Gender Bias in Engineering: Does More Contact with Female Engineers Reduce Bias?

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Abstract

Status Characteristics Theory and Contact Theory are tested to measure gender bias in engineering students, and to determine if contact with female engineers helps reduce gender bias. To assess this, two versions of a resume, one with a female's name and one with a male's name, were given to senior mechanical engineering students (n=225) to establish if they would rate the male applicant better than the female applicant. Respondents were asked how qualified they thought the respondent was, how much they would want the respondent on their team, and whether or not they would hire the applicant. Respondents were also questioned about contact with female engineering faculty, having female engineers in the family, and having female engineering co-workers. Results showed that all of the effects that were expected to occur were not significant, except one. The interaction between having a female engineer in the family and the applicant sex of the resume significantly impacted males' desire to have the applicant on their senior design team. Therefore, overall there is very little support for Status Characteristics Theory and Contact Theory. Only one result supports both Status Characteristics Theory and Contact Theory – having a female engineer in the family seems to reduce gender bias toward team members among males.

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Chapter 1.

Statement of Problem

Gender bias towards women in math-oriented fields, often referred to as STEM (science, technology, engineering, and math), is a big problem. In 2005, the Harvard president, Lawrence H. Summers, suggested that innate differences exist between males and females, which cause women to be underrepresented in math and science fields (Dobbs, 2005). He also questioned how much discrimination was at fault for the under-representation of females in math and sciences at elite universities. His statements caused a great deal of controversy, and Summers eventually resigned from Harvard as the president.

In direct opposition to Summers's statements, a National Academies panel (as cited in Fogg, 2006) stated that women are underrepresented in math and science leadership positions at universities not because they are innately less capable than men, but because of biases and discrimination that occurs. Fogg (2006) states that after reviewing a large amount of scientific literature, which included studies on brain structure and function, the National Academies panel found no significant biological gender differences in science and mathematic ability that can account for the small number of women in mathematical and scientific fields.

Perhaps if one believes that there is an innate difference in math ability between sexes, then it is easier to justify biased thoughts and discrimination. Some studies have shown that men perform better than women on math-based tests. In 2003, males scored, on average, a score of 537 on the quantitative portion of the SAT, while the females on average scored 503 (Altermatt & Kim, 2004). Although this may be true, this does not indicate that men are innately better at math than women. Also, even though some results show that on average, men perform better at math than women, obviously all males are not better at math than all females, and generalizations can not be made.

One reason why gender bias matters is that bias can affect performance, thereby creating a self-fulfilling prophecy. Women may think that they are worse at math than men, so they perform worse in math-oriented fields. For example, Jane Elliott, a third-grade teacher, did a fascinating study to demonstrate the effect of a self-fulfilling prophecy (Elliott, 1973). One day she told her students that blue-eyed children were inferior to brown-eyed students, and minutes afterward, the blue-eyed students started performing poorly on their lessons. The next day she told the students that she made a mistake, and that the brown-eyed students were inferior to the blue-eyed students. After she made this statement, the brown-eyed students' class performance deteriorated and the blue-eyed students' performances increased. From this study it can be seen that it is important to educate others that males are not innately better at math than females because this myth could become a self-fulfilling prophecy, or what is sometimes also referred to as a stereotype threat.

Another example of a stereotype threat can be seen from a study that was published in 1992, by Spencer and Steele (as cited in Valian, 1998). College students, who did well on the quantitative portion of the SAT and indicated that doing well in math was important to them, took a math test. Before they took the math test, half of the women were told that women usually score lower on the test than men do, and the other half of women were told there was no difference between men's and women's scores on the math test. Scores were compared to males who took the math test, and for the women who were told there was no gender difference between scores, there was no difference between men's and women's scores on the math test given. However, the women who were told there generally was a difference in math scores between men and women scored lower on the math test than the men who took the test at the same time.

Although some studies have shown that men are doing slightly better on some standardized tests, it seems women engineering students are doing better than their male counterparts in undergraduate studies. A study which analyzed data from nine colleges in the Southeast U.S. showed that women who stopped studying engineering had higher grade point averages than men who stopped studying engineering. Comparisons for male and female students leaving engineering in their second, third, fourth, fifth, and sixth semester were made, and of the 26 comparisons that were available from 1996 to 2001, there was only one instance that males had higher GPAs compared to females (Borrego, Padilla, Zhang, Ohland, and Anderson, 2005). These findings indicate that the women did not leave the field of engineering because of ability.

Women engineering students are doing better in school, but men still seem to be succeeding professionally more than women. The National Academies panel (as cited in Fogg, 2006) reported that although more women are studying science and engineering in college, women continue to hold a small portion of faculty positions at research institutions and usually don't get as many resources and support as male co-workers. Also, according to the Bureau of Labor Statistics, in 2003, the median weekly earnings for females in full-time wages and salaries in architecture and engineering occupations were $945, and for men in the same category earnings were $1133 per week. Similarly, for women engineering technicians (except drafters) the median weekly pay for full-time workers was $695 and for men it was $819.

Since gender bias is such a pervasive problem in professional fields, this study seeks to determine if gender bias occurs among senior undergraduate mechanical engineering students at Virginia Tech. Also, results will be analyzed to see if the bias decreases when respondents have contact with female engineers. The study will determine if the sex of an applicant for an entry-level mechanical engineering job impacts the perceived qualifications of the applicant, whether respondents would hire the applicant, and the desire to have the applicant as a team member. This will be determined by fictitious resumes (one with a “female” name and email address and one with a “male” name and email address) and a survey that was completed by 225 undergraduate senior mechanical engineering students. Participants were asked about the qualifications of the applicant, if they would hire the applicant, and whether the participant would want the applicant as a team member. They were also asked about contact with female family members, professors, and co-workers who are engineers to determine if contact with female engineers reduces bias.

The information of this study is useful because the results will be given to the Engineering department at Virginia Tech. If this study shows that gender bias does exist, this research will hopefully make the department more aware of the problem, and ideally, the results of this study will facilitate the department to take steps to reduce the problem. This study attempts to discover if contact with female engineers is one factor that impacts gender bias perceptions in regard to female engineers. If the results show that contact with female engineers reduces bias, perhaps the Engineering department will try to hire more female engineers. Also, the department could pass the information on to the students, and they would become more aware that gender bias is currently a problem at Virginia Tech, and not only something that used to be a problem, or is a problem at other universities. It seems that Virginia Tech is committed to reducing discrimination because AdvanceVT, a five year grant received by Virginia Tech, aims to increase the advancement of women in academic science and engineering by changing institutional culture and practices. Also, there is a Center for the Enhancement of Engineering

Diversity at Virginia Tech which provides support to under- represented populations of engineering students. Finally, results from this study could be evidence that further research needs to be done to measure gender bias and contact, both within engineering, and in other arenas in which gender bias is a problem.

If seniors have gender bias currently, they will likely continue to have this bias when they enter a career in engineering. Therefore, if the results of this study indicate that gender bias does occur in this population, it is important to rectify the problem now. If the bias continues, it could lead to discrimination and negative beliefs about women engineers in the future, and this could cause qualified people to be overlooked for jobs and promotions.

If the results show that gender bias is found in this study, this supports Status Characteristics Theory, and if contact with female engineers results in less bias, this supports Contact Theory. Therefore, if gender bias occurs and contact with female engineers reduces bias, perhaps this would be an indication that the theories are applicable to other types of prejudice, in addition to gender bias in math oriented fields. Knowing this, attempts could be made to combat other types of prejudice by having more contact with members of outgroups. Also, knowing about previous research done on Contact Theory and Status Characteristics Theory is useful to the current study. Therefore, the literature summarized in this study addresses Status Characteristics Theory and Contact Theory research.

