The Ford/University of Detroit Mercy Engineering Opportunity Program

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Abstract

This paper describes a unique high school/industry/university initiative to promote engineering to and recruit high school students. Participants in the program include Ford Motor Company, the University of Detroit Mercy, and 13 high schools. The program is unique for several reasons. The scale of participation is large: approximately one hundred people are directly involved in interactions with high school students. Each high school is assigned a team consisting of two or three Ford engineers, one or two high school teachers, one or two UDM faculty members, a UDM engineering student, and a UDM admissions staff member. The teams are charged with developing their own activities depending on student needs, interests, and team member expertise. Some of the more novel activities are described, including the founding of a junior National Society for Black Engineers chapter, small-scale experiments in UDM engineering laboratories, and participation in a public water-sampling project. The schools represent a diverse mix, enabling communication among communities normally isolated from one another. The high schools include public and private, suburban and urban, with some serving primarily African American and Hispanic communities. The motivation for the program was a survey of high school math and science chairpersons to gain insight into the causes of low engineering enrollments in Michigan and to develop possible solutions. An informal assessment of the program was performed by team members, and a more formal assessment process is being developed.

I. Introduction

The Gap between Engineering Graduate Supply and Demand: 1983 was the start of a twelve-year downtrend in full-time freshman engineering student enrollments in the United States. With the exception of 1988 and 1992, which saw minor increases, enrollments dropped an average of 3.3% per year and by 1994, enrollments were down 22.4% as compared to 1983. Full-time freshman engineering enrollment was at an eighteen-year low in 1994. While 1997 and 1998 saw a 6.5% and 4.4% increase respectively (with 1998 reaching a ten-year high), first year enrollments again dropped 1% in 1999[1,2]. Since demand for engineers is strong, and in many disciplines growing, engineering enrollments today are not adequate to provide the flow of engineering graduates needed in the nation.

The reduced number of students pursuing engineering and the increase in engineering jobs, coupled with the retirement of large numbers of engineers, will cause a gap. The gap between the engineering needs

of U.S. corporations and the availability of engineering talent is cause for major national concern. This concern is known and expressed by some of our nation's top leaders. At a recent summit meeting on women in engineering, Rodney E. Slater, U.S. Secretary of Transportation said, "As Secretary of Transportation, I can tell you that the declining number of students in the engineering pipeline over the last 15 years has already started to create shortages of trained engineers in many parts of the country. This is a source of serious concern. As the current . . . engineers, trained in the 1960's, continue to retire, these shortages threaten to impede our continued economic success. ... to produce engineers in the numbers we need, we need more young women to enter the engineering profession."[3]

One of the major concerns about engineering enrollments is their demographics. Engineering enrollments have been historically dominated by white, male students. During recent years, enrollments of minority and female students in engineering have increased, but still lag far behind their levels by population proportion. Since 1993, the percent of women studying engineering has fluctuated between 17.7 and 20.1%. During the same period, the percent of underrepresented minorities (African American, Hispanic and Native American) studying engineering has been between 15 and 16%.

Of course, some schools have been able to surpass the averages. Of the full time students in engineering at the University of Detroit Mercy since 1993, between 24 and 29% have been women and between 21 and 29% have been underrepresented minorities. None the less, UDM is committed to further growth in participation of women and minorities in engineering. This priority is shared by UDM's corporate partners. James Padilla, Executive Vice President of Ford recently stated, "Diversity of culture in our technical workforce is not only the right thing to do, but also provides a competitive advantage by creating new products that better reflect our diverse consumer base."[4]

Project Discovery – a study of causes and possible solutions: Policy makers, educators and industrial leaders need to better understand the issues of high school students' understanding of, interest in and preparation for engineering education. Only then can informed, effective action be defined and carried forward.

To this end, in 1999 the University of Detroit Mercy and the *Detroit News* undertook a comprehensive survey of those closest to these challenges, high school math and science teachers from across Michigan. The survey and the resulting whitepaper, *Project Discovery,* focused first on attitudes, understanding and preparation of high school students[5]. It then sought the advice of these teachers on possible solutions, especially ways in which professionals and educators could encourage students' interest in engineering and motivate their studies of areas important to their preparation for college level engineering studies. Seventy teachers completed the survey.

