Women In Engineering at Duke University

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The Problem:

The national undergraduate enrollment in engineering was only 20% female in 1998. This national trend is also reflected within Duke University's Pratt School of Engineering, which was only 25% female in 2005. This number is so low due to a variety of societal factors that make it more difficult for women to enter the field of engineering. It is important to consider the barriers and obstacles that have prevented women from entering the School of Engineering at Duke throughout its history and to consider the opportunities available to women who are interested in engineering. Given that women are far outnumbered by men within Pratt and within engineering on a national level, there is a severe lack of female role models in the field that can encourage young women to be engineers. In order to investigate the effects of this problem, the actions of the Duke Administration and the climate within the School of Engineering need to be closely examined to analyze what Duke has done over the years to try to make engineering more female-friendly and to try to increase the female engineering student body.

Importance of Problem:

The lack of equality in numbers for women in engineering even today is a very important problem to consider because equity still has not been achieved for women in this field. The changing gender ideals nationwide have greatly helped over the past 50 years to make it much more accessible for women to enter the field, but it is still definitely a work in progress. Women make up only about a quarter of The Pratt School of Engineering at Duke and this percentage is even smaller within Electrical and Computer Engineering and Mechanical Engineering majors. Women make up half of the worldwide population and it is crucial that women get the opportunity to use their talents for to help advance science through engineering. Working towards equity in engineering also acknowledges the fact that women are very smart, creative, and innovative designers and that they have something to offer to the field of engineering. This is a crucial message and idea that many young women don't receive and that needs to become the norm. Making engineering accessible and desirable to females also opens up immediate and lifetime opportunities for fascinating and exciting careers that they may not have otherwise viewed as a possibility. So, looking at Duke will provide a window to see what is being done to work towards gender equity in engineering and how this has changed over the years.

Methods:

The materials collected to study women in engineering are largely from The Duke University Archives Collections. I used various collections from the Archives, including The Woman's College Collection and *The DukEngineer* Archives Collection from The Pratt School of Engineering Records. I used The Woman's College records to get a better idea about the transfers that took place between into the School of Engineering before women could be admitted directly. I used *The DukEngineer* Collection to go through all of the magazines dating back to the early 1940s. I went through every magazine and searched for any articles related to women in engineering. Once women started to express themselves in the magazine, I also kept track of how many women were contributing to each article and how many articles they wrote. I took note of any articles that highlighted women's achievements or paid particular attention to women in engineering. This allowed me to develop a context for what the climate was like the School of Engineering throughout the past 65 years and what was on the minds of administrators and students within Pratt.

I also collected data for the degrees awarded to women in the School of Engineering from Dean Connie Simmons, who is the Associate Dean for Undergraduate Affairs. She provided me with data for BSE degrees, Master's degrees, and Doctorate degrees awarded since 1978. She also provided me with information from the Engineering Manpower Commission, now known as the Engineering Workforce Commission, which provides useful national data for comparison. The national data collected from the Engineering Workforce Commission provides a useful context for comparison that *The DukEngineer* uses multiple times to show how Duke ranks against other top engineering universities. Dean Simmons also helped me obtain some data about the women faculty in the School of Engineering, but it only goes back until 1991 and therefore, the other female faculty were found by searching through the introductions of new faculty in *The DukEngineer*. This provides data for when faculty arrives but it does not make announcements when faculty leave, which makes the date they left unclear. But, the presence of these faculty introductions provides some of the missing information from the 1980s about female faculty members.

This method for collecting data clearly has consequences because I focus in more in depth on some aspects of Duke's engineering history and skip over other aspects. Also, I am using *The DukEngineer* as my major source of evidence for the climate within the School of Engineering, which is dangerous because it only provides one view of what the atmostphere was like over the years. Therefore, this causes a slightly slanted view of the history of the School of Engineering. The interesting articles and facts collected that illustrate the problem at hand or an attempt to improve it will be presented. But, it is important to remember that this is primarily from one source and thus must be analyzed with a critical eye so that you see all angles of the story.

Introduction:

Currently, only 9% of American engineers are women and women earn only 20% of engineering degrees.[1] The low number of women in engineering is a problem nationwide for many reasons. First of all, there is a shortage of skilled workers in the U.S., which is usually the number one barrier to growth for business across the country. Unless women and minorities are attracted to science and engineering, the U.S. will not have enough trained workers to meet its need. Secondly, a more diverse engineering community benefits society because more problem solving perspectives and approaches are utilized to design the technology that is advancing science. Women add new ideas about effective teamwork and how to address a problem that helps generate more creative solutions to meet the needs of society. Since women make up 50% of the population and a very large consumer group, attracting women to the field of engineering can help companies gain a better understanding of the customers' needs, improve their product designs, and compete more effectively with product sales. Finally, engineering is a very rewarding lifetime career that provides many opportunities for different work environments and can offer women significant financial benefits and job security.[2]