Alternatively, if no gender bias is found, this result may indicate several things. One reason for this result might be because bias toward female engineers is not a big problem with senior mechanical engineering students at Virginia Tech. However, stating this is problematic because there could be other reasons which suppressed gender bias from being revealed. One reason is perhaps students have bias, but are intuitive enough to know that expressing the bias is not socially acceptable. However, the likelihood of this occurring is probably low since methods were used to hide the purpose of the study. Another reason bias may not be shown in the study could be because the study is somehow flawed, and is not accurately measuring gender bias towards female engineers.

Chapter 2.

Literature Review

Status Characteristics Theory

In 1977, Berger, Fisek, Norman, and Zelditch stated that they consider a status characteristic to be a:

> characteristic around which differences in cognitions and evaluations of individuals or social types of them come to be organized. The idea is quite general; it covers anything from race, sex, age, or occupation to physical attractiveness and even specific 'skills' and 'abilities', such as mathematical skills and reading ability. (p. 5).

The authors state that once these characteristics are realized, these characteristics determine future interactions. Since the current study is analyzing gender perceptions of engineering skills, this theory is very relevant.

Some studies have been done to determine the effects of Status Characteristics Theory dealing with employment issues. Bertrand and Mullainathan (2004) did a study to determine the differences in regards to hiring between names that sounded like they were names of African Americans, and names that sounded like they were names of Caucasians. They sent out approximately 5000 resumes to ads in sales, administration support, clerical, and customer service which were advertised in *The Boston Globe* and *The Chicago Tribune.* Results showed that resumes that had white-sounding names were about 50% more likely to be called than resumes that had black-sounding names ($p < .001$). The white-sounding names were called back 9.65% of the time, and the black-sounding names were called back 6.45% of the time.

Another study that tested hiring prejudices is an experiment by Frazer (2001) which showed that there was no significant difference as to whether students would hire an equally qualified black or white applicant for a job as a bookstore manager. The participants were given scripted questions and asked the black or white confederate of the study, who had scripted responses, these questions. The participants then stated whether or not they would hire the person. However, a week later, the participants were asked to recall the confederate's responses, and overall, participants recalled the black applicant as being less intelligent than the white applicant when the black and white applicant actually gave the same responses ($p < .01$).

Steinpreis, Anders, and Rizke (1999) studied the impact of applicant's gender on the evaluation of curriculum vitae for hiring and giving applicants tenure. They sent out to psychology academics four versions of a curriculum vita which included a female job applicant, a male job applicant, a female tenure candidate, and a male tenure candidate. The subjects then answered questions as to whether they would hire the applicant, tenure the applicant, and what starting salary they would offer the applicant. Results showed that both men and women were more apt to say they would hire the male applicant compared to the female job applicant ($p <. 001$). However, there were no significant differences ($p > .05$) when comparing whether or not the respondents would tenure the candidate.

Research has been done to confirm that there is also bias towards women in mathematical fields. Foschi, Lai, and Sigerson (1994) did a study that examined if undergraduates would evaluate male and female engineering job applicants the same. The subjects viewed two applications in which one was a male applicant and one was a female applicant. The subjects had to choose who they would hire, and for some subjects, the female applicant was more qualified with a slightly higher GPA, and for other subjects, the male applicant was more qualified with a slightly higher GPA. The results show that men significantly ($p < .05$) rated the more qualified male applicant higher than the more qualified female applicant, but there was no significant difference in the way females evaluated the applicants ($p <.05$). Therefore, this study shows it is important to analyze the sex of the subject when dealing with engineering applications.

Ridgeway (1997) states that sex categorization is a habitual, automatic part of how we perceive people and repeatedly distinguishing between sexes reinforces gender differences. This can then lead to gender status characteristics, widely held cultural beliefs that view one sex as more competent that the other sex. Rashotte and Webster (2005) state that status characteristics cause people to continue to have biased evaluations of others, have biased behavior, and give more advantages to men.

Rashotte and Webster (2005, pp. 626) tested gender status characteristics by showing 174 students pictures of a man and a woman and asking, "[Diane] took the FAA exam for a private pilot's license. How well do you think [Diane] did on this exam?" Diane and Jennifer were female names used and Bill and John were male names used. The results showed that the mean estimated score for the target men was 5.97 and for the target women was 4.68, which is significantly different ($p < .001$). Also, there was a slightly larger difference in the male participants scores compared to the female participant scores (1.41 and 1.23 respectively) which was significant ($p < .001$). Students were then told that women are better at verbal tasks and men are better at mathematical tasks, and were asked to state how many people of each gender they would hire out of 20 people. Both men and women stated they would hire significantly more women for reading jobs and more men for mathematical jobs ($p < .001$).

Gender also impacts leadership influence. A study by Thomas-Hunt and Phillips (2004) showed that women were perceived as less expert than men ($p < .05$). Subjects were asked to rank 12 items to survive in an Australian bushfire, and the person with the highest score in a group, which was based on the correct ranking by survival experts, was deemed the expert. There was no significant knowledge difference between expert men and women and nonexpert men and women. In this study, women leaders were less influential on their groups than men ($p < .001$). Another study showed that women leaders were less influential than male leaders (Lucas, 2003). On a computer screen, subjects selected answers to questions about the improvement of performance in organizations. They were shown answers from group members on the computer screen, including the group leader, and then were able to choose their final answer. Influence was measured by the number of times, out of 10, that the participant changed their answer to the same answer their leader provided. In one condition, participants were told that the leader was randomly assigned, and in another condition, they were told that the leader was appointed based on ability. In both cases, the differences between male and female leader influence was significant ($p < .05$) and respondents changed their answers to male leaders' answers more often than female leaders' answers.

A study by Foschi and Lapointe (2002), which also gave participants information by computer, showed that when students had to work with a partner to choose which picture of two had more white in the picture than red, there was no significant difference in response as to whether the partner was male or female. The students made a choice, and 20 out of 25 times, the computer generated the opposite answer. Then, the student was able to change his/her answer. The participants thought that their partner received what they had chosen, and that the partner could also change answers. Subjects thought the goal of the study was to have both partners be correct, and that the top four pairs involved in the study would receive $20. Therefore, there was motivation to be correct. As the authors of the study suggest, perhaps the task of choosing the proportion of red or white in a picture is not thought of as a task that men are better at, which is why gender did not result as a status characteristic.

Research by Heilman, Wallen, Fuchs, and Tamkins (2004) reinforced the fact that men are preferred when a job was viewed as masculine. Undergraduate students were asked to evaluate one man and one woman in what was perceived as a male-oriented field of Assistant Vice President in sales for an aircraft company. Products mentioned in the job description included engine assemblies, fuel tanks, and other aircraft equipment and parts. They were also showed 10 names, of which 8 were men. To show that the subjects thought it was more of a masculine job, the participants indicated that they were significantly more surprised to see the female applicant than the male applicant ($p < .01$). Participants read information about three people, and responses to the first two, which were either male or female, were analyzed. Subjects received either two people's job reviews which stated they were highly qualified or two people's job reviews whose qualifications were ambiguous. Results showed that there was no difference in ratings of competence for the highly qualified person, but there was for the person whose qualifications were ambiguous ($p < .01$). Also, when the qualifications were unknown, there was no significant difference as to whether the participants liked the male or female applicant better, but when both were highly qualified, participants liked the female significantly less ($p < .05$).