Some of the most significant findings of the survey were:

- In general, high school students in Michigan are unaware of the magnitude of the opportunity for engineering careers today and for the foreseeable future.

- Students are unaware of the demand for engineers and current high levels of starting salaries for

engineering graduates.

- The majority of teachers also felt that their female and minority students were unaware of the increasing opportunities for female and minority engineers.

- There is inadequate understanding of the differences between careers in the various branches of engineering: civil, chemical, electrical, manufacturing, mechanical, etc.

Teachers criticized those in engineering for not promoting their profession. One teacher indicated, "Those individuals involved in engineering do not propagate the growth in their own field, whereas, other professionals effectively 'sell' their careers to youth."

Teachers were consistent in their requests for assistance in their efforts to stimulate student interest in engineering. Over 60% of teachers do not feel that they have tools that are sufficient to give students good guidance regarding engineering An even larger percentage (71%) do not feel that their schools offer enough extracurricular activities involving math and science to help make these subjects fun. When asked to predict the effectiveness of various interest-raising activities, teachers ranked the following alternatives highly (in order of effectiveness, from very high to moderately effective):

1. Touring engineers' workplaces
2. Student visits to universities and their engineering departments
3. Inviting engineers to class
4. Presentations by college engineering students
5. Students talking with teachers and counselors
6. Science and technology contests, like the Science Olympiad
7. Presentations to high schools by university faculty
8. "Engineering Fairs"

II. Objectives

In response to the shortfall in engineering supply and the results from Project Discovery, the University of Detroit Mercy has partnered with the Ford Motor Company to create a program whose objectives are to increase student interest and enrollments in engineering.

The objectives are being achieved in three specific ways:

- by attempting to eliminate ambiguities surrounding the engineering profession and by distinguishing among the engineering disciplines

- by connecting high school subjects to engineering disciplines

- by raising the visibility of the University of Detroit Mercy's engineering programs and Ford's engineering activities and careers.

Eliminating Ambiguities: Many high school students have unclear ideas about the engineering profession. A description of the field often lacks the impact that other, more visible professions such as law or medicine can produce. The *Discover Engineering* website offers the following observation:

> *Engineering has been called the "invisible profession" or the "stealth profession" because most people have no clue what engineers do. This is unfortunate, because everything in society is linked to engineering.*[6]

Freshman engineering design courses have been added to many university curricula in an effort to clarify student misconceptions, and to generate enthusiasm for and increase retention in engineering.[7] Indeed, research suggests that some students enter the field under strong parental influence, and wind up leaving after beginning a college program where they discover that engineering is not for them.[8] The Ford/UDM Engineering Opportunities program hopes to pre-empt mid-year turnarounds by assisting pre-college students in making an informed decision prior to entering the university.

Making Connections: As high school students study the foundational principles of mathematics and science, examples of applications to engineering practice are frequently lacking. By linking the high school subjects to engineering through case studies or projects, the program hopes to provide the connections between theory and practice.

Increasing Visibility: Finally, the program hopes to recruit students by raising the visibility of UDM's engineering programs and Ford's engineering activities in the community. The College has a mandatory cooperative education program through which students receive one full year of engineering work experience before graduating. Virtually no engineering classes are taught by teaching assistants, and the faculty is dedicated to excellence in engineering education. These outstanding aspects of the UDM engineering program will be highlighted for students participating in this program. The excitement of Ford's products and processes will be conveyed by participation of Ford engineers, and by direct exposure to products, product development activities and manufacturing processes at Ford.

III. Program Structure and Processes

In order to accomplish these objectives it was necessary for Ford and UDM to directly engage high school teachers, drawing them into a partnership to define, develop and deliver activities for students. Thirteen high schools were selected, with diversity and academic quality being the top criteria for selection. The schools selected are shown in Table 1, along with demographic information.

