Why Some Community College Students Choose Engineering and Some Don’t

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Mary Anderson-Rowland, Arizona State University MARY R. ANDERSON-ROWLAND is the PI of an NSF STEP grant to work with five non-metropolitan community colleges to produce more engineers, especially female and underrepresented minority engineers. She also directs two academic scholarship programs, including one for transfer students. An Associate Professor in Computing, Informatics, and Systems Design Engineering, she was the Associate Dean of Student Affairs in the Ira A. Fulton Schools of Engineering at ASU from 1993-2004. Anderson-Rowland was named a top 5% teacher in the Fulton Schools of Engineering for 2009-2010. She received the WEPAN Engineering Educator Award 2009, ASEE Minorities Award 2006, the SHPE Educator of the Year 2005, and the National Engineering Award in 2003, the highest honor given by AAES. In 2002 she was named the Distinguished Engineering Educator by the Society of Women Engineers. She has over 180 publications primarily in the areas of recruitment and retention of women and underrepresented minority engineering and computer science students. Her awards are based on her mentoring of students, especially women and underrepresented minority students, and her research in the areas of recruitment and retention. A SWE and ASEE Fellow, she is a frequent speaker on career opportunities and diversity in engineering.

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Prior to joining the ASU Electrical Engineering faculty in 1990, Dr. Armando A. Rodriguez worked at MIT, IBM, AT&T Bell Laboratories and Raytheon Missile Systems. He has also consulted for Eglin Air Force Base, Boeing Defense and Space Systems, Honeywell and NASA. He has published over 200 technical papers in refereed journals and conference proceedings – over 60 with students. He has authored three engineering texts on classical controls, linear systems, and multivariable control. Dr. Rodriguez has given over 70 invited presentations - 13 plenary - at international and national forums, conferences and corporations. Since 1994, he has directed an extensive engineering mentoring-research academic success and professional development (ASAP) program that has served over 500 students. These efforts have been supported by NSF STEP, S-STEM, and CSEM grants as well as industry. Dr. Rodriguez’ research interests include: control of nonlinear distributed parameter, and sampled-data systems; modeling, simulation, animation, and real-time control (MoSART) of Flexible Autonomous Machines operating in an uncertain Environment (FAME); design and control of micro-air vehicles (MAVs), control of bio-economic systems, renewable resources, and sustainable development; control of semiconductor, (hypersonic) aerospace, robotic, and low power electronic systems. Recently, he has worked closely with NASA researchers on the design of scramjet-powered hypersonic vehicles. Dr. Rodriguez’ honors include: AT&T Bell Laboratories Fellowship; Boeing A.D. Welliver Fellowship; ASU Engineering Teaching Excellence Award; IEEE International Outstanding Advisor Award; White House Presidential Excellence Award for Science, Mathematics, and Engineering Mentoring; Ralf Yorque Memorial Best Paper Prize. Dr. Rodriguez has also served on various national technical committees and panels. He is currently serving on the following National Academies panels: Survivability and Lethality Analysis, Army Research Laboratory (ARL) Autonomous Systems. Dr. Rodriguez received his Ph.D. in Electrical Engineering from the Massachusetts Institute of Technology in 1990. Personal Web site: http://aar.faculty.asu.edu/

Ms. Anita Grierson, Arizona State University

Anita Grierson is the Director of the METS Center in the Ira A. Fulton Schools of Engineering at Arizona State University. She guides the activities of the METS Center and oversees its staff of engineering transfer students. Ms. Grierson has over 12 years corporate experience in Program Management, Business Development, and Biomechanical Engineering, with products as diverse as air bag systems for helicopters, body armor, and orthopedic implants. She received her Bachelors Degree in Mechanical Engineering from the University of Michigan in 1990, her Masters degree in Mechanical Engineering from Northwestern University in 1994, and a Masters in Business Administration from Arizona State University in 2000.
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Abstract
For the past 10 years, engineering outreach programs have been conducted by a major university with local and rural community colleges (CCs). Currently, in the fourth year of a National Science Foundation STEP grant with a focus on five rural community colleges (CCs), engineering professors and staff go into mathematics and science classrooms and encourage students, especially those undecided, to consider engineering as a career. We also go with CC leaders to talk with their local high school students in mathematics and science classes. The results of the “Changing the Conversation” research are being used along with our own experience. This research is an attempt to quantify how these potential transfer students view and understand engineering to better inform our presentations. A survey was given to students at five non-metropolitan CCs to answer the following question: “What about engineering attracts or does not attract you?” We also wanted to know if there is a difference in perception of engineering and computer science by gender.

