

DIVERSITY IN ENGINEERING -- A DEAN'S PERSPECTIVE

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The three questions supplied by the panel moderator are addressed here. As background, let me first describe Thayer School of Engineering at Dartmouth College. I firmly believe that our program is the ideal model for an engineering school that will be attractive to women and minorities. How do we do that?

First, we provide engineering education within a liberal arts and sciences framework. I believe that people who are breaking down barriers to participation need to constantly remind themselves of the larger context (personal and societal) in which they find themselves. This is the role of liberal education. Without proper liberal education, engineers do not have a framework around which to understand the world in which they ply their trade. Additionally, students who have not thought about engineering, or who are uncertain about it, can be recruited into the profession from the arts and sciences part of the campus. The barriers to students entering engineering education after the first year are removed at Dartmouth.

Second, we have an interdisciplinary curriculum. It is well-known that, in general, women are attracted to certain engineering disciplines more than others (environmental, biomedical, industrial more than electrical and mechanical). Engineering in the future, however, will demand more and more interdisciplinary approaches. I firmly believe that an interdisciplinary curriculum makes the best engineers and is more attractive to women and minorities than traditional, highly structured, disciplinary engineering.

Third, we have an intimate program, with personal attention paid to each student. The total school has approximately 500 students, with typically 80 in each undergraduate class. The required core courses are taught twice a year, so that class size is usually 40 or under. We make extensive use of technical support staff to provide hands-on education in laboratories, teaching (often one-on-one) the "real world" engineering skills that are missing more often in women and minorities than in the average engineering student. These staff are hired for their ability to inspire confidence in young people. (As opposed to using first-year PhD students who may not even speak English well.) All students, faculty and staff, classrooms and laboratories are in a single building; the library and business school are connected through an underground passage. The environment is safe and friendly.

Fourth, we provide a team-oriented, project-based education. Our introductory course is described below; our capstone two-term design project is usually team-based, with an industrial customer, and many of our courses have group design projects. Most of our students have internship experiences in addition. This approach is well-suited for those who are well-qualified, but may be insecure about their personal technical abilities.

These features of our engineering program make it friendly to women and minorities at the graduate level as well. We have research-based MS and PhD programs, as well as a management-based ME program. We have an ABET accredited BE program that is a fifth year provided to students with science-based undergraduate degrees. We encourage applications from qualified women and minorities to graduate school. They will receive the personal attention that will facilitate their success, as well as sufficient financial aid to ensure their completion of a degree. We have 100% success in placing all our American citizen graduate students in good jobs.

Here are the statistics for women and minorities in our program:

25% of our graduating class of ABET accredited engineers in 1996 were women; 7% were of African and Hispanic descent. This is almost double the national average. In graduate school, 20% of our PhD students this year are women.

Dartmouth as a whole admitted slightly more women undergraduates than men in 1995 and slightly more men than women in 1996. In 1990, 25% of the science majors were women. In 1995, after our Women in Science Program (WISP) had been in place for five years, 40% of the science majors were women. As a fraction of the women undergraduates, 23% majored in science in 1995, up from 12% in 1990. This shows that advocacy programs like WISP work.

Also, Dartmouth has the highest proportion of female tenure-track faculty of any Ivy League school (26%). At Thayer School of Engineering, as of this year, women comprise 10 % of the tenured faculty and 40 % of the untenured tenure-track faculty.

Question 1: How is the current climate toward affirmative action going to impact the recruitment and retention of women and minorities in engineering?

What do we mean by "affirmative action"? This word means different things to different people. I like the term "pro-action". That is, action that advocates and encourages underrepresented groups to become equal participants in engineering. This is very different from "lowering the standards" for certain groups. This means pro-actively making sure that any required standards are meaningful and reflective of the needs of society as a whole, not designed by one segment of society for that segment alone. Pro-action means convincing underrepresented groups that engineering is still a very attractive major. Pro-action means convincing the majority population that underrepresented groups have something substantive to contribute.

As dean of engineering at Dartmouth, I can describe the present state of affirmative action at the Ivy League and probably most other private Universities. Today's public discourse about affirmative action does not lessen our efforts on behalf of diversity.