When focusing on sex, a similar theory to Status Characteristics Theory is called Gender Schema in other disciplines, such as engineering. Valian (1998) states:

> A set of implicit, or nonconscious, hypotheses about sex differences plays a central role in shaping men's and women's professional lives. These hypotheses, which I call gender schemas, affect our expectation of men and women, our evaluation of their work, and their performance as professionals. Both men and women hold the same gender schemas and

> begin acquiring them in early childhood…Our reactions to an individual are, inevitably, affected by the group the person belongs to. Our implicit ideas about men and women as a whole condition our reactions to men and women as individuals. (pp. 2 - 3)

Thus, gender schema theory, similar to status characteristics theory, posits that gendered expectations lead to differing evaluations for men and women.

Contact Theory

Contact is one potential way to reduce the implications of Status Characteristics. Williams (1947) was one of the first well-known researchers who published information stating that contact with members of other groups could help reduce prejudice. He listed 102 statements which he felt were true in regards to intergroup behavior. Williams stated that some statements, or propositions, are educated guesses and have no data supporting them, while others are supported by a great deal of literature. He indicated that propositions are meant to bring together what is already known in the field and to state what type of research should be done in the future.

Allport (1954) took what Williams reported into account and stated conditions that should be met to help reduce prejudice towards outgroup members by means of contact. First of all, he stated people should work together for a common goal. Allport used the example of a multi-ethnic sports team to illustrate this. People of different groups also need to work cooperatively. In addition, equal status between groups is important in fostering a reduction in bias. Allport stated that having a difference in status between groups in the workplace actually creates and maintains prejudice. Finally, institutional support, such has having positive laws and customs, helps create positive intergroup interactions. Cook (1962) later stated that acquaintance potential, the opportunity for people to get to know and understand each other in certain environments, was another dimension to help reduce bias towards outgroups by contact. Cook (1962) states that encountering another person every day for months, in two different types of clubs, can produce very different acquaintance potential, depending on the atmosphere.

There is controversy as to which contact criteria need to be met to reduce prejudice. A study by Ludwin and Wittig (2006) measured which aspects of Contact Theory seem to reduce prejudice in middle school and high school students. The authors reported four separate samples, and results showed that acquaintance potential was significant ($p <.05$) in reducing prejudice in three out of the four samples. Acquaintance potential was measured by asking three questions (Ludwin and Wittig, 2006, pp. 495). “In this class, I talk to students of different races only when I have to” (reverse coded), “In this class, students of different races just do not like being together” (reverse coded), and “I often go through a whole period in this class and never say more than a few words to a student of a different race” (reverse coded). Three statements, taken from the Quick Discrimination Index (Ponterotto et al., 1995, pp. 1024-1025), were used to measure affective prejudice which included, “I feel I could develop an intimate relationship with someone from a different race” (reverse coded), “I would feel O.K. about my son or daughter dating someone from a different race” (reverse coded), and “I think it is better if people marry within their own race.” In the study, equal treatment and interdependence were each significant in reducing prejudice in one of the four samples ($p < .05$) and institutional support was not significant in any of the samples.

The current study includes the four main elements of contact that Allport (1954) stated would help reduce prejudice. Allport (1954) stated that equal status is one condition, but since the practicing engineers the participants have contact with are in a higher status than the student participants, rather than a lower status, this criterion is deemed as being met. Also, there is support from authorities and institutions at work and school which support contact with female engineers. In addition, the participants have worked together and worked towards common goals with the female engineering faculty and co-workers by trying to succeed in class and at work. Since the four criteria stated by Allport (1954) were stated to reduce racial and ethnic prejudice, and most of the research of Contact Theory has been done on racial and ethnic issues, the four criteria are not as relevant for female engineers in the family. Because family members are usually from the same race and ethnic group, they might not be considered an outgroup member. However, the four criteria can still be applied because usually within the family, interaction between family members is supported, they have worked on common tasks, and they have worked cooperatively together.

Although many studies have supported the fact that more contact with an outgroup member is related to lower bias towards that group, Pettigrew (1998) states that there is little causal evidence. It may be that contact with other groups causes a reduction in bias, or it may be that those who are biased avoid interactions with members of other groups. To test this, a study was done measuring prejudice of college students, with those who chose a roommate of a different race, and those who were randomly assigned to a roommate of a different race (Van Laar, Levin, Sinclair, and Sidanius, 2005). Results showed that overall, there was a reduction in prejudice towards whites, African Americans, and Latinos when living with a member of a different race, whether or not the roommate situation was randomly assigned or voluntary. However, living with an Asian American actually increased prejudice for those who chose to live with Asian Americans and for those who were assigned to live with Asian Americans. The researchers found that Asian Americans had higher prejudice than other major ethnic groups, and suggested that perhaps exposure to the Asian Americans roommates' prejudice was an influence.

Other studies have been done to measure prejudice in school settings. A meta-anlaysis of the effectiveness of multicultural education programs found that out of lectures, assigned readings, videos, group discussions involving all the participants, small-group discussions, one-on-one interactions, and contact with target group members who were not participants, the only component that showed a significant positive behavior change ($p < .05$) was contact with a target-group member who was not part of the program (Stephan & Stephan, 2004). Those who had contact with a target-member outside of the program showed a more positive behavior change than those who did not have this contact.

Increasing contact with members of different racial and ethnic groups through cooperative learning is one method used in multicultural programs. Cooperative learning usually entails putting people (usually of different ethnic groups and sexes) into small groups and having them perform a task together in order to attempt to attain a reward (Stephan & Stephan, 2004). Stephan and Stephan (2001) state that overall, research shows that cooperative learning environments result in more positive feelings toward racial and ethnic outgroups, increased numbers of friends in general and friends from different racial and ethnic groups, and an increase in the liking and respect among students.

Several studies have showed that having friendships with members of other groups is also related to less prejudice towards outgroups. Levin, Van Laar, and Sidanius (2003) studied over 2000 college students and found that those who had more outgroup friendships during their second and third years of college had less ingroup bias during their fourth year ($p = .001$). The study also reported that those who had more ingroup bias at the end of their freshman year had fewer outgroup friends during their second and third year of college ($p < .001$). Also, Johnson and Jacobson (2005) found for each one-unit increase on a four point scale of having friends of a different race, there was a 34% increase in the approval of interracial marriages ($p < .001$).

Another finding in the study by Johnson and Jacobson (2005) showed that contact in the workplace with an outgroup member does not affect attitudes. The authors analyzed data from a New York Times telephone survey done in 2000, and found that there was no association between whites' contact with blacks in the workplace, and whites' attitudes towards interracial marriage ($p = .4$). However, the question asked, "About how many of the people you work with are black?," (Johnson and Jacobson, 2005, pp. 391) did not specify whether or not the respondents worked together, worked towards a common goal, or had equal status, which are three of Allport's (1954) criteria to reduce prejudice. Perhaps the respondents worked in the same building as blacks, but did not interact with them in a meaningful way.

The literature mentioned in this paper about Contact Theory, up until this point, has focused on racial and ethnic issues. It seems to be true, as Fenwick and Neal (2001) state, that a lot of the research on Contact Theory focuses on racial groups and changes in attitudes. However, Contact Theory also applies to other groups in addition to racial groups. A meta-analytic test of 713 independent samples from 515 studies shows that contact helps reduce prejudice (Pettigrew and Tropp, 2006). The authors of this study state that although Contact Theory was established to help reduce racial and ethnic biases, from the results of the study it can be seen that reduction in bias through contact can be extended to other groups that are not racial or ethnic. Although they did not include a specific category for gender bias in their analysis, they included categories for sexual orientation, physical disabilities, race/ethnicity, mentally disabled, mentally ill, elderly, and other, which all showed that contact significantly (p-value $<.001$) reduced prejudice.

