

WOMEN IN ENGINEERING: THE ROLE OF COMMUNITY COLLEGES

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A year ago, I was asked by the National Governors' Association (NGA) to write a paper on the role of community colleges in increasing the supply of women and minorities in engineering. To be honest with you, I had not given the topic much thought until I was challenged to look into the issue. The National Governors' Association has put the improvement of engineering education as a top priority, believing that without higher quality engineering programs and more engineers the country will be unable to compete in a global economy. Further, the NGA noted that if the country is to keep up with the spiraling demand for engineers by the year 2005, more women and minorities will need to be recruited into the profession.

As most people are aware, there has been a sharp decline in the number of white males entering engineering schools and an equally steep climb in the number of foreign born studying engineering in the United States. The NGA has postulated, then, that unless more students are attracted into engineering, there will be a drastic under-supply of engineers in this country by the year 2005. One solution to this crisis would be to attract more women and minorities into engineering to off-set the decline of white males and the increase of foreign born engineers. Carrying the logic further, if 47 percent of the women, 42 percent of the black students and 54 percent of the hispanic students are in community colleges in this country, then the community colleges represent a major potential pool of minority and women engineering students. Approximately 38 percent, or 4.1 million, of the students in postsecondary education in the United States are enrolled in the 1,458 community/junior colleges. In Florida, over two-thirds of the postsecondary students are in community colleges. Florida's master plan established that the majority of students seeking a bachelor's degree are to begin in a community college. As a consequence, there are more community college transfers in the upper divisions of the state universities than students who moved up from university lower divisions. Strong articulation between and among the institutions and sectors of education has been essential in order to make the state's master plan scheme work.

Strong articulation between community colleges and university schools and colleges of engineering is absolutely necessary in order to make the National

Governors' Association logic workable. If students are going to be encouraged to start engineering in a community/junior college, then their programs must be designed so that they can move smoothly and efficiently into engineering programs with a maximum of credit and a minimum of redundancy in learning. If transfer is cumbersome and it represents for potential women or minority engineering students a substantial lengthening of their degree programs, this new pool will not be tapped. Few students today can afford the horrendous costs of higher education. Students in community colleges are generally less able than traditional students in four year institutions to afford higher education. The typical community college student in Florida, for instance, is 29 years old, married, working and going to college part-time. While no students can afford to waste time and money learning things they already know, community college students are even more resistant. When one adds transfer complications to the other inhibitions and barriers that women and minorities have about going into engineering, the potential pool of women engineers in community colleges will be nil.

While it may be more complicated for students to begin engineering in a community college and then transfer, it can be done, and it is being done all over the country. Again, in Florida, in 1989-90, 33 percent of the engineering students in Florida's state university upper division engineering programs were graduates of Florida community colleges and another 25 percent had begun their studies in a community college but did not graduate from one. Only 29 percent of the upper division university engineering students were students who began their engineering as a freshman in a university engineering program. Further, it is interesting to note that 15 percent of the university engineering students were women and 6 percent minority, right about at the national average for engineering programs. Although Florida has an outstanding program of community college/university articulation, the program does not seem to show up in higher women and minority enrollments in engineering.

What do we mean by articulation? The word 'articulation' was stolen from the medical profession, where it has to do with the fitting together of bones and muscle so that the body is able to flex and move. The analogy fits well for education, as we must have educational levels and sectors and all their discrete parts fit together snugly enough for people to move efficiently and effectively along a learning continuum from kindergarten to graduate school. Although incredibly numerous, complex, and varied, the discrete parts of the body of education should be naturally predetermined to articulate. Regrettably, this is not always the case in American education. To some observers, articulation in education is an unnatural act. Educational structures do not recognize a single continuum of learning, but rather the lines we draw reinforce wasteful territorialism between and among disciplines and academic departments within institutions and between and among institutions at large. The students are the ones victimized too often by the

crossfires of competing institutions and local academic interests.

The establishment of articulation processes and procedures is not easy. It takes time, thought, and energy, but most of all, effective articulation takes an open and accepting attitude among all the parties involved. While the details of Florida's statewide articulation agreement are not always known by Florida college students, teachers, and administrators, attitudes of respect and acceptance embedded in the agreement are almost universally acknowledged and operated upon. Florida has a compact that says, in effect, if students complete an associate in arts degree, they will have a place in the university system for their baccalaureate program and all of the credits will be accepted in transfer en bloc. This agreement was established in state administrative code twenty years ago when the community college system was just emerging and the university system was expanding from three to nine universities.

The effectiveness of Florida's articulation is born out by the following facts: (1) two out of every three baccalaureate degrees awarded by the Florida universities are given to students who began in a community college; (2) the academic performance of community college graduates generally mirrors that of students who began in the universities (2.72 Community college graduates to 2.79 Native university students); and (3) community college students take only three credits longer on average to get a baccalaureate degree given testimony to the strength of the two plus two system. While this is impressive, with respect to engineering, the picture is somewhat different. While the engineering programs are highly dependent upon an in-flow of community college transfers, the academic performance of transfers is below that of university native students. In 1989-90, all associate in arts engineering transfers had a 2.66 grade point average, while the native students had a 2.80. Community college students, also, took about six credits more than native students to earn a degree. Students transferring with associate in science or job entry degrees achieved a grade point average of 2.75 and took 16 credits longer. When looking at the transfer situation for women and minorities in engineering the, 1989-90 data showed the following very disturbing patterns of performance:

- female community college graduates achieved a 2.70 gpa compared with a 2.84 gpa for female native university students. Male native students achieved a 2.77.
- Hispanic female transfer students achieved a 2.58 gpa, while black female transfer students achieved a 2.32 gpa.
- Hispanic male transfers achieved a 2.54 gpa compared with a 2.28 gpa for black male transfers.
- Female transfer students on average took 165 credits to earn an engineering

degree compared with an average of 153 credits for all native students.