Even with these clear benefits from having more women in the field of engineering, the numbers are still very low across the country and one of the main contributors to this problem is the discouragement, both subtle and direct, that young women receive from adults, their friends, and the media. It is extremely important to consider what we view as good career choices for women and to challenge what we view as traditionally male or female jobs. Stereotypes about good careers for women have changed drastically over the past century but engineering and other highly technical fields

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[1] "Celebration of Women in Engineering." Engineer Girl.
[2] "Celebration of Women in Engineering." Engineer Girl.

are still considered the male domain. Girls are often given the impression that they aren't smart enough to succeed in engineering or that doing well in math and science marks them as a social outcast. One of the reasons this occurs is because society often sends very traditional messages to girls about how we expect them to succeed and how we expect them to act. Girls need encouragement to enter the field of engineering and the messages in society that view certain careers as being more suitable for men can severely undermine the chances of them considering engineering a possible career.[3]

There are still many myths that perpetuate our society about engineering careers that can discourage a smart young woman from wanting to enter the field. Some of these myths include that boys are better at math and science than girls, girls don't like technology, women engineers can't be feminine, and women can't succeed professionally in engineering careers. In reality, there is no difference in the ability to learn math and science between boys and girls and girls are very interested in technology. It is the cultural differences in the way that boys and girls are raised that limit the experiences that girls have with technology. Also, looking at the female engineers of today shows that they are just as feminine as women in other professions. Finally, even though engineering is still a male-dominated profession, women can and do build successful careers in this field and it is starting to become more welcoming as more women enter the engineering workforce.

Sections:

In order to examine the disparity between the number of women in engineering at Duke in comparison to the long-term presence and dominance of men, I will examine three separate time periods and show the change that occurs as we advance towards the

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[3] "Celebration of Women in Engineering." Engineer Girl.

present. In the early time period beginning in the early 1940s, Duke was all-male until two brave souls broke the ground for all future aspiring female engineers. But even after women entered the School of Engineering, they existed in an unrecognized state for many decades until around 1970.

Beginning with the start of the women's movement in the early 1970s, this second time period from around 1970 to the mid-1990s is a time where women begin to gain access to more equal expression in *The DukEngineer*, where they are acknowledged and respected, and where the student enrollments jump up. This is also the time period where the first female faculty member comes to the School of Engineering. The Alumni notes in this time section start to recognize the female engineering alums and they indicate how successful the women graduates are in the endeavors after Duke. It is almost as if Duke does not recognize the need for women in engineering until the 1970s and then there is a large influx once they do.

Finally, a new era for women engineers at Duke seems to begin when Dean Kristina Johnson takes over the newly endowed Pratt School of Engineering. Dean Johnson works very hard to recruit women faculty to Duke's team of educators and is successful considering the numbers before she arrived. But, the percentage of women receiving BSE degrees from Duke is remaining stagnant at around 25% and another step may need to be taken to break this plateau. Also, the distribution of women throughout the four engineering departments is not equal and the discrepancies illustrate that Duke is not actively trying to emphasize fixing this inequality. Despite the fact that there have been drastic changes and improvements over the past 3.5 decades, Duke only tries to recruit up to a certain point due to size limitations. Then, it just accepts where it is after applauding itself for increasing one sector of women in Pratt (either undergrads, grad students, or faculty) while the rest of the groups of women remain at the plateau or even decrease from year to year.

1940s – Late 1960s: A Barely Detectable Existence

Up until 1942, the School of Engineering at Duke was a completely male environment situated on East Campus near Markham Avenue. Even after women began to enter their ranks to study engineering, many people did not seem to even recognize they were there. After World War II in 1944, Kraybill proposed a document describing the Postwar Development plan for the College of Engineering. In the very first objective set forward for the College of Engineering, it states, "By developing men of high professional ideals, broad social vision, and high technical competence."[4] This very clearly emphasizes that the engineering school is geared towards the education of men and focusing on their development as strong contributors to the world of engineering at large. It is important to note that the first women graduated from the College of Engineering in 1946 and therefore there were currently at least 2 women enrolled in engineering at the time this was written.

On September 6, 1944, C.R. Vail prepared a document for Kraybill titled "Arguments in Favor of Location of College of Engineering" and argued for the location to change from the corner of East Campus to West Campus. According to Vail, the present location provided greater "freedom of action" than would be available on West Campus. But, it also lacks prestige because it appears to be "stuck in a corner on a back street", it is inaccessible, and the buildings are inadequate. The West Campus location has maximum prestige in the eyes of the public, the university community, parents and visitors, prospective students, and other schools. Vail also mentions that the West

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[4] Kraybill. "Proposed: Postwar Development Plan, Duke University College of Engineering." May 1944.

Campus location would provide "maximum accessibility to parents and other visitors who, naturally, gravitate first to the 'Men's College'".[5] This very explicitly states how the administrators and people making arguments to them view East Campus and West Campus at this time. Even though East Campus houses all of the Women's College, women still attend classes on West Campus, yet it is still viewed as a Men's College.