As a highly selective school (in which less than 25% of the applicants are admitted), our admission decisions are based on a desire for a well-balanced class. Thus we seek diversity, not only along gender and racial lines, but also geographic, ethnic, professional interests and personal passions (sport, music, art, literature, etc.). The private schools have more options than the state schools, as their programs are presently constructed (particularly admissions). However, many state schools have not taken advantage of all the options that may, in fact, be available to them. By basing admissions criteria solely on exam scores (which are known to be biased), admissions automatically becomes biased. MIT increased the fraction of women in their entering class merely by changing the weight ratio between SAT scores and high school grades, which worked because the women, on average, had better grades but lower SAT scores. States can do this. Also, if states would include non-quantitative factors such as "evidence of creativity" or "evidence of perseverance" as part of the admissions requirements, then additional weight could be given to part-time jobs, raising children, etc., in weighing who is admitted.

Private schools such as Dartmouth are committed to maintain programs to improve retention of women and minorities in engineering, even in the face of public doubts. We are encouraged to do this by representatives from industry, who continue to actively seek diversity in their employees. Many companies know that expanded markets lie in the global economy, in which there are more people of color as prospective customers than white males. Thus industry believes that engineering must incorporate people of all backgrounds and they are eager to hire people who can interface with diverse groups.

2. What steps need to be taken to increase the participation of underrepresented groups in engineering?

A. Improve Freshman Engineering Courses

Many engineering programs begin with a heavy emphasis on math and physics, without any experience of what engineering is until sophomore year. Opportunities to experience team projects are put off until even later. How can students from underrepresented groups, with no role models as engineers, know what they are getting themselves into if they major in engineering? How can they be motivated to put in the effort required to become engineers, particularly when there may be no voices of encouragement at home?

The solution we have at Dartmouth is to introduce an Introduction to Engineering course in the Freshman year. In this course students are given a general problem area (last fall it was "winter"), assigned to interdisciplinary groups, and required to come up with a possible marketable product that will solve any specific problem in the general problem area that the student group chooses to define. The students are taught how to work in groups, how to brainstorm, how to evaluate trade-off matrices, how to do patent and market searches, how to develop a list of specifications. They are expected to build a prototype, test against specifications, give two oral presentations before a review board, write a proposal and final report. All this is before they have taken a single course in engineering science. Thus students learn that engineering is not all solving formulas. We find that this course has excellent retention value for women and minorities.

B. Increase Technological Literacy Campus-Wide

Many students in underrepresented groups do not think to major in engineering, and they get no exposure to engineering unless they have already decided to major in it. Dartmouth is one of only a handful of schools that require a course in technology or applied science for all students. This enables the engineering school to teach courses for non-majors that introduce them to technology. Such courses provide accessibility into engineering for groups who may not have considered the field. Popular courses at Dartmouth are "Everyday Technology", in which students take apart everyday items of technology and figure out how they work, "The Technology of Sailing" in which students learn about fluid mechanics, materials, construction techniques, and the force laws (students then go for a sail to test what they have learned!). The most popular courses are "Introduction to Environmental Engineering" and "The Technology of Cyberspace", in which students write their own web pages.

C. "Get The Word Out"

It is the responsibility of everyone involved -- universities, industry and government -- to let students from underrepresented groups know that engineering is open to them and that there will be excellent opportunities for good jobs at the end of their education. At Dartmouth we have begun, with financial assistance from AT&T, an e-mentoring program, in which women students are paired, via e-mail, with women engineers in industry. These mentors let the students know that there are good jobs out there and that they are very rewarding. They also can help the students through their rough times in school. The internet represents a low-cost way to "get the word out" to women and minorities.

D. Internships And Coops

The opportunity to actually work for a company and see what "real world" engineering is like, is one of the best recruiting tools for women and minorities into engineering. When industry, with assistance of universities, takes an active role in ensuring placement of underrepresented groups in these opportunities, retention and recruitment into engineering is helped immensely. Since there is much more flexibility in placing students in internships and coops than in the rigid admissions policies of many state universities, this provides pro-active opportunities for retention activities. Why retention? Again, students learn that "real world" engineering contains exciting projects that involve teamwork and people-skills, that most engineers do not sit alone in front of a computer all day, that engineers need the skills that underrepresented minority groups have to offer.

