"Designs Not Considered": the limitations of using retention as an indicator of diversity in engineering education

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Introduction

The engineering population's homogeneity is a matter for widespread concern. Engineering students and faculty still tend to be white, male, middle-to-upper class, or all three, and this poses a distinct disadvantage to engineering as an academic discipline and as a profession. William Wulf, current president of the National Academy of Engineering (NAE), addressed the need for diversity in engineering in his 1998 address to the NAE annual meeting, saying that "in any creative profession, what comes out is a function of the life experiences of those who do it." He points out that "Sans diversity, we limit the set of life experiences that are applied, and as a result, we pay an opportunity cost." That cost, he argues, takes the form of "products not built…designs not considered… constraints not understood,… [and] processes not invented."[1]

Engineering educators, administrators, and funding agencies have demonstrated their concern in improving diversity in a variety of ways. Engineering programs at colleges and universities across the nation have set up special offices dedicated to improving the diversity of their student bodies, special courses are designed to promote diversity in engineering by creating support networks for underrepresented students, dozens of books and articles are published every year on how and why to improve the diversity of engineering student and faculty bodies, national funding agencies support programs aimed at improving diversity, and even conference divisions are dedicated to studying aspects of diversity in engineering.

Simultaneously, however, even though we may recognize the need for a more inclusive and varied population of engineers, the general understanding of "diversity" still appears severely restricted. One measure of diversity dominates most remediation efforts: the retention of women and underrepresented minorities in academic engineering programs. In fact, this measure has become transformed into such a standard definition of diversity that we have lost sight of its limitations, and we ignore the ways in which its use may actually undermine many of our well-intentioned efforts to improve diversity in engineering. The phrase "women and underrepresented minorities" has been naturalized into a surrogate for diversity. This naturalization carries three particular problems in its wake: 1) the number of women and minorities graduating has become the end goal rather than one step in the quest for different perspectives; 2) the use of retention limits who "counts" as being able to provide different perspectives, and, most importantly; 3) within an institution set up and maintained by and for

white, affluent men, using retention as a measure of diversity does not necessarily persuade us to create a space for those different perspectives to actually be heard.

Just graduate 'em!

Easily measurable and capable of satiating engineers' penchant for quantitative data, retention is frequently used as one of the few (if not the sole) measure of diversity in educational programs. It costs little to calculate, and superficially gives program administrators and facilitators a magic number that they can take responsibility for—to get as many "special" people as possible through the program, regardless of whether they want to get through it, and what they decide to do once they leave.

Unfortunately, retention numbers do not give any indication of the quality of students' educational experiences, and ostensibly allow educational instruction to sink to the lowest common denominator (just getting people to stay in the class or program) while placing the responsibility for potential failure entirely upon the students. It permits the administration to believe that students who drop out can't survive engineering rather than that they may have found another career path to follow. It authorizes them to assume that if students cannot "survive" in the engineering curricula, then they need to have special services such as tutoring and linked courses available to them; if they can't survive even with those services, then perhaps they should not be engineers. Essentially, it encourages us to focus on students' abilities in engineering (or apparent lack thereof) and ignore the possibility that it is the program that is biased and the curriculum that is flawed.

Using retention as a benchmark also assumes that there is an "acceptable number" of "special" students whom we are trying to reach—that once we retain appropriate proportions of numbers of women and men, of black students and white students, our diversity problem will be "solved." However, even equal numbers do not necessarily mean equal educational experiences. In discussing gender issues in education, Sara Davis et al. write:

> "Although they [may] represent a numerical majority, the *experience* of education for women is often that of being in a minority partly because the institutional climate remains organized around men and masculinity…. The myth of coeducation pretends that equal numerical access to higher education gives women and men the *same* education."[2]

In her autobiography "Walking Out on the Boys," Frances Conley (professor of neurosurgery at Stanford University) reports the same observation on gender inequities in medical schools:

> "Despite a class composition of 40 percent women, in 1991 the educational environment was not significantly different from the one I had experienced thirty years before…The women were still expected to conform to male standards of behavior and, without questioning it, humbly accept the fact that they will never be perceived to be "as good as" their male compatriots."[3]

When we ask all our students to perform their best, to stretch the limits of their capabilities and imaginations, to put in 110%, we must make an equal effort to do more than merely "get them

through:" students deserve more from us than programs designed for their "survival." We must provide an educational environment and experiences which enable *all* our students to truly succeed.