According to *The Chronicle*, in around 1946 while the new engineering building was being constructed, there were over 500 students enrolled in the engineering college, which was housed on the Women's College campus on the Markham Avenue side.[6] At this time, there were 150 seniors who would graduate in June, including the first women to ever receive degrees in engineering at Duke. Both Marie L. Foote from Mobile, AL and Muriel G. Theodorsen from Hampton, VA graduated in 1946 with degrees in electrical engineering.[7]

These two women become the foundation for all future aspiring engineering women at Duke because they paved the way and opened up Duke's mind to the possibility of female engineers. Marie Foote Reel originally entered The Woman's College in 1943 with the intention of studying Spanish and becoming a teacher. She decided to transfer to the College of Engineering in 1944 after discussing with her friend's father, who was an engineer. She graduated magna cum laude and later became the Assistant Editor of *Electrical Engineering* magazine. During her career she served as an Instructor of Electical Engineering at Texas A & M University and as Chief

[5] Vail, C.R. "Arguments in favor of Location of College of Engineering." 6 Sept. 1944. Duke
[6] "Engineering College to Move: New $750,000 Building to be Ready for Occupation By Fall of Next Year." The Chronicle. 27 Sept. 1946.
[7] "Work progressing Satisfactorily on Engineers' Building." The Chronicle. ~1946.

Specifications Engineer for DeLeuw Cather, which is the engineering design consultant group for the Washington, D.C. Metro System.[8]

Muriel Theodorsen Williams entered The Woman's College as a Physics major in 1942. She soon learned about a program sponsored by Curtiss Wright Corporation that was designed to train women as engineer's aides to replace the men who were serving in the Armed Forces during World War II. She entered this program at Rensselaer Polytechnic Institute with 99 other women and then returned to Duke in the School of Engineering. After she graduated, she worked as a statistician for the Minute Maid Corporation and as a consultant for ensuring calibration of precision tools.[9] These women set the standard and led the way for women in engineering at Duke, but many years passed before other women followed their lead. As shown by the records from the Dean's Office, only 23 women graduated and earned a BSE from Duke between 1946 and 1974. It was not until the late 1970's during the rise of the women's movement that women began entering the school of Engineering in larger numbers.

The DukEngineer first features women on the cover of the magazine in Sept. 1943 and March 1944 to highlight women's efforts in World War II. The Sept. 1943 inside cover features "the woman behind the man behind the gun" because America is changing its views about how women help in the war efforts. The inside cover also states, "America needs such women and Duke is giving them. Drafters, sketchers, designers, calculators who work with electric calculating machines, slide rules, planimeters, integrators, steam charts, and blueprints on production, test and development projects, and students—we salute their willingness to learn, their attentiveness to their work,

[8] Hendrix, Melissa, O'Barr, Jean, and Amy Threewitts, comps. and eds. "Portraits of Women Firsts."
[9] Hendrix, Melissa, O'Barr, Jean, and Amy Threewitts, comps. and eds. "Portraits of Women Firsts."

neatness and good housekeeping, and their quick grasp of the job to be done."[10] This is a very good acknowledgement of the achievements of the women who used technical skills to work for the war cause shows that men were noticing and appreciating their work. This acknowledgement of their efforts and how well they are doing is also emphasized in the March 1944 Issue. This issue also states that 82 women have taken courses in the College of Engineering since it opened up its classes to women when the war was declared. These 82 women hail from over all over America, representing over half of the states, and 51 of them have already graduated.

By the Sept. 1944 Issue of *The DukEngineer*, the war has ended and an article is now written about women in the College of Engineering. Effendi classifies the women on Duke's campus by class and begins by stating that "Freshman engineers, or social climbers, date seniors exclusively, in the erroneous impression that all the cream is on the top." Effendi goes on to describe all of the classes of Duke women in terms of the dating culture for that class, including the fact that the juniors have already dated every available male, found them uninteresting, and now only want sex. He continues on to say, "Sex consisting of the application of an unbalanced-immediately-balanced force with a magnitude F = MA in the general direction of Haines Field; *F* being the *force*, *M*, the mass, and *a*, the attraction."[11] This clearly illustrates an engineer's attempt to make a witty analogy between an established law of science and women's behavior on campus. The author continues with the same types of descriptions of women throughout the article and does not once mention women in any academic or professional manner.

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[10] The DukEngineer Staff of '43-'44. "The Woman Behind the Man Behind the Gun." DukEngineer. April 1948.
[11] Effendi. "Duke Women." DukEngineer. September 1944.

Another article featured in *The DukEngineer* that tries to make a witty analogy between the laws of engineering and relationships with women is titled "Efficiency of a Couple". E.H. Gautier uses the outline of a lab report, including objective, theory, procedure, results required, and calculations, in order to address his hypothesis that it is possible to have an excellent evening with a member of the opposite sex. The procedure involves making an appointment, also known as a date, with a person of your choice and trying to measure the various physical constants of the "chosen specimen", which is a very "touchy proposition."[12] The article also states that the statistics are part of the required results, including "age, coloring of features, and important dimensions."[13] This suggests that the author is expecting men to look at the women as specimens as part of their study and to treat them nicely only to be able to get the desired dimensions, which is not how women are discussed in the present day.