Based on the results of these surveys, areas of interest that are of particular concern with potential engineering CC transfer students, especially women, are identified. These areas include feelings of inadequacy relative to math, not being aware of engineering job opportunities, engineering not sounding interesting, and engineering being boring.

I. Introduction
The general public knows little about engineering. Some people still believe that an engineer is “one who drives a train.” The word engineer may be associated with “engine” and “someone who “designs and builds things.” This does not sound very exciting and therefore not many children aspire to be an engineer. Authored by a Committee on Public Understanding of Engineering Messages, “Changing the Conversation” was published in 2008.¹ Slogans and tag lines were tested for their appeal to adults, teens, underrepresented minorities, and females. One of the goals of this study was to attract young people to careers in engineering. “A better understanding of engineering should encourage students to take higher level math and science courses in middle school, thus enabling them to pursue engineering education in the future. This is especially important for girls and underrepresented minorities who have not historically been attracted to technical careers in large numbers.”¹ A better and more attractive understanding of engineering is needed for high school and undecided community college (CC) students.

The 2012 Noel-Levitz National Freshman Attitudes Report² shows that nearly 95% of incoming freshman express a “strong desire” to finish a college degree, with females doing so at 96.5% and males at 93.7%.² However, only 54.3% of these students are likely to finish a degree in a
four-year private school, 37.9% at a four-year public, and only 26.9% at two-year public and privates. A few selected attitudes of incoming freshman give a clue to what may be happening after the students begin their college career. Only 37.5% of males (54.3% of females) say that they “get a great deal of personal satisfaction from reading.” Even more alarming perhaps is that only 52.6% of males (72.9% of females) “take very careful notes during class and review them thoroughly before a test.”2 Only 70.9% of males (77.8% of females) “would like to receive some instruction in the most effective ways to take college exams”. Only 39.9% of males (47.4% of females) “would like to receive tutoring in one or more of my classes.” “Math has always been a challenge for me” is true for 49.2% of the females and 37.6% of the males. In addition, 41.8% of the males (33.1% of the females) “have always enjoyed the challenge of trying to solve complex math problems.”

These last two items especially bode poorly for females to choose engineering as a career. On the other hand, some students (especially women, from the authors’ experience) may choose engineering as a career because they are told that since they are good at math and science they should go into engineering. These students may have little or no understanding of what engineering really is, but select engineering because they do not have a passion about any other subject. Students also have many myths about what engineering really is. It is important for retention that students develop a passion in some area of engineering.

How can we get the message to students about what engineering really is? In a survey by Noel-Levitz3, students were asked, “What is the most effective way for you to learn about a school’s academic program options?” “Printed brochures sent by mail or distributed at college fairs” received the highest rank at 70.8%, followed closely by “Program descriptions on a Web site” (69.2%). However, the third most highly ranked method at 59.6% was “Presentations from faculty or students during campus visits.” “Email messages from program faculty” rated a 55.7%.3 An advantage of presentations from faculty or students during campus visits is that they can be tailored to the particular audience. In this way myths can be challenged and information can answer questions that students might not have thought of.

Another insight we can gain about messages to students comes from Vincent Tinto, a distinguished professor in the School of Education at Syracuse University, who has researched why students leave or complete college. In his recent book, Tinto outlines the four conditions shown by research that students need to be successful in college: high expectations; academic, social, and if needed, financial support; assessment and feedback; and involvement or engagement.4 Tinto states that “the more students are academically and socially engaged with faculty, staff, and peers, the more likely they are to succeed in college.”

The authors of this research believe that if a student is passionate about an area or subject, then they will do well in that area. When we talk to students at community colleges, we are primarily talking to undecided students or students that may have selected a major on flimsy or incorrect reasons. For example, one student told us that he used to want to be an engineer, but now he
wanted to be a scientist because he “learned” that only scientists work in labs to really discover something new and that engineers just build what someone else tells them to build.