The Current Study

The main goal of the study is to analyze gender bias in engineering students at Virginia Tech. For this study, gender bias is evaluated in three ways by comparing the responses from those who got the female resume to those who got the male resume. First, bias is measured by having the respondents evaluate how qualified an applicant is for an entry level mechanical engineering job. Second, bias is measured by having the respondent state whether or not they would be willing to hire the applicant for a job. Third, bias is measured by having the respondents state to what degree they would want the applicant on their senior design team. It is hypothesized that the female resume will be rated lower than the male resume on how qualified the person is for an entry level mechanical engineering job, that those who received the resume with the female name will be less apt to state they would hire the person than those who received the resume with the male name, and participants who received the female resume would be less likely to want the person on their senior design team project than those who received the male resume.

The study also seeks to determine if contact with female engineers reduces bias. For this study, contact with female engineers is evaluated in three ways. First, contact is measured by whether or not respondents have a female engineer in their family. Second, contact is measured by how many female engineers respondents have had as professors. Third, contact is measured by whether or not respondents ever worked with a female engineer. It was hypothesized that contact with female engineers reduced the difference in perceived qualifications between the male and female resume. It is expected that those who have had experience working with a female engineer, who have had a larger number of female engineering professors, and who have a women engineer in their family will not have as much bias.

The results of this study seek to add knowledge to the current literature about Status Characteristics Theory and Contact Theory. If the results show that contact with female engineers reduces bias, this would support the fact that contact not only helps reduce racial bias, as previous literature has shown, but also that contact with females in certain areas of specialization reduces gender bias. There does not seem to be a great deal of published literature, if any, which proves that contact with females reduces gender bias, and this study attempts to add to the sociological literature by studying gender bias in engineering students.

Chapter 3.

Methods

Data

Prior to the study, the resume and survey were given to a focus group of graduate students in mechanical engineering to verify that the questions were easy to comprehend. The graduate students also gave input as to whether the resumes state average qualifications for someone who has recently completed an undergraduate degree in mechanical engineering. They gave their suggestions in regards to what changes might be made before the survey was given to the undergraduate mechanical engineering students. One suggestion they made was to switch the order of the first two questions so that first the respondents were asked to rate the qualifications of the applicant, then were asked to state whether or not they would hire the applicant, instead of vice versa.

There are 225 participants in this study. The participants are senior class mechanical engineering students at Virginia Tech enrolled in a course titled, "Engineering Design and Project." All senior mechanical engineering students are required to take this class in order to graduate. There are 13 departments in Blacksburg within the College of Engineering, and the mechanical engineering department was chosen for this study because it has the largest senior class. The senior class was chosen because they will have the most knowledge about looking at resumes and determining who is qualified for an engineering job.

The resumes, along with the survey, were handed out to students in a lecture hall at the beginning of class. The surveys and resume, as one packet, were distributed by giving the people in the aisle seat a stack of resumes and surveys, and having them pass the papers down the row so each person in the row got a copy. The resumes alternated male and female versions of the resume. The front page did not show the resume, so the subjects were not able to see what other resumes were being passed out. The students were instructed to complete the survey alone to prevent the students with different versions of the resume from recognizing that the only difference on the resumes was the name and the email address. They were also told that participation in the survey was voluntary, and the results are anonymous.

There are two versions of a resume. Appendix A illustrates a copy of the resumes. The resumes have the exact same information and formatting, except for the first name and email address. One resume has a stereotypical female name, Rebecca L. Jackson, and one resume has a stereotypical male name, Robert L. Jackson. The last name Jackson was used because it is a common last name in the U.S. According to the 1990 U.S. Census Bureau, Jackson ranked as the 13th most common name in the U.S. The names Rebecca and Robert were chosen because they are stereotypical gender specific names. According to the Social Security Administration, for the past 60 years Rebecca was among the top 100 most popular girls names and only one year in the last 60 years was it one of the top 1000 most popular names for boys. In 1975 it was #984 for boys. Robert has been one of the top 40 boy names in the past 60 years, and for girls the highest it ranked was #540 in 1946. Approximately half of the participants in the study received the resume with the stereotypical male name, and half of the participants received the resume with the stereotypical female name. The participants in the study only received one resume, and did not know that the purpose of the study is to measure bias. The subjects were told that the purpose of the study was to determine how students evaluate resumes.

The resume was constructed so that the applicant is an average student in mechanical engineering. If the applicant was too experienced, then perhaps almost all the participants would have viewed the applicant as qualified, and if the applicant didn’t have any experience, then perhaps almost all the participants would have viewed the person as not qualified. The GPA was listed as 3.18, an average GPA for senior mechanical engineering students, according to the focus group. Also, senior mechanical engineering students typically have two summer internship experiences before they graduate. Finally, mechanical engineering students normally are involved in the American Society of Mechanical engineers as an undergraduate.

The information of the resumes was compiled by using several different entry-level mechanical engineering resumes that were online, along with created fictitious information. The resumes online were actual people looking for jobs, but only small parts of each resume were used. The name and address information on the resume for this study is fictitious. Some of the coursework was copied from a resume online. Several of the classes listed on the online resume were changed because, according to the focus group, they were usually graduate level classes. Therefore, the classes were replaced by other classes suggested by the focus group. The computer skills listed were chosen by looking at several resumes, along with considering input from the focus group, to determine what computer skills the typical entry-level applicant has. The expected graduation date on the resume was stated as 2007 to make it appear like the person was at the same stage as the participants. University of Michigan was chosen as the college attended because it is an average school for engineering. Also, the internship experience listed at General Motors needed to be in Detroit. Therefore, to make it look as if the applicant did not travel a far distance for the internship, which was ideal to demonstrate average experience in the field, it was best to have it located in the same state where the applicant attended school.

There are two summer internships listed on the survey resume, and each internship experience came from two different online resumes. Also, the information for the internships was from a different resume than the one used for the coursework. One internship experience found online had an internship experience from Malaysia, and the location of this internship experience was changed to Ann Arbor, Michigan for the resume in this study. Also, the name of the company was changed to Wegand Engineering Consultants (a fictitious name) in case the actual company name was a well-known corporate name in Malaysia, and there happened to be a student in the sample from Malaysia. Also, the internship experience at General Motors was slightly changed due to suggestions by the focus group to make the experience less vague.

Measures

Dependent Variables

Two dependent variables, the first and third questions on the survey, will be treated as continuous variables. A copy of the survey is listed in Appendix B. The first question asks the participant to rate the qualifications of the applicant on a scale from 1 to 5, with 5 being "Extremely Qualified" and 1 being "Not Qualified." The exact question is, "On a scale of 1 to 5, how qualified do you think the person on the previous page is for an entry-level mechanical engineering position?" The third survey question asks about the desire to have the applicant as a group member by asking, "On a scale of 1 to 5, based on this person's qualifications, how much would you want the person on the previous page to be a member of your senior design team project?" The ends of the scale are labeled as 1 being, "Don't Want as Member" and 5 being "Really Want as Member."

The second question concerns whether or not students would hire an applicant. This is determined by asking the question, "If you were in charge of hiring qualified entry-level mechanical engineers, would you be willing to hire the person on the previous page?" The goal of this question is to see if students think that men are more qualified to work as an entry-level engineer than women. To make sure that the students would not hire a man over a woman for reasons other than qualifications, it was important to include the portion of the question that mentions hiring a qualified person. If the results show that people are more likely to hire men, the researcher wants to make sure that this is not for some other reason besides bias due to qualifications. For example, unfortunately, the student might not want to hire the applicant because he/she thinks the female applicant is more likely to quit after a short period of time to raise a family. The response categories are "yes" or "no" for this question, so this information will be analyzed as a dichotomous variable.