One article that is featured twice in *The DukEngineer* in the 1960s is "The Stress Analysis of a Strapless Evening Gown", which does a full on free-body diagram with all of the forces drawn in of a woman wearing a strapless dress. Charles E. Siem states that one of the best methods for achieving a "libido awakening infliction on the poor male" is to wear a durable but fragile appearing cloth which "gives the impression that at any moment the garment will slip down or that, better yet, certain parts might slip out of place."[14] The author then goes on to describe that how the strapless evening gown poses significant engineering problems for a structural engineer because the dress must appear as if it is going to fall off any moment but actually stay up safely. The article does a

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[12] Gauti. "Efficiency of a Couple." DukEngineer. December 1948 (38).
[13] Gauti. "Efficiency of a Couple." DukEngineer. December 1948 (38).

[14] Siem, Charles E. "The Stress Analysis of a Strapless Evening Gown." DukEngineer. December 1964 (20).

structural analysis of the dress in figure 1 and a structural analysis of the female breast in figure 2 and identifies the forces required to keep the dress in equilibrium and therefore prevent it from falling. This article talks about the women as if women are not going to read the article because it discusses the female being "naturally endowed" and how to pull the dress down to get more exposures and correspondingly more attention.[15] Despite the fact that this is just a joke by a CalTech engineer, it does not regard women with the most respect and does not recognize the fact that women should not be the center for engineering jokes anymore because women are engineers now too.

Even after the first women graduated from the College of Engineering, the cover of the DukEngineer magazine for the April 1948 issue has a picture of 8 men standing in front of the new engineering building (Old Red) in a glass ball held in the palm of someone's hand.[16] This sends a message that the men of the engineering school were idealized and held up on a pedestal as the great members of the institution. A complementary article to this is when *The DukEngineer* presents women in a traditional manner by including an article entitled "Memories: Engineer's Wives' Club of '54-'55". This article talks about the activities that all the wives of duke engineering students do together to bond, which involves traditional domestic activities. The members of the club are identified by husband name, type of engineering, and year/ occupation, which is a good way to completely associate you with your husband. This article does not encourage women to pursue engineering but rather celebrates the women who sit back and watch their idealized men study hard to become engineers.

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[15] Siem, Charles E. "The Stress Analysis of a Strapless Evening Gown." DukEngineer. December 1964 (20).

[16] The DukEngineer Staff of '47-'48. "DukEngineer." April 1948.

Another instance of pure neglect of women who may want to pursue engineering is the formation of the "Freshman Engineer's Big Brothers" program. This was a program designed by the Engineers Guidance Council (EGC) to make sure that as many freshman engineers stay in the engineering program as possible. This article uses the phrase "EGC man" multiple times as a description of the person who can help the freshman engineer, which implies that the older "brothers" are ready to help their fellow younger engineer brothers. The creation of this program without the sensitivity include female students in1956, 10 years after the first women graduated from the School of Engineering, just shows how much the students seem to ignore the presence of women in as engineers. Although *The DukEngineer* only illustrates the presence of 5 women alumni and 1214 men alumni in the College of Engineering by 1953, the women still should not be ignored.[17]

Marie Foot Reel, one of the first two female graduates tries to reclaim her status as a woman engineer by submitting an article to *The DukEngineer*. Throughout her over 11-year career, people have constantly told her, "You certainly don't look like an engineer!" But, she is "quick to assert that [she is] one and [she's] GLAD."[18] Marie has been teaching electrical engineering at Texas A&M for one year and previously has served as assistant editor with the American Institute of Electrical Engineers publication. Marie lays out the qualities that a woman engineer must have to be successful in this male-dominated field.

> "The successful woman engineer needs all the usual qualifications plus a few more. She must be better than average in ability so that she can earn and expect respect based on accomplishments alone. Not only can she expect special treatment because of her sex, she must be careful not to accept it. Chivalry has no place in the laboratory, but respect and courtesy are much more satisfying. She

[17] The DukEngineer Staff of '53-'54. "Engineering Alumni." Letter. 11 Nov. 1953.
[18] Reel, Marie Foote. "But I am!!!: A Woman Engineer." DukEngineer. February 1958 (19).

> also must be a "good sport" with a good sense of humor and be willing to do her share of the "dirty work." … Lastly, she must be able to change her attitude and even personality to suit the occasion as appropriately as she changes clothes. A woman engineer is still a woman when she is in a woman's world."[19]

Therefore, Marie acknowledges that women must earn their respect for their accomplishments and she must be careful not to accept the traditional ways that men treat women. As a woman engineer, you cannot allow chivalry to take place but you should be a "good sport" and have a sense of humor in order to move up the engineering social ladder to be accepted by the men of the group. This is the first time that advice for fellow female engineers could be found in *The DukEngineer*.