Taking a survey of students’ attitudes and interests toward engineering as a career is a natural starting point according to social cognitive career theory if we are to influence the career decision of students. Lent, Brown, and Hackett use the word “career” to primarily refer “to interest and choice processes.” These authors give a framework of “three social cognitive mechanisms that seem particularly relevant to career development: (a) self-efficacy beliefs, (b) outcome expectations, and (c) goal representations.” Self-efficacy refers to “people’s judgments of their capabilities to organize and execute courses of action required to attain designated types of performances.” These three authors further “define vocational interest as patterns of likes, dislikes, and indifferences regarding career-relevant activities and occupations.” Betz and Hackett did a study on the relationship of career-related self-efficacy expectations to perceived career options in college women and men. They found that females reported significantly higher levels of self-efficacy with regard to traditional female occupations and significantly lower levels of self-efficacy with regard to nontraditional female occupations. The males reported equivalent self-efficacy with regard to the two classes of occupations. Lent, Brown, and Hackett “believe that interest in a particular academic or career-relevant activity depends, in part, on the outcomes that are anticipated to result from participation in the activity, along with the relative value or importance of these outcomes to the individual.”

Thus, if a student does not believe that they are good at math (poor outcome) or does not believe that engineering is relevant to their life (low importance), then the student is unlikely to have a goal of becoming an engineer. In addition, Bandura warns “that there may be a temporal lag between newly acquired self-efficacy and investment of interest in activities that have previously been perceived as neutral or unenjoyable by the individual. If so, it may take repeated mastery experiences for self-efficacy to promote new interests in such activities. Increased interest might then emerge after a time delay rather than as an immediate consequent of enhanced self-efficacy.” This means that it may take more than one visit to the classroom to convince a student to consider engineering as a career.

II. The Community College
We have worked with CCs in outreach programs for over 10 years. We worked primarily first with six metropolitan schools and presented “Be An Engineer” events. For a “Be An Engineer” event, just advertising the event, which included educators and engineers talking about engineering and pizza, usually brought a good crowd of students. This venue worked especially well when several professors would release their math or science classes and give extra credit if the students showed proof of attendance at the event. Although we were able to successfully set up a “Be An Engineer” Event in local metropolitan CCs, this setting did not work in non-metropolitan CCs for two major reasons: usually there were not multiple mathematics and science classes being held at the same time to send students to attend such a meeting and it was
really impossible to ask working engineers to travel three hours each way (for four of the five schools) to be on a panel about engineering for an hour or two.

Recall that the most effective ways to help students learn about a school’s academic program (Noel-Levitz survey) were a brochure at a career fair, websites, and presentations from faculty and students on campus visits. Currently, in the fourth year of a National Science Foundation STEP grant (#0856834) with a focus on five rural community colleges (CCs), engineering professors and staff go into mathematics and science classrooms and encourage undecided or uninformed students to consider engineering as a career. The PI and co-PI of the grant, both engineering professors, as well as the Director of the Motivated Engineering Transfer Students (METS) Center, who has a Master’s degree in mechanical engineering as well as an MBA, make the trips to the CCs. Sometimes students travel to the CCs, but, due to the distance from ASU, usually students cannot afford to miss classes for a whole day. Our message to the CC students is for them to consider engineering as a career, but to stay at their CC as long as they can make progress in their major. We also go with CC leaders to talk with local high school students in mathematics and science classes. We encourage these students to consider engineering and to start their engineering major at their local CC. We know that, for most of these students, the only way they will continue school by attending their local CC. The exception to this message is for high school honor students who are interested in an Honors College. Our university’s Barrett, the Honors College, is unique with its own campus, library, class rooms, and dormitories, and is ranked as one of the top Honors Colleges in the nation.

Talking to high school and CC students is just the first step in our program. Our partner CCs have scholarship money for students interested in engineering. We assist in their transfer. The partner CCs bring a van load of students to the ASU campus each semester for an orientation and to become acquainted with our METS program. We have special scholarships ($4K) through the STEP grant at ASU for transfer students from our targeted non-metropolitan CCs. Over the last five years, we have graduated approximately 95% of the metropolitan transfer students and over 50% of them have gone on to graduate school, which is much higher than the rate for upper division transfer students in general (<70%). The nonmetropolitan program is relatively new and the financial situation for many of these students is difficult, but we hope to attain similar success rates with these students.