Who counts?

Frequently, the quest for diversity in engineering is limited by our definition of the issue in terms of the familiar phrase "women and underrepresented (ethnic) minorities."[4] The use of this term results in two major side-effects: the homogenizing of the people represented by the categories, and the exclusion of other underrepresented people from diversity efforts.

In describing "diversity" with only the discrete categories of gender and ethnicity, we have homogenized women and ethnic minorities in two ways. When we dedicate programs to serving "women and underrepresented (ethnic) minorities," we make the assumption that women have the same needs as ethnic minority students, and vice versa. Simultaneously, we also assume that all women have the same needs as each other, or that all African-American students would benefit from the same programs. This latter concern is frequently addressed in Women's Studies—the analysis of whom is included and excluded when we define "women," "African-Americans," "Hispanics," or many other demographic descriptors is the subject of and inspiration for countless paper and essays.[5] Davis et al. address the homogenizing effect of using gender specifically in education as a category to distinguish people:

> "…[U]sing gender as the only lens for comparison obscures the differential effects of educational inequities on particular groups of women…low income women have educational needs that differ from those of upper-income women as well as from their male peers."[6]

Myra and David Sadker analyzed data collected from elementary school classrooms for ethnicity and gender interactions, and found that "[t]he students most likely to receive teacher attention were white males; the second most likely were minority males; the third, white females; and the least likely, minority females."[7] Grouping students solely by gender or ethnicity, rather than as nested categories, or by excluding other potential factors (such as income level), often results in our overlooking such biases, and failing to adequately address the needs of such underrepresented individuals. Indeed, even to assume that all middle-class black women will be functionally equivalent engineering students is unwarranted.

At the same time, in limiting our definition of diversity to those described by gender and ethnicity, we exclude any demographic differences in students *except* those described by gender and ethnicity. Older students, homosexual students, students who are single parents, physically disabled students, poor students, and many others who could greatly add to the diversity of experience described by Wulf (and hence to the creativity of engineering and engineering design), are summarily ignored except occasionally at the campus level. Disabled students are provided with services on the campus level largely due to ADA requirements; more progressive campuses fund LGBT student coordinators, while older students and single parent students are largely left to fend for themselves.

It is odd that we so severely limit our definition of diversity. It seems unlikely that increasing the scope and flexibility of our definition would be so financially burdensome as to dissuade engineering administrators from doing so. Perhaps our definition is frequently limited because institutional practices of asking students to declare gender and ethnicity on admissions forms facilitate the labeling of students as "underrepresented;" we do not (as yet) ask students to declare their sexual orientation or their social class on institutional forms (nor do I recommend that we do so). Perhaps gender and ethnicity have become more politically-charged topics, with legal precedents and increasing lobbying power, while class and orientation remain hidden (perhaps due to individuals' fears of prejudice and violence, or other repercussions). Whatever demographic categories we choose to include under the heading "diversity," we must take care not to allow our affinity for statistics blind us to the goal behind the numbers.

Where has all the diversity gone?