Independent Variables

The purpose of the research is to determine if gender bias exists and if having more contact with female engineers reduces gender bias. One very important independent variable is the sex of the applicant, which is determined by the name on the resume the participants received. There are only two categories for this study, so this will be a dummy variable.

Two questions are asked to measure the amount of contact with female engineers in the participant's family. The first item asks, "Do you have any family members that are engineers?" The following questions asks, "If you answered "yes" to [the previous question], please write the number of engineers in your family who are your:" and then listed are categories for "father," "mother," "brother," "sister," "cousin," "aunt," "uncle," "grandmother," and "grandfather." Cousin is not a gender specific-term, but the category is included for the subjects because it seems appropriate considering aunt and uncle are both listed as categories.

Three other questions are asked to determine contact with women engineers. One question asked is, "Approximately how many engineers have you worked with on a regular basis? (Please include engineers you've worked with at internship experiences and co-ops, but don't include professors you've had in class." This is followed by the next item concerning contact with female engineers, "Of all the engineers you have worked with on a regular basis (including engineers at internships and co-ops but not professors you've had in class), approximately how many people would you estimate have been women?" The number of women engineers the participants worked with will be used for analysis. Finally, the last question asked to determine contact with female engineers is, "Of the approximately 20 engineering faculty you have had as professors for class, approximately how many people would you estimate have been women?" The number of female engineers the participants had as professors will be used for analysis.

Because the distribution of women engineers in the respondent's family and women engineers the respondents had worked with was so skewed, they were coded into dummy variables. Responses were coded as 1 if they had a response of 1 or more, and 0 if they had a response of 0. Of the 225 respondents, only 21 people had 1 or more female engineer in the family, and 112 respondents worked with a female engineer, with a large portion of them working with only one or two female engineers. It was proposed that in addition to numbers being used to measure contact for these two variables, percentages would also be used. However, since these variables were coded as dummy variables, percentages were not used. Finally, the variable which measured the number of women engineering faculty the respondents had was fairly normally distributed, so that remained a continuous variable.

<u>Control Variables</u>

The control variables are sex of the respondent, race/ethnicity, undergraduate GPA, highest level of formal education completed by the participant's mother and father, and how qualified the participant thinks he/she is for an entry-level mechanical engineering position. The sex of the respondent is dichotomous with “male” and “female” options, and therefore a dummy variable. Race is a three category dummy variable that compares “Asian” and “Black,” “Hispanic,” and “Other” race to “White.” Blacks, Hispanics, and people who stated they were from an “Other” race were combined into one variable because of the small number of people in each category. There were 5 blacks, 7 Hispanics, and 5 “Other” race respondents. Asians were left in a separate category because there were 21 Asian respondents. Also, the mother’s and father’s highest level of education, “Some High School, “High School,” “Some College,” “Technical College,” “Bachelors,” “Masters,” and “Doctorate,” will be treated as continuous. In addition, the question asking the participant’s GPA is continuous. Finally, the question that asks how qualified the applicant thinks he/she is for an entry level mechanical engineering position is measured on a Likert scale from 1 to 5, and is treated as a continuous variable.

Miscellaneous Variables

To try to make the purpose of the study less obvious to the participants, several questions were added to the survey that were not analyzed. These questions were very similar to the two questions asking about contact with female engineering professors and female co-workers except the questions ask about race. The first of these questions is, “Of the approximately 20 engineering faculty you have had as professors for class, approximately how many people would you estimate have been racial minorities?” Another question asks, “Of all the engineers you have worked with on a regular basis (including engineers at internships and co-ops but not professors you’ve had in class), approximately how many people would you estimate have been racial minorities?”

The location of where the respondents grew up, although included in the survey, had to be dropped from the model. The question stated, "What county and state did you spend most of your childhood living in? (If you did not grow up in the U.S., please indicate the country where you are from. Please write your response.)" However, out of 225 respondents, 123 answered the question incorrectly. Many respondents seemed to have misread the question and instead of writing the county and state where they grew up, they wrote down the country and state, or just the country were they grew up. A small number of other respondents didn't answer the question, or wrote numerous locations. Because so many respondents answered the question incorrectly, the information could not be used.

Also, respondents were asked, as an open-ended question, what their mother's and father's occupations were. These responses were coded into occupation categories (scientific, other employment, or no employment), but were dropped from the model because they were not significant. Respondents who had mothers and fathers who were engineers were accounted for in the variable that measures engineers in the family.

<u>Analytic Strategy</u>

Using SPSS, regressions were run for each of the three dependent variables. For the two continuous dependent variables, two separate linear regression models were run, and for the dichotomous dependent variable, a logistic regression was run. First of all, in each model, it was determined if the sex of the applicant affects the ratings of the applicant, whether or not they would hire the applicant, or the eagerness to have the applicant as a group member. Any p-value of .05 or lower was considered significant. Also for each model, it was determined if there was a significant interaction (a p-value of .05 or lower) between the sex of the "applicant" and whether or not respondents have a female engineer in the family, whether or not the respondent has worked with a female engineer, and the number of female engineers the participant has had as professors. Also, for all the models, sex of the applicant and sex of the respondent was tested to see if there was any significant interaction. Finally, all the control variables were included in these models.

Also, the number of women respondents was extremely small in this sample, which may lead to difficulties detecting the interaction between respondent sex and applicant sex. Thus, separate analyses by gender were also performed for all three regressions. These analyses will be only shown for men because the number of women respondents is too small to provide reliable results for multivariate analyses.

Status Characteristics Theory states that people have preconceived notions about others by what certain groups others are in. This study analyzes whether or not knowing the sex of the applicant affects the perceived qualifications of the applicant or the desire to have the applicant as a team member. Contact Theory states that the more one interacts with people of a certain group, the more accepting that person is of that group. This study aims to see if knowing more female engineers make the participant more accepting of female engineers. If the results of this study support Status Characteristics Theory and Contact Theory, then perhaps facilitating intergroup contact can reduce bias not just towards female engineers, but for all forms of bias.

Chapter 4.

Results

Table 1 shows the means and standard deviations for all of the variables included in the analysis (excluding interactions). There were 25 female respondents, 198 male respondents, and 2 respondents who did not state their sex. Of all the respondents, 17 identified as Black, Hispanic, or from a race that was not Black, Hispanic, Asian, or White. There were 21 people who identified as Asian. Only 9% of respondents had a female engineer in the family, whereas almost 53% had a female engineering coworker. On average, respondents indicated that they had about three female engineering professors.