Students who were already considering engineering have been especially delighted to see since we are the first engineering professors, staff, and students from a university to ever visit their campus. We soon discovered that our time was best spent on the CC campus by visiting with captured audiences in mathematics and science classes. Our first hurdle was to get permission from the instructors to allow us to have some class time. The liaison for each CC works with their faculty and draws up a schedule of presentations for us. Sometimes we present together in one classroom and sometimes we split to cover two classrooms in the same hour. In some cases we are given at most 10-15 minutes. In most cases, after the instructor has seen our message encouraging the students to take as much mathematics and science as they can so they have the
option of participating in engineering or computer science, the instructor is willing to give us a full class period. The students usually are delighted to have a break in their regular classroom schedule, but there is still the challenge of getting them to pay attention and to consider the message. We have experimented with several methods and try to tailor the presentation to the class level. We use a PowerPoint presentation which includes information on the Grand Challenges for Engineering for the twenty-first century. A reference to the current unemployment problems is a good way to try to excite the students about what engineers do and to assure them that there are many problems for engineers to work on that will not easily be solved very soon.

We give the students materials on our METS Center, about scholarships available through our program at both the CC and at ASU, and our website http://mets.engineering.asu.edu/. An important message is to urge the CC students to apply for fall admission during the fall a year before and definitely before the general scholarship deadline of February 1. In the past only 50% of incoming fall transfer students had applied for admission by May. Half of the entering transfer students had then missed the scholarship deadlines and were late in registration with fewer choices for classes. We give the students a timeline flow chart with important deadlines for a successful transfer. We also distribute the ASEE eGFI: Engineering, Go For It magazine to students interested in learning more about engineering. In addition, we give a handout which lists our contact numbers, the contact numbers for academic advisors in each major and additional websites that have information on engineering. We encourage the students to look at the classes and their contents listed for their major of interest on the web for each school which they are considering. We further encourage the students to take the opportunity to make a trip to ASU, sponsored by their school, to see our engineering facilities and to meet students who have transferred to ASU from their CC. We try to time our CC visit to be a few weeks before the ASU student visit since more students are interested in taking the trip after we have spoken to them in class.

We have learned that a good way to get the CC students involved is to first ask them to describe the characteristics that they would like to have in whatever career they will choose. The usual answers include: good-paying, interesting, not boring, challenging, stable, and sometimes there is a hope that the job will not be “too hard”. If the students imply that engineering may be “hard”, then we ask, “Engineering is hard relative to what?” Being a single mom with four children and a minimum pay job is hard. Being the head of a family and having just lost your job is hard. After this discussion, we can point out that engineering is a good-paying, interesting, not boring, challenging, and creative career “where dreams can be turned to reality”.

A next step is to ask the students what career they have chosen at this time. This gives us a better idea of our audience. If we are speaking to a Physics class, many of the students may already be planning to go into engineering. On the other hand, if we are speaking to a pre-calculus class, many students may be unsure of what interests them and why. For example, one student said she had chosen geology as her career because she wanted to work outdoors. We pointed out that
there were many engineering jobs, especially in civil and environmental engineering that are also outside. Or we may hear a student say that they want to be a veterinarian or doctor. We suggest to the student that biomedical engineering is an excellent major to obtain before going to medical or veterinarian school. We also point out that sometimes students who intend to be a doctor change their mind or are not able to get into a medical school. In these cases, an engineering degree is a good backup plan. If students are thinking about becoming a lawyer, we inform them that again engineering is an excellent undergraduate degree for law school. We also point out that an engineering degree is required for patent law, which is a very good paying career. We also caution the students about doing any major that has a “pre” in front of it, such as pre-law, pre-medicine, or pre-business, since if they change their mind or are unable to get into medical school, a “pre” degree does not have a lot of value in the marketplace and emphasizes that the student was not able to carry through with their intent. We also tell the students about industrial engineering, a combination of engineering, business, and computer science for students who are interested in computers and/or business, since many students are not aware of this option. We do stress that if a student is passionate about a career, they should go for it.

Part of our message for students who are at least in calculus is that if they come to ASU we will encourage them to think about graduate school and that we have a 4 + 1 program at where students can double count two or three courses for their Bachelor’s and Master’s degree, and thus get a Master’s degree one year after a Bachelor’s. We did worry at first if we were frightening the students and making the transfer to a university sound too difficult. These students had not even survived transferring and we were talking about graduate school. However, we were pleased to learn through focus groups, that the students enjoyed this challenge and it was one of the reasons that convinced them to transfer to ASU and to our program. This is setting high expectations as touted by Tinto.