Shortly after this appeared in the magazine, a brief article is written about two freshman engineers who "look out of place in the Engine house class rooms" because they don't "look like engineers."[20] Even though no one can seem to describe what an engineer should look like, it is pretty clear that most people think of men when they think of engineers. Luckily, the two freshman Kathleen and Katharin do not seem too phased by being surrounded by men in all of their classes. The next year, *The DukEngineer* recognizes 4 new freshman engineering women (Class of 1965) and welcomes them to the School of Engineering.

Despite the fact that *The DukEngineer* is starting to recognize that women actually attend the School of Engineering, it also seems to regress in its forward thinking by starting up a section of the magazine called the "Engineer Girl of the Month". This section starts in February 1961 and continues for the next decade until October 1972. It includes attractive photos of women students and includes some fun facts about them,

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[19] Reel, Marie Foote. "But I am!!!: A Woman Engineer." DukEngineer. February 1958 (19).

[20] Leonard, Bruce. "These are Engineers?" DukEngineer. October 1960 (16).

such as hair color, where they are from, and what they like to do. A complete list of the "Engineer Girls of the Month" is shown below.

February 1961 – *Bess Montgomery* (freshman, interested in music, "welcome addition to the Duke campus)
October 1961 – *Jo Ann Appleyard* (combines beauty with brains, won a Nursing School Scholarship, 5'½", wonderful contribution to the DukEngineer)
December 1961 – *Tally Burrill* (freshman, studying nursing, loves men with sports cars; love the outdoors, California, and Duke Park)
October 1964 – *Barbara Collins* (water sports, cars, ME – Bob Graham)
December 1964 – *Linda Brown* (junior, likes swimming and having a good time)
February 1965 – *Barbara Jan Albers* (senior, Kappa, cheerleader)
October 1965 – *Connie Hill* (sophomore)
December 1965 – *Bebe Nichols* (freshman, she will award the prizes to the winners of the Engineer's Show as an added incentive)
February 1966 – *Barbara Nadel* (junior, painting, playing the guitar, and editor Jim Moreng)
April 1966 – *Sherry Smith* (freshman, cheerleader)
Spring 1967 – *Margie Leland* (from University fo the Pacific, enjoys surfing, skiing, beaching, sports cars, interests at Duke = CE)
October 1967 – *Sally Getter* (TriDelt, 5'4", loves skiing and horseback riding)
December 1967 – *Emily Williams* (freshman, psych major, long brown hair, green eyes, 5'5", "We suggest you sit back and enjoy the benefits of being a Duke engineering student")
February 1968 – *Robin Anderson* (freshman, blue eyes, blonde hair, Marine Biology, "digs tennis and cooking and especially dating")
April 1968 – *Diana Leavengood*
October 1968 – *Terry Ann Carpenter* (freshman, Math or French major, water skiing, horseback riding, and snow skiing, "Obviously Terry is a beautiful addition to Duke, and one we hope to see more often in the future.")
December 1968 – *Chris Doyle*
February 1969 – *Margie Livingstone*
April 1969 – *Jane Rippe*
October 1969 – *Mary Gibson* (sophomore)
December 1969 – *Phyllis Scholl*
February 1970 – *Bobbie Jetton*
April 1970 – *Carol Winterton*
October 1970 – *Linda Kynett*
December 1970 – *Robin Specht*
February 1971 – *Robin Fowler*
October 1971 – *Rene Johnson*
December 1971 – *Jane Barnholdt*
April 1972 – *Anita Birch*
October 1972 – *Lynn Vanderwist*

As you can tell from some of the quotes or facts included in some of the issues, these pictures of female students were clearly for the male engineer's pleasure, which is just another example of how the men fail to recognize the presence of women engineers at Duke.

Shifting over to The Woman's College Records now, the administration starts keeping records of women engineers who live with The Woman's College Students during the 1960's. On July 23, 1964, Jane Philpott sent a note to deans of the Woman's College and the College of Engineering that there were three women engineers in the class of 1967, two in the class of 1966, and two incoming freshman interested in engineering. The status of female engineers at Duke is clear in another memo written by Jane Philpott stating that in the past the administration agreed that "freshmen women should be classified in the Women's College since so many of them give up engineering".[21] On Friday October 14, 1966, an article came out in "The Daily Tar Heel" featuring Marsha Lynn Nelson, a senior in the School of Engineering who is the only woman studying mechanical engineering and one of seven women among 400 in the entire school. Marsha acknowledges the facts frankly when she says, "Engineering is traditionally a man's field and I think it's only natural that some of the boys would look on me as an intruder."[22] This shows that the perpetual view of engineering as a man's field was still very prevalent even 20 years after the first women graduated from the School of Engineering. But, Marsha is able to overcome this and excel among her peers when she is elected to Vice President of the Engineering Student Government. Marsha states that being a woman engineer has some advantages because you attract special attention from your professors and everybody knows you, since there are only seven