School	Large percentage female	Large percentage African American	Large percentage Hispanic	Public/Private
Benedictine		X		Private
Brother Rice				Private
Cass Technical		X		Public
Communication & Media Arts		X		Public
Holy Redeemer			X	Private
Ladywood	X			Private
Lasher				Public
Mercy	X			Private
Renaissance		X		Public
Southfield Lathrup		X		Public
Southwestern			X	Public
U of D Jesuit		X		Private
Western International		X		Public

Table 1. High school partners in the Engineering Opportunities Program. An "X" identifies those schools with a large percentage of female, African American, or Hispanic students. The schools are also noted as public or private.

A team was created for each school to develop and offer student activities. Each team is comprised of:

- At least two engineers from Ford
- One or two UDM faculty members
- One UDM student
- One UDM staff member
- At least one teacher or staff member from the high school

In all, there are over 100 team members for the 13 schools.

The activities undertaken were left to the discretion of the team, with the high school representative advising the team on which activities would be most effective and welcome at their school.

The sequence of development and student activities during the last year follows:

- Spring/Summer 2000 – exploratory meetings with Ford, UDM and high schools
- August 2000 – activity survey followed by launch meeting
- Fall Term 2000 – student activities launched at 11 high schools
- November 2000 – mid-year sharing/assessment meeting

IV. Description of Key Activities

The thirteen teams met at UDM in August 2000 to plan the fall term's activities. The teams developed their own activities depending on student/teacher needs, interests, and team member expertise. This brainstorming session resulted in an ambitious list of activities. Activities that were executed or initiated during the term included the following:

- Engineering laboratory demonstrations
- Small-scale engineering laboratory experiences
- Panel discussion with Ford engineers and/or college students
- Science fair consulting: brainstorming with faculty
- Institution of National Society for Black Engineers Jr. chapter
- Tours of Ford facilities
- Engineering career presentations by faculty, engineering students and Ford engineers

Note that in cases where laboratory apparatus was demonstrated, efforts were made to avoid one-way presentations and make the experiences as interactive as possible within the short allotted times.

With two exceptions, all teams held events in the fall term. Table 2 shows how the activities were linked with ways of meeting program objectives. Also listed are activities associated with each high school. Some of the activities are described below.

University of Detroit Jesuit High School brought a group of about 20 sophomores and juniors to campus in November. Four young Ford engineers – two of whom are UDM alumni – sat on a panel and described their education and job functions, then answered questions from the students. The panel session was followed by demonstrations in two engineering laboratories. Each of the demonstrations involved state-of-the-art applications of technology. The civil engineering demonstration covered the operation of a Geographic Information System. The demonstration from mechanical engineering covered the measurement of vortex shedding frequency behind a cylinder using a laser doppler velocimeter. Both demonstrations seemed to generate interest among the students as shown by their asking many questions. The most successful aspect of the visit, however, was the display of two late-model Ford vehicles. The display was particularly effective because knowledgeable Ford engineers were on hand to answer questions.

Several activities were held with students from Renaissance High School in Detroit. The UDM student chapter of the National Society of Black Engineers organized an engineering information fair held in the school cafeteria. About 200 students attended round-table discussions and saw displays covering the fields of civil, electrical, mechanical, and chemical engineering. The displays were staffed with NSBE student engineers and a faculty member from mechanical engineering. Two additional activities involved two-hour laboratory experiences for about 15 – 20 students. These were condensed and simplified versions of experiments that college students perform in advanced engineering courses. The

experiments were performed in UDM laboratories. The first involved an experiment demonstrating the principal of fluid momentum. Students were given governing algebraic equations, asked to predict reaction forces of water jets on several targets, and then performed experiments to confirm their predictions and compare experiment to theory. The second involved a student competition to build and program small robots consisting of several servo motors and simple links. Both experiments were preceded with brief lectures describing the governing principles and placing the experiments in a real-world context. The faculty member coordinating the activities was initially apprehensive about "entertaining" 16 and 17-year olds for two hours, but the seriousness and interest of the students pleasantly surprised him.