We often run into myths that the students have about engineering such as “engineers have few job opportunities.” We have also realized, due to feedback from the students, that they are very aware of the economic situation and therefore are interested to learn that engineers command the highest salaries among Bachelor Degree graduates and also that engineers enjoy one of the lowest levels of unemployment currently, about half of the national average. We decided to research further through a survey what interests CC students about engineering, what turns them off, and what misperceptions they might have about engineering. By understanding our audience better, we should be better able to talk about items of interest to them.

III. The Survey
We designed a survey for CC students to answer the question: “What about engineering attracts or does not attract you?” During Fall 2012 campus visits, we asked the students in the classes of all five of our partner CCs to complete the survey. After asking for demographic data, we asked the students if they were interested in engineering as a career or if they were not. If they were interested in engineering, they were asked to check all of the reasons why from a list, to list any additional reasons, and to indicate their top three reasons. If they were not interested in
engineering, they were asked to check all of the reasons why from another list, to list any additional reasons, and to identify their top three reasons. Figure I shows the survey.

Is Engineering your career choice?
IF YES, please check all of the factors that are true for you as to why engineering is your choice.
Then rank your top 3: 1=most important, 2=2nd most important, 3=3rd most important.

-Money
-Job Locations
-Easy work
-Exciting
-Challenging
-Want to help people
-Want to make a difference
-Flexibility
-Like math/science
-Good income
-Many job opportunities

-Low unemployment rate/plenty jobs
-Hours
-Ability to choose work
-Father
-Mother
-Sibling
-Mentor
-Like to solve problems
-Job security
-Rewarding
-Other (specify: ____________________________)

IF NO, please check all of the factors that are true for you as to why engineering is not your career choice.
Then rank your top 3: 1=most important, 2=2nd most important, 3=3rd most important.

-Do not like math
-Not good enough at math
-Do not like science
-Not good enough at science
-Do not like physics
-Do not like to study
-Do not want to work with machines
-Do not like computers
-Think engineering would be boring
-Thinking engineering is NOT ‘cool enough’
-Thinking engineering is simply too hard
-Not for women
-Does not sound interesting to me

-Do not understand national engineering importance
-Think engineering is not sufficiently relevant to my life
-Not aware of the many engineering job opportunities
-Do not know many engineers/engineering role models
-Unaware of the many possibilities for advancement
-Do not really understand what engineering is about
-Do not think I can really help people as an engineer
-Do not think I can make a difference as an engineer
-Do not think there is much flexibility in engineering jobs
-Don’t want to be a “geek” or a “nerd”
-I want to work outside, not in an office
-I do not really understand what engineering is about

Other (Specify: ______________________________)

Figure I. Engineering Career Interest Survey

IV. Survey Results and Analysis
The survey was given to 295 students at the five CCs: Arizona Western, Central Arizona, Eastern Arizona, Cochise College, and Mohave College. We first give the top three reasons why students said YES to being interested in engineering in Figure II.

We see that money, like math/science, exciting, many job opportunities, challenging, and want to make a difference were the top six choices. Money was the undisputed number one reason why students said they were interested in engineering. Reasons that were not very often mentioned as factors in choosing engineering for a career include: father, ability to choose work, flexibility, good work environment, mother, and easy work. Good income in itself did not seem to be an adequate reason and was considered a separate category from “money” by the students.
Next we looked at the reasons that females had for selecting engineering as a career. Figure III shows these results. The top six reasons for choosing engineering by the CC females were in order: money, like math/science, challenging, exciting, want to make a difference, and want to help people. These results show that the engineering message for females needs to include showing them how engineering does support making a difference and helping people. Figure III also shows that there is a wide variety of reasons for females to be interested in engineering. It is important to mention these many reasons when talking to women about engineering. Factors that did not seem that important to females included: flexibility, ability to choose work, the influence of their father, the hours, job security, and that engineering can be rewarding.

In Figure IV we see the top 3 reasons for the males. Their top six reasons were money, many job opportunities, like math/science, like to solve problems, and challenging. This Figure also shows the wide variety of reasons that males find engineering interesting. Two of the top six reasons for females were altruistic: making a difference and helping people. Wanting to make a difference was ranked 8th by the males and wanting to help people was ranked 14th. It is interesting to note that “low unemployment rate” was ranked 11th by both females and males. Factors that did not seem very important to males included: influence of a father, ability to choose work, a good work environment, flexibility, easy work, and hours.
Figure III. Top 3 Reasons Why Female Community College Students Said That Engineering Was Their Career Choice

Figure IV. Top 3 Reasons Why Male Community College Students Said That Engineering Was Their Career Choice
Now we look at the reasons that students are not interested in engineering. First, Figure V shows the top three reasons why CC students said that Engineering was not their career choice.