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[21] Philpott, Jane. Memo to Dean Ellen H. Huckabee. 12 March 1964.
[22] "Among 400 Men: What? A Coed Engineer?" The Daily Tar Heel. 14 Oct. 1966.

women in the whole school. Also, Marsha mentions that "the recent emphasis on 'equal opportunities for women' enhances a woman engineer's chances for a better job than she might have expected a few years ago" since many engineering firms are searching for qualified women. Despite these potentials for good opportunities as a female engineer, Marsha still has difficulty with convincing people that she is actually an engineer because many men don't really believe her and just want to ask her on a date. One important fact to note is that Marsha actively recruited other women engineers, which is a phenomenon that has not been seen in the records up to this point.

On June 17, 1970, the "Policy on Transfer of Student Records from the Woman's College to the School of Engineering" stated the protocol for how a female student could transfer from the Woman's College to the Duke School of Engineering. The student must request the appropriate dean to write a letter of recommendation to a dean in the School of Engineering and the student must send her transcripts. A dean in the Woman's College must send the dean in the School of Engineering the original jacket that contains school records and test information for the student wishing to transfer.[23] In Sept. 1970, Assistant Dean Annie Leigh Broughton discusses the changes that would result if women were directly admitted into the school of engineering instead of having to transfer in once getting to Duke. She makes an appropriate analysis when she states that this is a good plan because it will result in more applications to Duke from women interested in engineering. Also, it will help prevent the women who enroll in engineering feel like they are being slighted, as compared with men.[24] In July 1971, the Women's College Records contains a sample letter from the Dean of Women, Paula R. Phillips, to a female

[23] Philpott, Jane, and Edward Kraybill et al. "Policy on Transfer of Student Records from the Woman's College to the School of Engineering."
[24] Broughton, Annie Leigh. "Changes That Would Result If Women Were Admitted Directly Into The School of Engineering." 30 Sept. 1970.

student who is accepted into the Duke Class of 1975 and is officially enrolled in the School of Engineering. At this point, the female engineers were housed with the Woman's College students even though they are directly accepted into the School of Engineering.[25]

1970 – 1999: A Substantial Growth Period for Women Engineers at Duke

The 1970's marks a major change in the status of women in engineering at Duke. The sheer number of women in the program grows significantly: it jumps from 9 graduates in 1976 to 27 in '77 and continues to rise to 47 in '80. Although there are some fluctuations, the number of women engineering graduates reaches a peak of 66 in 1985 and has hovered between 30 and 65 ever since then. The late 1970's also marks many firsts in The DukEngineer magazine, which represents the views of the engineering school. The "Engineer Girl of the Month" series that started in the 1960's was discontinued in 1973 when the editor started to recognize that women are serving a much more influential role in the School of Engineering and that they do not need to have a "Girl of the Month" to represent an male engineer's ideal woman. The same year that the "Girl of the Month" is discontinued, women start to hold positions on the staff of The DukEngineer. They start out as contributing editors and then work their way up to writing articles for the issues, being assistant editors, and even chief editor by 1978.

During this time period, there also starts to be many more examples where Duke tries to recruit women and other minorities into the School of Engineering. The Career Development Center starts to print out special programs for freshmen to encourage them to consider engineering. Also, there start to be many more reports found in the Archives relating to Statistics of Women in Engineering and Conferences held to improve the

[25] Phillips, Dean Paula R. "Acceptance Letter." Letter. 20 July 1971.

status of women in engineering. The Archives also kept some pamphlets of other Engineering Schools and their efforts to recruit women, including MIT and Berkeley. There also start to be many articles written in Engineering Journals and other publications regarding the new image of women in engineering as it starts to be more accepted within the field and as women who pursue it are more successful. The Society of Women Engineers is formed as a chapter at Duke University during the late 1970's, but it dwindles until revamping later in the '90s. The Archives has saved some pamphlets from SWE that contain statistics about nationwide enrollments in undergraduate engineering programs. Some figures will be discussed regarding national statistics in undergraduate enrollment, graduate enrollment, earning a bachelor's degree, earning a master's degree, and earning and doctoral degree. The data dates from the late 1970s to the late 1990s and does show a slow but steady climb as numbers nationwide begin to rise.

Getting women onto the staff of *The DukEngineer* appears to be one of the crucial steps to changing the culture regarding women in engineering at Duke. Once women started working on the staff of the magazine, the "Girl of the Month" feature was immediately discontinued and a full magazine feature on "Women in Engineering" is produced within a year. A table for the number of women on *The DukEngineer* staff has been compiled based on research from the Archives and is shown below from 1972 up to 2003.