E. Open Up Programs But Educate On Diversity Issues

Many of the programs founded to encourage diversity, including Dartmouth's Women in Science Project (WISP) are wondering about their future, in the face of attacks on affirmative action. One promising direction is to open up many aspects of the program to others, but to require a discussion of and advocacy for diversity issues as part of the stated requirements for involvement. In many cases, educating main-stream faculty and students on diversity issues is as fruitful to retention as providing services to minority students. State requirements to open programs to all students can be met and still serve the goals of WEPAN and NAMEPA if all participants are required to be

involved in ongoing discussions designed to remove the present cultural biases in engineering and advocate for inclusion of all.

F. Find Ways To Fund Mature Programs

The challenge is to find funding for programs encouraging diversity in engineering, to ensure that they can be maintained, even during times of increased financial constraint. Many programs have previously found support as "pilot" projects. Now that they are not "new", they are often unable to obtain NSF or Foundation support. This requires a renewed commitment and advocacy, at every level, to these programs. Advocacy at the industrial level is particularly promising, since industry represents the future employers and has been articulate about the need for a diverse workforce. Financial support from industry (e.g. memberships on an industrial board), or university commitment at the highest level, is necessary for these programs to remain in place, especially during times of financial stress.

3. What has the impact been of my presence as a woman dean?

To first order, women deans are no different from any other deans. We face the same challenges and opportunities. Since most deans are appointed with both faculty and upper administration approval, we work in environments that are basically supportive to us. The impact of being a woman dean, nonetheless, is considerable. Here are some thoughts:

A. Increased Attention To Diversity On The Faculty

I joined a faculty of 35 that had only one woman faculty member (untenured). Thus I became the first tenured woman on the engineering faculty in the history of Dartmouth (and most of the Ivy League). Thus my appointment provided a proof-in-principle. During my first year, the only other woman on the faculty was tenured. During that first year I also recruited two new woman faculty members, so that now 4 out of 35 faculty who are women, and we now have one of the highest fractions of women engineering faculty in the nation. Pro-active women and minorities as deans have the clout to increase faculty diversity.

B. Increased Spirit Among Women Students

While I don't expect my presence to have an immediate impact on retention of women students, anecdotally I understand that there is an increased spirit in the student SWE chapter, since I have been talking to them about women in leadership. I would expect that their increased activity will help with retention and recruitment.

C. Changes In Campus Climate

There are a number of changes due to my arrival that are considerably more subtle and cannot be proven, but should be discussed as possible impacts that diversity at the top can bring to a college campus. It is important to point out that any dean with interest in these issues can make a difference -- the dean need not be a member of a minority group. This includes increased interest in and emphasis on staff issues. This includes increased attention to curricular issues -- we are working on the substantial curricular change in 25 years. Finally, as dean I have been appointed to a number of important

search committees on campus. My input on who is hired into top positions within the university (and in recruiting them) gives me additional opportunities to act as a champion of diversity.

D. Impact On The New Hampshire /Vermont Area

Because the engineering community in New Hampshire and Vermont is sparse, my visibility as a woman dean has given considerable reinforcement to the few women engineers in the area and, through SWE, I have become an active role model. Parenthetically, because I was president of the Optical Society of America, I have also given reinforcement to the sparse optical community in this part of the country.

E. Impact On The National Scene

As dean and member of the National Academy of Engineering, I have the respect of the University engineering community. As one of the few women, I am often asked to be on advisory committees -- of government organizations and of universities. This has allowed me to impact policies in many institutions beyond Dartmouth. In fact, it is this impact on the National scene, that is, I believe, the most important impact that my being Dean of Engineering at Dartmouth can have. I believe that there is a lot in engineering education (and practice) that needs fixing before engineering in this country will be optimized for the 21st century and before it will naturally attract larger numbers of women and minorities. I want to do all that I can to contribute to these changes. This is why I became a Dean of Engineering in the first place. I went to Dartmouth because I believe that Thayer School is the ideal role model for what needs to be done.