We see that the top six reasons that CC students were not interested in engineering were: does not sound interesting, not good enough at math, think engineering is simply too hard, do not like math, not aware of the many engineering job opportunities, and want to work inside, not in an office. The fact that engineering did not sound interesting was by far the most common reason for students not choosing engineering as a career. Some of the next most common reasons were all reasons that could be fixed with some education about engineering: do not know many engineers/engineering role models, think engineering is not sufficiently relevant to my life, think engineering would be boring, do not really understand what engineering is all about, do not like to study, do not like computers, unaware of many possibilities for advancement, do not want to work with machines, do not think I can really help people as an engineer.

In Figure VI we see the primary reasons that females were not turned on to engineering. Their top six reasons are: does not sound interesting, not good enough at math, not aware of many engineering opportunities, engineering is simply too hard, do not like math, and do not like physics. The overwhelming primary reason for lack of interest in engineering for females was because engineering did not sound interesting. The students need to be shown that there is something in engineering that is interesting and exciting. Very few females gave “do not like to study” as a reason for avoiding engineering which agrees with the Noel-Levitz Report mentioned earlier.²

Figure V. Top 3 Reasons Why Community College Students Said That Engineering Was Not Their Career Choice.

We see that the top six reasons that CC students were not interested in engineering were: does not sound interesting, not good enough at math, think engineering is simply too hard, do not like math, not aware of the many engineering job opportunities, and want to work inside, not in an office. The fact that engineering did not sound interesting was by far the most common reason for students not choosing engineering as a career. Some of the next most common reasons were all reasons that could be fixed with some education about engineering: do not know many engineers/engineering role models, think engineering is not sufficiently relevant to my life, think engineering would be boring, do not really understand what engineering is all about, do not like to study, do not like computers, unaware of many possibilities for advancement, do not want to work with machines, do not think I can really help people as an engineer.

In Figure VI we see the primary reasons that females were not turned on to engineering. Their top six reasons are: does not sound interesting, not good enough at math, not aware of many engineering opportunities, engineering is simply too hard, do not like math, and do not like physics. The overwhelming primary reason for lack of interest in engineering for females was because engineering did not sound interesting. The students need to be shown that there is something in engineering that is interesting and exciting. Very few females gave “do not like to study” as a reason for avoiding engineering which agrees with the Noel-Levitz Report mentioned earlier.²
If we compare the main reasons that females were not interested in engineering with the main reasons that males (Figure VII) were not interested in engineering, we see a similar, but somewhat different order of reasons. Both females and males overwhelmingly do not think that engineering sounds interesting. Males give “do not like math” as their second most popular reason and females give “not good enough at math” as their second reason. This fits with research that shows that females in general are less confident about their math skills even though they may be quite good at them (self-efficacy attribute). Interestingly, the males’ reason tied for third is that “engineering is not sufficiently relevant to their life,” while females rank this reason 15th. “Not good enough at math” is ranked fourth for males, while females fourth rank is “think engineering is simply too hard.” Females follow with not liking math and physics. A surprising fifth reason for males is that they want to work outside, not in an office.

We see some trends here that agree with the Noel-Levitz National Freshman Attitudes Report. The Report noted that males did not enjoy reading as much as females and they did not prepare for exams as carefully as females. We note that the seventh ranked reason for not being interested in engineering for the males was “do not like to study”. This reason was ranked 18th by
the females. Another obvious difference between the male and females was their dislike of computers which was ranked 17th and 9th respectively.

![Top 3 Reasons why Males said NO to Engineering (All Schools), n= 81](image)

**Figure VII. Top 3 Reasons Why Male Community College Students Said That Engineering Was Not Their Career Choice.**

In order to give a better perspective on the differences between the females and males, we considered which reasons were statistically different from each other by gender. In Table I we see the rankings by gender for the top three reasons for saying YES to engineering. The reasons for which the percentage of females and males differed statistically are marked with asterisks: 

*** = p < .025, ** = p < .10, * = p < .16. These values were chosen to display the statistical significance easily. Since we are not testing hypotheses, but are look for trends, we are willing to note a difference even if there is a 16% chance that we are wrong.