Table 1: The Number of Female *DukEngineer* Staff Members and Contributions in Terms of Articles/ Chief Position

DukEngineer Magazine	Female Staff Members	Articles written by women	Notes:
1972	1	0	Quarterly
1973	3	4	
1974	9	3	Editor in Chief in October!
1975	9	5	

1976	4	2	Editor in Chief in April!
1977	-	-	Semi-Annually
1978	9	5	Editor in Chief in Spring and Winter!
1979	12	4	Editor in Chief in Fall!
1980	12	3	Editor in Chief in Spring!
1981	4	2	
1982	7	5	Editor in Chief in Fall!
1983	4	4	(1/2 magazines)
1984	12	7	(1/2 magazines)
1985	11	10	
1986	15	8	
1987	15	12	
1988	15	12	
1989	12	7	
1990	10	10	
1991	10	8	
1992	9	10	
1993	7	6	
1994	7	5	
1995	7	8	
1996	9	3	(1/2 magazines)
1997	16	7	
1998	12	4	
1999	4	2	(1/2 magazines)
2000	4	2	(1/2 magazines)
2001	6	6	
2002	5	2	

This table indicates that once the women "broke-in" to *The DukEngineer* in 1972, they wanted a say and they were not going to let the men get away with anything. The women quickly organized the "Women in Engineering" feature issue and soon afterward became Chief editor over multiple years. The numbers have fluctuated throughout the past 10 years or so but the first two decades that women expressed themselves in *The DukEngineer* showed great presence and a desire to make their voices heard.

The "Women in Engineering" feature includes many articles that expose the stigmas about women as engineers and tries to dispel some of the myths regarding this idea. “The Dean’s Message” section of the magazine includes a hypothetical dialogue with a woman who wants to transfer into the School of Engineering and illustrates many of the stereotypes that are often associated with women engineers, such as being unfeminine, only being an engineer until you get married and have kids, and being unable to handle all the plug-and-chug engineering courses. This is a sexist image of an engineer, just like the “Girl of the Month” photographs are a sexist representation of women. The rest of the magazine goes on to try to dispel these stereotypes and clarify the misconceptions that people have about women in engineering, a profession that has been traditionally classified as “male”. One of the main reasons that there are so few professional women engineers is because there are so few women in engineering schools. At Duke in 1973, less than 1% of the engineers are women and this is fundamentally a result of cultural pressure in society. U.S. society today forces women who have interests in “non-feminine” things like science and mechanics to believe that they cannot do as well as men in engineering. Although it is true that women generally are not as interested in engineering and tend to choose the humanities instead, it is possible that part of this difference in interests lie in the childhood conditioning and adult example setting.[26] In early education, boys and girls do equally well in math and science, but girls tend to fall behind both in ability and interest by high school. Therefore, both sexes have high potential to learn technical subjects like engineering, yet traditional sex roles still dominate the minds of many girls and force them to believe they should not study engineering.

Even though these stereotypes still exist today as illustrated in the introduction, the “attitudes are changing and women are undoubtedly finding themselves now more

[26] Ross, Ortho B. “The ‘Male’ Profession.” DukEngineer. April 1973.

welcome in engineering than ever before."[27] The demand for engineers is high and companies are starting to actively recruit women, partly due to the Federal Law requiring non-discriminatory employment. Duke is also trying to change people's mindset that "engineering is only for males", since this is still a very pervasive idea. But, Duke is already off to a slow start as a result of the current status of women in the School of engineering. "From [Duke's] girl-of-the-month to the fact that there are only twelve women in the School of Engineering are reasons enough for women to consider engineering a very unfeminine field, and because of these common misconceptions, very few women consider engineering as a possibility, even though the opportunities and the advantages of being a woman engineer are great."[28] Based on the fact that Duke has been basically ignoring the presence of women in the School of Engineering and flaunting attractive women in their Engineering magazine for a decade, it is difficult for people to accept women as capable engineers. This makes engineering a less attractive field for women to want to go into because it appears socially unacceptable and unfeminine. In response to this problem, Duke started to create Outreach programs to Duke freshman women to acquaint them and introduce them to engineering and the career path associated with it. This women in engineering feature program for freshman was designed to clear up these misconceptions and make women more aware of their options to make intelligent career choices. The current demand for women engineers is high due to the pressure from the government to hire with equality. This feature also included the following data from the 1972 Engineering Manpower Bulletin showing the distribution of Women Engineers by the type of work they do.

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[27] Ross, Ortho B. "The 'Male' Profession." DukEngineer. April 1973 (7).
[28] Mccallie, David P. "Women in Engineering—What Duke is doing About It." DukEngineer. April 1973 (17).