Table 1. Descriptive Statistics for the Study Variables

	Mean	SD
Qualifications of Applicant	3.82	.779
Want Applicant on Team	3.32	.893
Willingness to Hire Applicant	.78	.415
GPA	3.09	.473
Mother's Education	4.64	1.413
Father's Education	5.07	1.412
Respondent's Qualifications	4.277	.827
Asian	.096	.295
Black, Hispanic, Other Race	.076	.265
Applicant Sex	.5	.501
Respondent Sex	.11	.316
Female Engineer in Family	.093	.292
Number of Female Engineering Faculty	3.249	2.008
Female Engineering Coworker	.526	.501

Table 2. Correlations of Dependent Variables, Applicant Sex, Respondent Sex, and Contact Variables

		Qualifications of Applicant	Want Applicant on Team	Willingness to Hire Applicant	Applicant Sex	Respondent Sex	Female Engineer in Family	Number of Female Engineering Faculty	Female Engineering Coworker
Qualifications of Applicant	Pearson Correlation	1	.441**	.477**	-.082	-.140*	.181**	-.121	-.100
	Sig. (2-tailed)		.000	.000	.221	.036	.007	.075	.144
	N	225	220	218	225	223	225	217	213
Want Applicant on Team	Pearson Correlation	.441**	1	.403**	-.026	-.169*	.151*	.042	-.030
	Sig. (2-tailed)	.000		.000	.707	.012	.025	.542	.662
	N	220	220	215	220	219	220	213	209
Willingness to Hire Applicant	Pearson Correlation	.477**	.403**	1	-.089	-.131	.023	-.049	.012
	Sig. (2-tailed)	.000	.000		.193	.055	.731	.478	.863
	N	218	215	218	218	217	218	211	207
Applicant Sex	Pearson Correlation	-.082	-.026	-.089	1	-.044	-.047	-.002	.126
	Sig. (2-tailed)	.221	.707	.193		.511	.481	.980	.067
	N	225	220	218	225	223	225	217	213
Respondent Sex	Pearson Correlation	-.140*	-.169*	-.131	-.044	1	.129	-.032	.085
	Sig. (2-tailed)	.036	.012	.055	.511		.055	.636	.217
	N	223	219	217	223	223	223	216	212
Female Engineer in Family	Pearson Correlation	.181**	.151*	.023	-.047	.129	1	-.045	-.017
	Sig. (2-tailed)	.007	.025	.731	.481	.055		.514	.809
	N	225	220	218	225	223	225	217	213
Number of Female Engineering Faculty	Pearson Correlation	-.121	.042	-.049	-.002	-.032	-.045	1	.190**
	Sig. (2-tailed)	.075	.542	.478	.980	.636	.514		.005
	N	217	213	211	217	216	217	217	212
Female Engineering Coworker	Pearson Correlation	-.100	-.030	.012	.126	.085	-.017	.190**	1
	Sig. (2-tailed)	.144	.662	.863	.067	.217	.809	.005	
	N	213	209	207	213	212	213	212	213

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 2 shows the correlations for the dependent variables, applicant sex, respondent sex, and the variables that measure contact with female engineers. Applicant sex has no significant correlation with the dependent and other independent variables. Respondent sex is negatively correlated with applicant qualifications and wanting the applicant on a senior design team, indicating that females believe that the applicant is less qualified and females are less positive about having the applicant on their team. Respondents who have a female engineer in the family rate the applicant more positively on their qualifications and wanting the applicant on their team. Respondents with a female engineer as a coworker tend to have more female engineers as faculty. Finally, the dependent variables (applicant's qualifications, wanting the applicant on a senior design team, and willingness to hire applicant) are all positively correlated.

Table 3 shows how the independent variables and control variables affect how qualified respondents think the applicant is, indicating several significant effects. First of all, GPA and respondent's sex are significant in how qualified respondents think the applicant is (model 3 p-value of .002 and .012 respectively). It can be seen that the higher the GPA, the lower the ratings of the applicant, which was expected. Also, female respondents rate the applicant significantly lower than males respondents do. GPA is significant in models 1, 2, and 3 (unstandardized coefficients of -.464, -.409, and -.428 respectively), and respondent sex's was significant in models 2 and 3 (unstandardized coefficients of -.349 and -.612 respectively). Respondents who had at least one woman engineer in the family seemed to rate the applicant more positively in the model 2 (p-value .016 and unstandardized coefficient of .440). This variable was not significant ($p < .05$) once the interactions were added in model 3 (unstandardized coefficient of .437), likely due to multicollinearity. Since the interactions terms were not significant in model 3, the results from model 2 should be used as the final interpretation to measure these variables.

Table 3. Qualifications of Applicant Regressed on Applicant's Sex, Contact Variables, and Control Variables

	Model 1		Model 2		Model 3	
	b	se	b	se	b	se
GPA	-.464**	(.134)	-.409**	(.134)	-.428**	(.135)
Mother's Education	-.026	(.043)	-.036	(.042)	-.038	(.042)
Father's Education	.071	(.042)	.058	(.042)	.054	(.042)
Respondent's Qualifications	.084	(.069)	.066	(.070)	.059	(.071)
Asian	-.291	(.186)	-.295	(.182)	-.298	(.183)
Black, Hispanic, Other Race	.159	(.224)	.125	(.219)	.207	(.223)
Applicant Sex			-.135	(.106)	-.272	(.221)
Respondent Sex			-.349*	(.171)	-.612*	(.241)
Female Engineer in Family			.440*	(.182)	.437	(.254)
Number of Female Engineering Faculty			-.045	(.026)	-.025	(.037)
Female Engineering Coworker			-.045	(.112)	-.243	(.159)
Applicant Sex x Respondent Sex					.513	(.342)
Applicant Sex x Female Engineer in Family					.038	(.364)
Applicant Sex x Number of Female Engineering Faculty					-.033	(.053)
Applicant Sex x Female Engineering Coworker					.359	(.222)
Constant	4.680***	(.476)	4.941***	(.479)	5.114***	(.494)
Adjusted R^2	.051		.098		.106	

* *p* < .05 ** *p < .01* *** *p* < .001 (two-tailed tests).

Table 3 also shows many insignificant effects (p > .05) on how qualified respondents rated the applicant. Mother's education, father's education, how qualified the respondent rated himself/herself, being Black, Hispanic, or from a race self-categorized as "Other", or being Asian showed no significant effects in any of the three models. Applicant sex, how many women engineering faculty members the respondent had, and whether or not respondents had a female engineering co-worker also did not seem to impact the dependent variable in the models they were included in (models 2 and 3) ($p > .05$). Finally, the four interactions, which analyzed applicant sex and respondent sex, applicant sex and how many female engineers respondents ever had as professors, applicant sex and whether or not respondents had a female engineer in the family, and applicant sex and whether or not respondents had ever worked with a female engineer, were all not significant in model 3 ($p > .05$). These interactions were also entered separately in additional analyses (not shown) but did not reach significance in any of these models.

Also, male respondent responses were analyzed without female responses (not shown). There was only one significant difference compared to the previous analysis including all respondents. Having a female engineer in the family, which was significant in the previous model, was not shown to be significant in the model with just male respondents. The unstandardized coefficient went from .440 (p-value .016) in the previous model 2 to .371 (p-value .063) in model 2 of the data with just male respondents.

Table 4 below shows to what degree respondents would want the applicant on their senior design team. Model 3 (unstandardized coefficient of .469), along with model 1 and 2 (unstandardized coefficients of .533 and .474 respectively) shows that Asians are significantly more likely overall to want the applicant on their team (p-value .029 in model 3). Also, respondent's sex is significant in model 3 (p-value .008 and unstandardized coefficient of -.748). It was also significant in model 2 (p-value .006 and unstandardized coefficient of -.556), and was not included in model 1. The results show that females are significantly less likely overall to want the applicant on their team compared to males. Finally, as in Table 3, the dummy variable for women engineers in the family was significant in model 2 (p-value .008 and unstardardized coefficient of .566), but not in model 3. Again, since the interactions may result in multicollinearity problems, the results from model 2 should be used to determine the effect of having a women engineer in the family.