We note that the reasons students are interested in engineering which vary the most (p<.025) by gender are three areas which were more important for males than females: many job opportunities, rewarding career, and like to solve problems. At the next level of statistical significance (.025<p<.10), females liked engineering because it was challenging more than males and males considered the security associated with engineering jobs to be more important than did females. Three areas differed by gender with .10<p<.16 for females considering a reason more important than males: like math/science, want to help people, and career flexibility. For the rest of the top 11 reasons there was no statistical difference between genders, including...
the reasons of money, exciting, want to make a difference, job locations, good income, good job benefits and perks, and low unemployment rates.

<table>
<thead>
<tr>
<th>Top 3 Reasons Why Students said YES to engineering</th>
<th>Rank for Females n=50</th>
<th>Rank for Males n=139</th>
<th>Statistical Significance</th>
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</thead>
<tbody>
<tr>
<td>Money</td>
<td>1</td>
<td>1</td>
<td></td>
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<tr>
<td>Like math/science</td>
<td>2</td>
<td>3</td>
<td>*</td>
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<tr>
<td>Challenging</td>
<td>3</td>
<td>6</td>
<td>**</td>
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<tr>
<td>Exciting</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Want to make a difference</td>
<td>5</td>
<td>8</td>
<td></td>
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<tr>
<td>Want to help people</td>
<td>6</td>
<td>14</td>
<td>*</td>
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<tr>
<td>Many job opportunities</td>
<td>7</td>
<td>2</td>
<td>***</td>
</tr>
<tr>
<td>Job locations</td>
<td>8</td>
<td>7</td>
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<tr>
<td>Good income</td>
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<td>Good job benefits/perks</td>
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<tr>
<td>Low unemployment rates</td>
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<td>11</td>
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<tr>
<td>Flexibility</td>
<td>12</td>
<td>18</td>
<td>*</td>
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<tr>
<td>Ability to choose work</td>
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<td>16</td>
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<tr>
<td>Father</td>
<td>14</td>
<td>15</td>
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<tr>
<td>Hours</td>
<td>16</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Job security</td>
<td>16</td>
<td>10</td>
<td>**</td>
</tr>
<tr>
<td>Rewarding</td>
<td>16</td>
<td>9</td>
<td>***</td>
</tr>
<tr>
<td>Like to solve problems</td>
<td>na</td>
<td>5</td>
<td>***</td>
</tr>
<tr>
<td>Good work with environment</td>
<td>na</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Easy work</td>
<td>na</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

na = no females selected this reason

Table I. Top 3 Reasons Why Students said YES to Engineering by Gender and Ranking

***=p < .025, **=p < .10, *=p < .16

Next we look at Table II for the ranks of the top reasons why students were not interested in engineering by gender. Females and males only differed on one reason with a p<.025: not aware of many engineering job opportunities. Females considered this as much more important than males. Females ranked this reason tied for third, while males ranked it twelfth. Two areas showed that the genders disagreed at the .025<p<.10 level. Although both females and males overwhelmingly ranked “does not sound interesting to me” as the number one reason they were not interested in engineering, this reason was given by more females than males at the significance level of p=.07. On the other hand males considered “do not like to study” as a more important reason than females for not being interested in engineering. Four reasons differed by gender at the .10<p<.16 level with all of them due to more females percentage-wise identifying the reason. The four reasons which affected females more than males at this level were: not good enough at math, think engineering is just too hard, think engineering would be boring, and do not like computers. The first two reasons, not good enough at math and think engineering is just too hard, are consistent with self-efficacy theory. Due to past performances and social
Top 3 Reasons why Students said NO to engineering