- Hispanic female transfers on average took 178 credits to earn a degree, while black female transfers took 185 credits.
- Hispanic male transfers on average took 160 credits to earn a degree, while black male transfers took 162 credits.

What these data tell us is that community college transfer women and minorities are not performing at the same level as other native university students in engineering and they are taking significantly longer to graduate.

In a nutshell, the situation for community college women and minority transfers in engineering is not good. I would be most interested in knowing whether the Florida patterns are typical of the rest of the country. I would urge you to conduct similar follow-up studies to see to what extent target groups such as those above have different performance patterns. Then use such data as a step off into more thorough joint analyses by feeder community colleges and universities as to what are the reasons for the differences in student performance. Such analyses should lead to corrective actions at either the community colleges where the students were prepared or at the universities, if the problems are related to environmental problems after transfer. Ideally, such analyses should be done as a partnership between the faculties of the feeder community colleges and the engineering programs. Faculty to faculty communication between and among institutions is central to whether or not articulation is going to work and patterns such as those above can be reversed. Learning expectations for engineering transfer students need to be explicit in publications and be conveyed clearly in face to face meetings of faculty. Counseling and advisement processes in the colleges must be based upon up-to-date engineering curriculum information. Community college students and teachers need to have this kind of information so that parallel course content can be delivered and students can map out their engineering programs at the time of entry into the community college. Community college administrators must help by allocating resources to support prerequisite engineering courses and programs.

The university community has obligations, as well, to provide orientation and counseling assistance to community college students, who often have first term adjustment problems at the junior year. These students often need special nurturing much like that typically afforded freshmen, rarely do they receive it. Transfer shock is a well documented phenomenon. The transfer population needs to be identified as a special population for financial aid, especially for women and minorities. Corporations such as General Electric have established financial aid programs specifically for community college transfers in science and engineering. More corporations benefiting from the production of engineers must assist, also. The community colleges and

engineering programs need to join hands and campaign together in the public schools and in the colleges to help change the negative images for women and minorities with respect to engineering as a career. Teams of faculty from both types of institutions should put on planned programs in the feeder schools and colleges to encourage women and minorities to go into engineering and show students how they can reach their objectives via a four year institution or through a community college/university articulated program. The increase of women and minorities, then must be a cooperative effort between and among schools, colleges, universities, and employers. In other words, it must be a partnership. As I indicated in my paper for the NGA, there are some other things that can be done to improve and solidify articulation between the schools, community colleges, and universities. They include:

- Formal/written articulation agreements between and among institutions and, if possible, statewide. Students are increasingly mobile in where they go to college, live and work, so statewide agreements afford the most protection to the most people. Such agreements should not only cover degrees specifically designed for transfer, but course work within degrees that are designed for job entry.
- Statewide or inter-institutional articulation committees should be established to monitor agreements, adjudicate conflicts, and foster articulation activities.
- States and governing boards should encourage collaboration and coordination to ensure that students in community colleges unable to offer part or all of a parallel engineering program have access to such instruction. Collaboration could include shared faculty and facilities, faculty and student exchanges, special financial aid for students to attend courses out-of-district, and dual enrollment within a district.
- Engineering faculty should meet regularly with appropriate faculty counterparts in feeder community colleges and work together to recruit students into engineering.
- Community colleges should encourage the formation of engineering interest groups or societies for students and encourage the participation of students and faculty from nearby engineering programs and practicing professionals. Such societies should encourage participation of women and minorities.
- Student follow-up systems should be built into statewide and/or institutional student data systems, so that receiving institutions will share student performance data with sending institutions. Such feedback should be used to make improvements in instruction or guidance and counseling processes at

community colleges and universities.

- Counseling manuals and other advisement literature should be developed by the universities in concert with feeder community colleges, so that students and teachers have up-to-date and accurate information to plan their community college/university program.
- Engineering programs should consider whether to identify an articulation officer or liaison person to coordinate articulation activities between feeder colleges and the engineering school or college.

These are but a few of the things that should be at least considered by those institutions and engineering programs that are serious about working together for the benefit of students and to change the enrollment patterns now seen with respect to women and minorities. It is evident that the community colleges of this country with approximately four million students can be used more systematically as a source for more women and minority engineers. Indeed, the community colleges represent a major source for engineers, a source that states and the nation can ill-afford to overlook. The tapping of this resource will take a renewed sense of partnership between and among all the levels and sectors of education and between education and employers. The women in engineering program advocates network is a wonderful national mechanism for spurring such partnerships. I am certain that the community colleges will do their part in sharing the challenge ahead.