Table 4. Want Applicant on Team Regressed on Applicant's Sex, Contact Variables, and Control Variables

	Model 1		Model 2		Model 3	
	b	se	b	se	b	se
GPA	-.238	(.157)	-.140	(.157)	-.170	(.158)
Mother's Education	.011	(.050)	.000	(.049)	-.002	(.049)
Father's Education	.016	(.049)	.002	(.048)	-.002	(.049)
Respondent's Qualifications	-.027	(.081)	-.077	(.082)	-.079	(.082)
Asian	.533*	(.215)	.474*	(.212)	.469*	(.213)
Black, Hispanic, Other Race	.195	(.268)	.146	(.263)	.244	(.268)
Applicant Sex			-.001	(.125)	-.193	(.262)
Respondent Sex			-.556**	(.198)	-.748**	(.281)
Female Engineer in Family			.566**	(.211)	.422	(.295)
Number of Female Engineering Faculty			.009	(.032)	.030	(.045)
Female Engineering Coworker			.033	(.131)	-.202	(.185)
Applicant Sex x Respondent Sex					.404	(.399)
Applicant Sex x Female Engineer in Family					.314	(.425)
Applicant Sex x Number of Female Engineering Faculty					-.031	(.064)
Applicant Sex x Female Engineering Coworker					.425	(.260)
Constant	4.009***	(.561)	4.009***	(.565)	4.207***	(.583)
Adjusted R^2	.021		.061		.066	

* $p < .05$ ** $p < .01$ *** $p < .001$ (two-tailed tests).

Most of the variables in Table 4 were not significant. Insignificant effects (p > .05) on how much the respondents would want the applicant on their senior design team are shown in all three models for GPA, mother's and father's education, how qualified the respondent thinks he/she is, and if the respondent is Black, Hispanic, or identified as being from a race other than Black, Hispanic, Asian, or White. Applicant sex, how many women engineering faculty the respondent had, and whether or not the respondents had a woman co-worker also did not impact the dependent variable in any of the models they were included in (models 2 and 3) (p > .05). Finally, the four interactions, which included applicant sex and respondent sex, and applicant sex and each of the 3 contact variables, were all insignificant (p > .05). Additional analyses (not shown) also indicate that none of these interactions are significant when entered separately.

Table 5. Want Applicant on Team Regressed on Applicant's Sex, Contact Variables, and Control Variables for Male Respondents Only

	Model 1		Model 2		Model 3	
	b	se	b	se	b	se
GPA	-.052	(.171)	-.040	(.169)	-.097	(.170)
Mother's Education	.026	(.052)	.006	(.052)	.009	(.052)
Father's Education	-.020	(.052)	-.027	(.052)	-.035	(.052)
Respondent's Qualifications	-.160	(.088)	-.186*	(.089)	-.183*	(.089)
Asian	.446*	(.214)	.424*	(.213)	.425*	(.212)
Black, Hispanic, Other Race	.157	(.280)	.144	(.277)	.224	(.278)
Applicant Sex			-.055	(.130)	-.274	(.267)
Female Engineer in Family			.593*	(.232)	.067	(.339)
Number of Female Engineering Faculty			.015	(.034)	.025	(.046)
Female Engineering Coworker			.086	(.136)	-.063	(.192)
Applicant Sex x Female Engineer in Family					.984*	(.467)
Applicant Sex x Number of Female Engineering Faculty					.001	(.067)
Applicant Sex x Female Engineering Coworker					.261	(.266)
Constant	4.181***	(.576)	4.273***	(.583)	4.543***	(.598)
Adjusted R^2						

* *p* < .05 ** *p < .01* *** *p* < .001 (two-tailed tests).

Analyses on men only are shown in Table 5. These results show three significant differences compared to the previous analyses. First of all, the male respondent's qualifications are significant in model 2 (p-value of .039 and unstandardized coefficient of -.186) and model 3 (p-value of .041 and unstandardized coefficient of -.183). This shows that males who rate their own qualifications higher are less likely to want the applicant on their team. Also, when analyzing just male respondents, there is a significant interaction between applicant sex and whether or not males have a female engineer in the family (p-value of .037 and unstandardized coefficient of .984). Therefore, according to these results, males who have a female engineer in the family are significantly less likely to have bias towards female engineers.

Table 6 shows the results for whether or not respondents would hire the applicant. The results in all three models show that GPA significantly negatively impacts the dependent variable (p-value .010 in model 3). The odds ratio for model 1 was .264, for model 2 was .269, and model 3 was .278 with a negative unstandardized coefficient in all three models. Results show that respondents with higher GPAs are less likely to want to hire the applicant.

The remaining variables in the models are insignificant. In all three models, insignificant effects were found for mother's and father's education, how qualified the respondent thinks he/she is, if the respondent identifies as Asian, and if the respondent identifies as Black, Hispanic, or self-categorized as an "Other" race ($p > .05$). Insignificant effects were found in Tables 2 and 3 for applicant sex, respondent sex, whether or not respondents had a woman engineer in the family, how many women engineering faculty the respondent had, and if the respondent had a female engineering co-worker ($p > .05$). Also, all four interactions which took into account applicant sex and respondent sex, and applicant sex and the three forms of contact with female engineers, were all not significant ($p > .05$). When added separately in additional analyses (not shown), these interactions were still insignificant. Finally, additional analyses (not shown) indicate the results for male respondents have no significant differences from the results for the full sample.

Table 6. Odds Ratios for Logistic Regression of Willingness to Hire Applicant Regressed on Applicant's Sex, Contact Variables, and Control Variables

	Model 1	Model 2	Model 3
GPA	.264**	.269**	.278*
Mother's Education	1.154	1.156	1.176
Father's Education	.925	.935	.919
Respondent's Qualifications	1.303	1.208	1.098
Asian	1.540	1.458	1.395
Black, Hispanic, Other Race	.395	.373	.330
Applicant Sex		.653	1.520
Respondent Sex		.431	.215
Female Engineer in Family		1.161	7.162
Number of Female Engineering Faculty		.885	1.035
Female Engineering Coworker		1.444	1.149
Applicant Sex x Respondent Sex			2.259
Applicant Sex x Female Engineer in Family			.059
Applicant Sex x Number of Female Engineering Faculty			.748
Applicant Sex x Female Engineering Coworker			1.710
Cox & Snell Pseudo R^2	.069	.095	.123

* $p < .05$ ** $p < .01$ *** $p < .001$ (two-tailed tests).

Chapter 5.

Discussion

Status Characteristics Theory states that people are judged on certain attributes they have, such as being female. Contact theory states that the more contact one has with members of a specific group, the less bias they have toward people who belong to that group. The goal of this study was to support both these theories by showing that more contact with female engineers helps reduce bias toward female engineers.

One interesting finding is that respondent sex seemed to have an influence on the way in which respondents evaluated the applicant overall. Female engineering students seem to be harder on other engineering students than male engineering students. Perhaps this is because women feel like they are under scrutiny because they are a small minority in engineering, and feel they need to work harder than males to prove themselves. Maybe they then judge others based on this caliber of work. However, it is important to remember that there were only 25 female respondents in the sample, so caution should be taken when making generalizations about the overall population.

The other significant findings are of interest also. The results indicate that the lower the respondent's GPA, the higher the rating of the applicant, which was to be expected. However, it was surprising to find that respondents who had one or more female engineers in their family seemed to rate applicants more positively overall. Results for teamwork seem to indicate that this could be due to males judging female applicants less harshly if they have female engineers in the family, although this interaction was not significant for rating the applicant's qualifications. It was also interesting to find that Asians, compared to Whites, are more willing to have the applicant on their team. Perhaps this is because Asian culture seems to be more collective, resulting in them being more likely to value the teamwork of others more equally regardless of the applicant's qualifications. Like the number of women in the sample, there were a small number of Asians (21), so generalizations should be used with caution.