While each of these problems is significant, I believe the "round peg/square hole" is the most critical concern in the use of retention to measure diversity. The curriculum and culture of American engineering education were developed in the 19th century when virtually the only people to attend university (the distinguishing feature between engineers and blue-collar workers) were white, middle-class (or wealthier) men.[8] Many of the curricular and philosophical changes engineering education has undergone since 1930, such as the debate over the balance of practice and theory,[9] have been based on the changing definition of engineering as a profession and the changing practical pre-university experience of incoming students, rather than to address the needs of the increasing numbers of other "types" of students: women, African-Americans, Hispanic-Americans, Native Americans, international students, less financially privileged students, and others. Returning to our analogy, the square hole of engineering education may have changed in diameter, in depth, or in other dimensions, but it is still a square hole; the fundamental pedagogical philosophies and approach towards engineering curricula continue to be directed towards an audience of white, affluent men. Our efforts to bring other students into engineering have been akin to re-shaping round pegs to fit this square hole, without really considering to what extent the hole represents what actually goes on in the profession: we have yet to seriously consider re-shaping the hole itself.

The result of our driving students through a program which was not designed with their particular point of views in mind is that we force them to suppress experiences that do not lend themselves to this pursuit. Unsurprisingly, making more square pegs—even if they were initially in some other shape—does not help improve the diversity or by extension the creativity of engineering. Countless books and research projects document the need for a changed curriculum and pedagogy to accommodate the viewpoints and strengths of the new population of students.[10] Yet almost nowhere in engineering are students—any students—encouraged to augment or expand their learning processes with their personal life experiences and perspectives, nor are they encouraged to share their perspectives with their peers. As the curriculum was designed around the life experiences of the middle- and upper- class white men who designed it (and, for the most part, is maintained by the same) this neglect is particularly devastating to those students who do not share those experiences.

Conclusions

In my criticism of the naturalization of "retention" as an indicator of diversity, I do not want to undermine Affirmative Action efforts or disempower current or future diversity programs. I fully support such initiatives, but unfortunately they are not enough. We are not going to be able to achieve an egalitarian, multi-cultural, well-represented population of engineers by having a designated diversity office work towards improving the numbers of women and ethnic minorities who graduate from our programs. The retention measure is flawed, and the diversity problem is so entrenched in engineering culture and curricula it will take a major re-educational effort of everyone associated with engineering—particularly faculty and graduate students intending to *become* faculty—to address it.

Regrettably, there are many people in engineering who do not subscribe to a structural understanding of discrimination, or alternatively who do not believe in approaching what is essentially an organizational design problem from a "macroergonomic"[11] perspective. There are even those who are happy with the way engineering appears to them—white, male, tough, and exclusive—and if "other" students cannot survive their trial by fire then they are not cut out to become engineers. These people would scoff at the proposition that engineering itself needs to change and become more inclusive.

However, there are also those who support Wulf's perspective—that having a homogenous population of engineers means "products not built…designs not considered… constraints not understood,… [and] processes not invented." If we truly believe that we must create a more diverse population of engineers who will go on to reshape the profession, then we must be willing to accept and work towards the considerable changes this will necessitate. This means going far beyond counting the number of women and underrepresented ethnic minorities who graduate with a degree in engineering.

It means we must cultivate an institutional support structure that encourages and rewards diversity initiatives created by faculty, staff and students. It means we must develop supplementary and alternative measures which inquire after students' (and others') experiences in engineering, which analyze the climate and culture of hostility and marginalization felt by underrepresented students and faculty.[12] It means we must admit that many traditional pedagogical methods for teaching are biased and oppressive, and we must be willing to dispense with those traditional methods to explore the development of new opportunities for students to truly display their diversity. It means we must distribute the responsibility for creating an inclusive environment to everyone who participates in it—from students to deans—and inspire within them a sense of personal accountability. Above all, it means we must not lose sight of what we are trying to achieve by blindly concentrating on the numbers we have uncritically declared so important.