<table>
<thead>
<tr>
<th>Reason</th>
<th>Rank for Females n=68</th>
<th>Rank for Males n=81</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does not sound interesting to me</td>
<td>1</td>
<td>1</td>
<td>**</td>
</tr>
<tr>
<td>Not good enough at math</td>
<td>2</td>
<td>4</td>
<td>*</td>
</tr>
<tr>
<td>Not aware of many engineering job opportunities</td>
<td>3.5</td>
<td>12</td>
<td>***</td>
</tr>
<tr>
<td>Think engineering is simply too hard</td>
<td>3.5</td>
<td>7</td>
<td>*</td>
</tr>
<tr>
<td>Do not like math</td>
<td>5.5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Do not like physics</td>
<td>5.5</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Think engineering would be boring</td>
<td>7</td>
<td>14.5</td>
<td>*</td>
</tr>
<tr>
<td>Do not know many engineers/engineering role models</td>
<td>9</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Do not like computers</td>
<td>9</td>
<td>16.5</td>
<td>*</td>
</tr>
<tr>
<td>Not good enough at science</td>
<td>9</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Don’t really understand what engineering is about</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>I want to work outside, not in an office</td>
<td>12</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Unaware of the many possibilities for advancement</td>
<td>12</td>
<td>16.5</td>
<td></td>
</tr>
<tr>
<td>Do not like science</td>
<td>14.5</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Think engineering is not sufficiently relative to my life</td>
<td>14.5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Do not want to work with machines</td>
<td>16</td>
<td>14.5</td>
<td></td>
</tr>
<tr>
<td>Do not think I can really help people as an engineer</td>
<td>17</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Do not like study</td>
<td>18.5</td>
<td>7</td>
<td>**</td>
</tr>
<tr>
<td>Do not understand national engineering importance</td>
<td>18.5</td>
<td>na</td>
<td></td>
</tr>
<tr>
<td>Think engineering is NOT ‘cool enough’</td>
<td>20</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Do not think there is much flexibility in engineering jobs</td>
<td>na</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

na = no students selected this reason

Table II. Top 3 Reasons Why Students said NO to Engineering by Gender and Ranking

***=p < .025, **=p < .10, *=p < .16

persuasion, the women students do not think that they are capable of performing well in math, which they know is required for engineering. Research has shown “the problem with girls is not the ability to learn math but the willingness to learn math.”¹⁴,¹⁵ Past studies have shown that both boys and girls have trouble doing math and do not like it, but “the difference between them is this: boys stick with math because they feel their careers depend on it and because they have more confidence than girls in their ability to learn it.”¹⁶ The third reason may be related to a lack of knowledge of the engineering. We would need to know more about the dislike of computers to understand if this has to do with programming, the computer hardware, or some other reason. However, these results are consistent with research on women in computer science.¹⁷

V. Summary and Future Work
This survey quantified general impressions that we were receiving from the CC students with whom we were working. Quite a few of the students who were not interested in engineering admitted that they did not really understand what engineering is about. It is very reasonable to not be very excited about something that you know very little. The main takeaways from this survey are that we need to continue to stress the main reasons that the students find as reasons to
choose engineering as their career. At the same time, we need to address the reasons that females and males are not interested in engineering, especially if they are based on a lack of information about engineering. Females need to be assured that you do not have to love math to be an engineer (many engineers don’t) nor do they need to be a “brain” or “genius” in math to be an engineer. Trying to destroying these two myths have been a part of our outreach program from the beginning along with the information that most engineers are not doing mathematics all day. When students say that engineering is “too hard”, we need to ask them, “Compared to what?” Compared to a boring, low-paying job? We need to remind students that not all engineers work with machines, and many engineers only use computers as a tool.

This all leads us back to the reason that the medical and law field now have as many women as men going into their schools: television programs feature well-dressed women doctors and lawyers in plush offices, helping people and solving interesting and exciting problems, usually in a short time. Because of these programs, the general public believes that they understand and know what a doctor or lawyer does. In addition, most people have their own doctor they have known for years and they know what doctors do from personal experience. The general public does not have their “own” engineer. Another factor to consider is that it is much more difficult to describe what an engineer does than what a doctor or lawyer does. We need engineering television shows with well-dressed woman engineers in exciting careers helping people to get the interest of young women.

We suggest that others working with CC students survey their students to learn what concerns and interests they have regarding engineering. With this information, presenters should be better able to design their presentation to get the attention of students.

Future work includes determining if these ranking of reasons from non-metropolitan students are similar to those of CC students in metropolitan schools. Also, we need to analyze the results by school to determine if the females and males from each school have the same reasons or if reasons vary from school to school. By talking with students in areas where unemployment is very high, we believe that money and stable employment may be a larger factor in these areas when selecting a career than in areas where this is not as large an issue.

The primary future work is to determine how better to help students realize that engineering can be very interesting and should at least be considered as a career. We believe the secret is for a student to find an area in engineering for which they have a passion which is consistent with Lent’s interventions derived from social cognitive career theory. In order to do that, we first have be make sure that the student is aware of engineering so that they can seriously consider engineering as a career. Our mission when we talk to young people about engineering as a career is to get them to at least give engineering an unbiased, fair consideration.
References