At Mercy High School, an all-female school in Detroit, over 200 students attended an engineering informational fair in September. Displays included a bike, a robot, Ford vehicles, and college displays. An engineering faculty member, engineering student and two Ford engineers talked with students throughout the 5-hour event. Ford used the opportunity to pass out questionnaires asking for student opinions about the vehicles. In November 15 students joined Ford University Graduates – and two current UDM students – for lunch at Ford, followed by a trip to the Spirit of Ford (a new museum near company headquarters) and a speech by Ford CEO Jacques Nasser.

Two of the high schools (Cass Technical and Communication & Media Arts in Detroit) hosted UDM faculty members who met with students considering science fair projects. The faculty and students brainstormed science project ideas. There are plans for students from Cass Technical High School to use UDM instrumentation to analyze soil and water as part of an environmental project.

Finally, it should be noted that the interaction between high school and industry resulted in at least two schools receiving substantial donations of laboratory and computing equipment from Ford.

Activity	High Schools involved (asterisk means activity held in Fall term)	Eliminating ambiguities	Making connections	Increasing visibility
UDM lab demos	Ladywood, Holy Redeemer, U of D Jesuit*, Western Int'l*		X	X
2-hour lab experiences	Renaissance*		X	X
panel discussion with engineers & college students	U of D Jesuit*, Western Int'l*	X		X
science fair project consulting	Cass Technical*, Comm. & Media Arts*		X	
NSBE Jr. chapter	Renaissance	X		
tours of Ford	Benedictine, Brother Rice*, Comm. & Media Arts, Ladywood, Mercy*, Renaissance, U of D Jesuit, Western	X		
career presentations	Benedictine*, Brother Rice*, Comm. and Media Arts*, Mercy*, Renaissance*, Southfield Lathrup*	X	X	X

Table 2. Linkages among activities and ways of meeting program objectives.

V. Lessons learned

In November 2000 the teams met at Ford Motor Company to assess the effectiveness of the program and to share ideas. The meeting resulted in a wealth of anecdotal feedback about the program.

High school teachers reported that they felt activities held so far were successful in increasing student understanding of the profession. Faculty and student presentations were effective in teaching students about engineering, and the laboratory demonstrations and experiments engaged the students and provided important links to basic physics and mathematics courses. There was a feeling, however, that more was needed. As a result, program leaders were charged with forming a task force to develop engineering projects that could be used in math and science classes.

Participants also felt the communication between college and high school students was of real value. This interaction occurred in several venues, including career presentations, panel discussions and

informal lunches. Communication between organizations, however, was at times difficult. Some attributed this problem to the variability in e-mail usage among the participants. As a result, it was suggested that a single contact person hold the organizational responsibilities for each team.

Several ideas for additional activities came out of the mid-year meeting:

- Give students a complete CAD experience where a car is designed from beginning to end
- Shadow student or engineer for a day
- Internships at Ford

Three action items emerged from the meeting. Volunteers were asked to form committees to do the following:

- assemble and/or develop print, computer and video materials that explain engineering careers and disciplines (to be shared and employed in structured presentations)
- develop a more formal assessment process for the overall program
- explore the development of project based high school curriculum that would bring engineering and pre-engineering experiences directly to high school students as part of their normal studies.

There was a feeling among teachers that one reason students do not enter engineering is lack of confidence in mathematics skills. It is hoped that the introduction of engineering-related material into classrooms may help to alleviate this anxiety, and also increase understanding of mathematics through contextual teaching.

VI. Summary

The effort has been time-consuming: meetings, travel, preparation for lab demonstrations and experiments, preparation for career presentations, and other organizational tasks all add to already-full schedules. The program has been successful because faculty, engineers and administrators have been very committed to the objectives.

A large benefit of the program is that each of the organizations gets to know the others better. The University learns more about industrial needs and becomes closely connected with the level of high school preparation. The high schools learn about engineering practice through interactions with Ford and become more familiar with university expectations of high school students. Ford develops better appreciation for the educational mission of the university and high schools.

Finally, the program is a chance for faculty members to appreciate the importance of high school connections to the recruitment process. The activity helps to dispel the notion that recruitment is solely the admissions department's job.

Ultimately the program's success will be seen through the increased enrollment and graduation of more diverse engineers (especially at UDM) and their successful careers in engineering (especially at Ford).

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