Bibliographic Information and Notes

1. Wulf, Wm. A. "Diversity in Engineering." *The Bridge*, Winter 1998, p. 9.

2. Davis, Sara N., Mary Crawford, and Jadwiga Sebrechts, eds. *Coming into Her Own: Educational Success in Girls and Women*. San Francisco: Jossey-Bass, 1999, pp. 4-5.
3. Conley, Frances K. *Walking out on the Boys*. New York: Farrar, Straus and Giroux, 1998, p. 104.
4. Occasionally, however, programs in engineering have even proclaimed their diversity by drawing attention to the variety of engineering disciplines represented — they are purportedly successfully diverse because they have (for example) both white male middle-class *mechanical* engineers and white male middle-class *electrical* engineers!
5. including, for example, Barbara Christian's "The Race for Theory," (in *Making Face, Making Soul=Haciendo Caras: Creative and Critical Perspectives by Feminists of Color*, edited by Gloria Analduza. San Francisco: aunt lute books, 1990), Paula Gunn Allen's "Where I Come From Is Like This," (in *Feminist Frontiers IV*, edited by L. Richardson, V. Taylor and N. Whittier. New York: McGraw-Hill, 1997), Patricia Hill Collins's "The Social Construction of Black Feminist Thought," (in *Feminist Frontiers IV*, edited by L. Richardson, V. Taylor and N. Whittier. New York: McGraw-Hill, 1997) Cherrie Moraga's "From a Long Line of Vendidas: Chicanas and Feminism," (in *Theorizing Feminism: Parallel Trends in the Humanities and Social Sciences*, edited by Anne C. Herrmann and Abigail J. Stewart. Boulder: Westview Press, 2001) and Alice Walker's "Womanist." (in *Making Face, Making Soul=Haciendo Caras: Creative and Critical Perspectives by Feminists of Color*, edited by Gloria Analduza. San Francisco: aunt lute books, 1990.)
6. Davis et al, p. 6.
7. Sadker, Myra, and David Sadker. *Failing at Fairness: How Our Schools Cheat Girls*. New York: Touchstone, 1994, p. 50.
8. Cowan, Ruth Schwartz. *A Social History of American Technology*. New York: Oxford University Press, 1997, p. 140
9. Seely, Bruce E. "The Other Re-Engineering of Engineering Education, 1900-1965." *Journal of Engineering Education* 88, no. 3 (1999): 285-94.
10. See, for example, Belenky, Clinchy, Goldberger and Tarule's *Women's Ways of Knowing* (New York: Basic Books, 1986) and Myra and David Sadker's *Failing at Fairness: How Our Schools Cheat Girls* (New York: Touchstone, 1994.) as well as Seymour and Hewitt's germinal work *Talking About Leaving: Why Undergraduates Leave the Sciences* (Boulder: Westview Press, 1997), Michael Apple's *Official Knowledge: Democratic Education in a Conservative Age*, (New York: Routledge, 2000) and the recently published *Flickering Clusters: Women, Science, and Collaborative Transformations* (Ney, Cheryl, Jacqueline Ross, and Laura Stempel, eds. Madison: University of Wisconsin Press, 2001.)
11. If one were to understand the concept of "ergonomics" as "fitting the environment to the individual," macroergonomics could be understood as fitting an organizational-level environment to individuals and populations. Hal Hendrick describes macroergonomics as "provid[ing] us with an organizational design strategy for developing or improving work systems that overcomes the dysfunctional shortcomings of historically used design practices…it meets the criteria of being human centered…and systematically considering the key sociotechnical system variables that have been found related to effective work system design." (p. 609, "Organizational Design and Macroergonomics." In *Handbook of Industrial Engineering*, edited by Gavrel Salvendy, 596-636: John Wiley & Sons, Inc., 1997).
12. A program being run out of UW-Madison which plans on analyzing climate in science and engineering (including computer science) for women faculty is the Women in Science and Engineering Leadership Institute (WISELI). For some brief information, please see the UW press release (http://www.engr.wisc.edu/news/headlines/2001/Nov05.html) or the NSF press release describing the ADVANCE institutional transformation grants (http://www.nsf.gov/od/lpa/news/press/01/pr0179.htm).

Biographical Information

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