Looking at only the male responses gave some good insight also. First of all, the way the males rated their own qualifications impacted how much they wanted the applicant on the team. Since there is a negative relationship, it seems that if they thought their qualifications were low, they were more apt to want the applicant on their team, which makes sense. Also, it was interesting to find the significant interaction between applicant sex and having a women engineer in the family for male respondents. It seems that for men, having a female engineer in the family reduces bias toward female engineers. Therefore, Contact Theory and Status Characteristics Theory are supported since having a female engineer who males know personally reduces gender bias. If this is true, it would be interesting to determine if friendship with female engineers also reduces bias.

From the results, it can be seen that the effects that were expected to occur, except for the one just mentioned above, did not occur. It was hypothesized that, compared to male applicants, respondents would rate female applicants' qualifications lower, be less likely to want female applicants on their senior design teams, and be less willing to hire female applicants. According to the findings, these hypothesized relationships were incorrect. It was also expected that the interactions indicating contact with female engineers, which took into account applicant sex and contact with female engineering faculty, applicant sex and contact with a female engineering co-worker, and applicant sex and having a female engineer in the family, would be significant. However, in most cases, these hypotheses were also incorrect. The one hypothesis supported was that male respondents who have a female engineer in the family seem to have less gender bias than those who do not have a female engineer in the family.

One reason for not seeing most of the expected effects could be because gender bias is not a problem for mechanical engineering students at Virginia Tech. This would suggest that Status Characteristics Theory and Contact Theory were not supported in the study, except when looking at the interaction between having a female engineer in the family and applicant bias for male respondents only. However, this conclusion cannot be made because there may have been some limitations of the study which prevented the gender bias from being recognized.

The absence of most of the expected effects could be caused by several things besides no gender bias. First of all, the sex of the applicant may not have been salient enough. If future research is done, one suggestion would be to make the applicant's sex more obvious, such as placing the pronouns of "she" and "he" into the questions on the survey. Also, another factor that could be influencing the results is that the respondents were surveyed in a class taught by a female engineering professor. Perhaps the contact with the female engineering professor reduced bias. In addition, all three people handing out the survey, along with the professor who was guest lecturing that day, and her assistant, were all female. Given that engineering is predominately male (about 89% of students in the class were male), perhaps this affected the students' responses. Also, there could be a discrepancy in the way respondents say they feel, and the way they actually feel or the way they would behave in a real life situation. Finally, respondents overall seemed to rate the applicant higher than was expected. Therefore, if this study is replicated, it is suggested that the applicant be slightly less qualified.

Future research should be done to get more information about gender bias in engineering students. One of the main findings of the current study is that there was a significant interaction for male respondents between having a female engineer in the family and applicant sex on wanting respondent as a team member. It would be interesting to see if other personal relationships, such as friendships, reduced gender bias in male engineering students also. Therefore a similar study could be done to ask questions about female friends who are engineers. Also, as mentioned above, it would probably be helpful to use a resume which shows a slightly less qualified applicant and to make the sex of the applicant more salient.

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Appendix A

Rebecca L. Jackson
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Objective
To obtain an entry-level position as a Mechanical Engineer utilizing my skills and abilities.

Education
University of Michigan, Ann Arbor, Michigan
B.S. in Mechanical Engineering, GPA: 3.18
Expected graduation date: May 2007

Relevant Coursework: Dynamic Systems Control and Design, Fluid Mechanics, Thermodynamics, Deformable Solids, Electrical Networks, Mechanics of Materials, Turbo Machinery, Heat Transfer, Machine Design

Work Experience
General Motors Corporation, Summer Intern, Detroit, Michigan, 5/05-8/05

- Assisted in experimental and literature research.
- Prepared data for technical papers.
- Performed vibration analysis.

Wegand Engineering Consultants, Summer Intern, Ann Arbor, Michigan 5/06-8/06

- Performed AutoCAD drafting.
- HVAC ducting analysis (with standard ducting handbooks).
- Learned and observed on-site installation of ducts and water chilled air conditioning systems.
- Calculated heat load and/or total power consumption.

Computer Skills
Matlab, C++, AutoCAD, Microsoft Excel, Power Point, and Word

Organizational Membership
American Society of Mechanical Engineers

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Objective
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Education
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- HVAC ducting analysis (with standard ducting handbooks).
- Learned and observed on-site installation of ducts and water chilled air conditioning systems.
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Computer Skills
Matlab, C++, AutoCAD, Microsoft Excel, Power Point, and Word

Organizational Membership
American Society of Mechanical Engineers

Appendix B

1. On a scale of 1 to 5, how qualified do you think the person on the previous page is for an entry-level mechanical engineering position? (Please circle one response.)

1	2	3	4	5
Not Qualified				Very Qualified

2. If you were in charge of hiring qualified entry-level mechanical engineers, would you be willing to hire the person on the previous page? (Please circle one response.)

   Yes No

3. On a scale of 1 to 5, based on this person's qualifications, how much would you want the person on the previous page to be a member of your senior design team project? (Please circle one response.)

1	2	3	4	5
Don't Want as Member				Really Want as Member

4. What is your sex? (Please circle one response.)

   Male Female

5. What is your race/ethnicity? (Please circle or write the category you most identify with.)

   White Black Asian Hispanic Other: ______________________

6. What is your overall undergraduate GPA? (Please write your response.)

   ____

7. What is the highest level of formal education your mother has completed? (Please circle one response.)

   Some High School
   Bachelors
   High School
   Masters
   Some College
   Doctorate
   Technical College

8. What is the highest level of formal education your father has completed? (Please circle one response.)

Some High School	Bachelors
High School	Masters
Some College	Doctorate
Technical College	

9. What was your mother's occupation during your childhood? (If your mother did not work at a job, please indicate this. Please write your response.)

____

10. What was your father's occupation during your childhood? (If your father did not work at a job, please indicate this. Please write your response.)

____

11. What county and state did you spend most of your childhood living in? (If you did not grow up in the U.S., please indicate the country where you are from. Please write your response.)

____

12. Do you have any family members that are engineers? (Please circle one response.)

Yes No

13. If you answered "yes" to question #12, please write the number of engineers in your family who are your:

Father_______ Mother_______ Brother_______ Sister_______ Cousin_______

Aunt_______ Uncle_______ Grandmother_______ Grandfather_______

14. Of the approximately 20 engineering faculty you have had as professors for class, approximately how many people would you estimate have been racial minorities? (Please write your response.)

____

15. Of the approximately 20 engineering faculty you have had as professors for class, approximately how many people would you estimate have been women? (Please write your response.)

____

16. Approximately how many engineers have you worked with on a regular basis? (Please include engineers you've worked with at internship experiences and co-ops, but don't include professors you've had in class. Please write your response.)

____

17. Of all the engineers you have worked with on a regular basis (including engineers at internships and co-ops but not professors you've had in class), approximately how many people would you estimate have been racial minorities? (Please write your response.)

____

18. Of all the engineers you have worked with on a regular basis (including engineers at internships and co-ops but not professors you've had in class), approximately how many people would you estimate have been women? (Please write your response.)

____

19. On a scale of 1 to 5, how qualified do you think you are for an entry-level mechanical engineering position? (Please circle one response.)

1	2	3	4	5
Not Qualified				Very Qualified

Thank you so much for your participation in this survey. If you have any questions regarding this study, please contact Elizabeth Hoeffel at sadielue@vt.edu