring program was developed in response to interest expressed from both faculty and students familiar with MentorNet's online mentoring program which enabled matches between student-protégés and mentors who were professionals working in industry or government. The initial thinking was that those graduate students interested in academic careers would readily find faculty mentors on their home campuses. Students, however, told us otherwise. They perceived even before MentorNet was fully aware of it, the powerful benefits of having mentors *external* to one's home institution, to complement *internal* mentoring provided by advisors, supervisors, and others. Would-be graduate student protégés recognized potential dangers of confiding fears and doubts to those who will be judging their interest, drive, and capabilities for moving on to the next step in their academic career progression. They sought to have an outside, "objective" mentor whom they felt would be non-judgmental and instead supportive of the protégés exploring and making their own decisions. Mentoring experts have in recent years suggested that everyone benefits from multiple mentors, or a mentoring network, rather than just one mentor. In science, where the notion of a mentor-advisor guiding a less experienced individual through years of development as a scientist, is strong, this idea may initially meet with resistance conceptually. Yet, in considering the natural collegial, cross-institutional, and discipline- or professional society-based networks which are regularly part of science and engineering faculty members' daily lives and work, particularly in the age of electronic communications, it is only natural that cross-institutional mentoring could be developed and be beneficial much earlier in the development of a faculty member.

MentorNet's ACE program provides "proof of concept" of both the demand for, and the substantive potential value of external mentoring relationships in developing young faculty. That mentoring can serve a critical and vital role in connecting women in particular, with additional valuable mentors.

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We appreciate the contributions of MentorNet's former Director of Programs, Dr. Jennifer L. Dockter, who helped to develop the conceptual framework for MentorNet ACE and implemented the pilot program in its first year, and those of Dr. Sylvia J. Barsion of SJB Consulting, who directed the program evaluation.

This material is based upon work supported by the National Science Foundation under Grants No. SBE-0318510 and SBE-0549084. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.