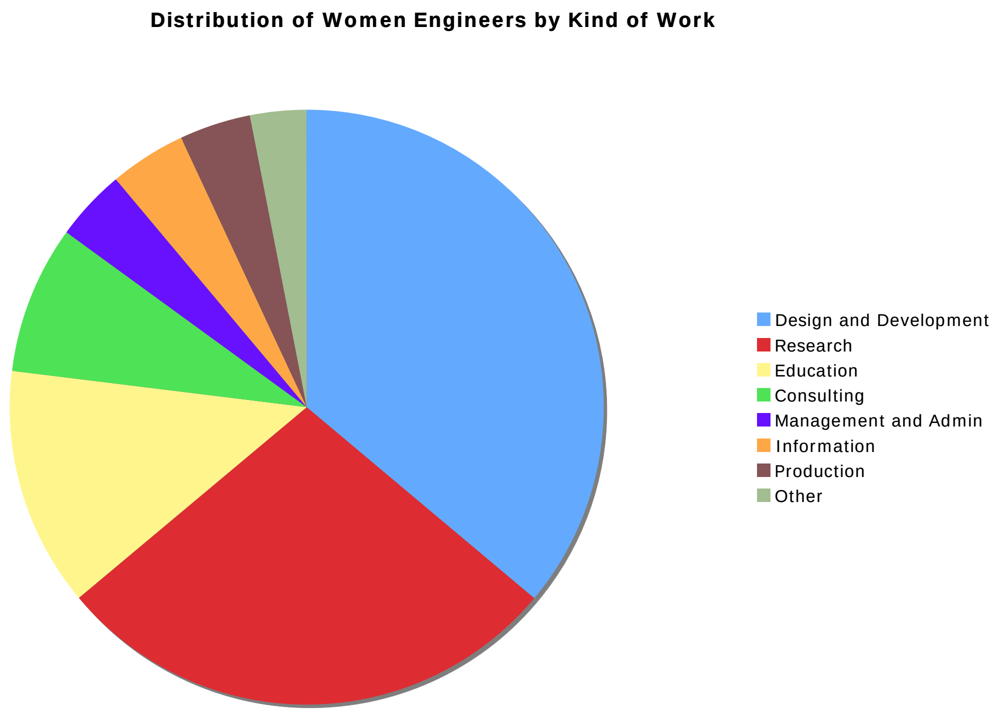

Figure 1: Distribution of Women Engineers by Kind of Work

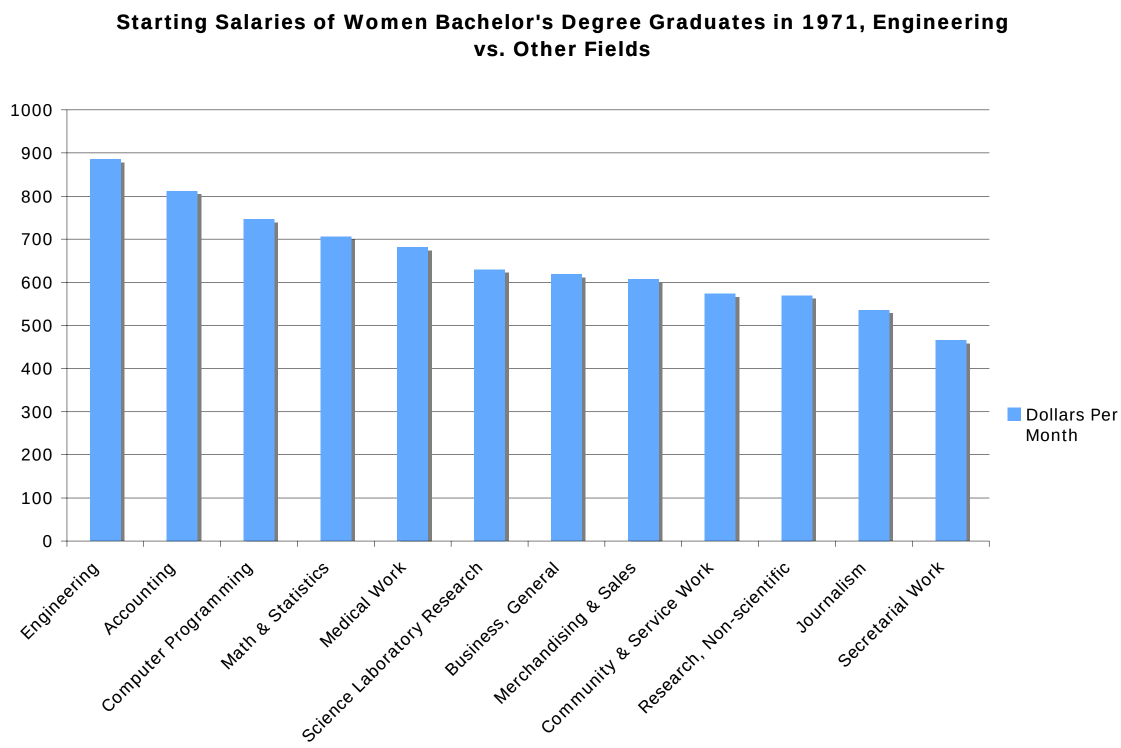

Figure 2: Starting Salaries for 1971 Female Graduate's Job Opportunities

These two figures illustrate the fact that currently women engineers are mostly going into design and development or research and that engineers earn the highest starting salary for all of the job occupations shown in figure 2. This shows the type of national data that the Duke Administration is trying to use to inform more women about the opportunities available to them as engineers.

Whether it is attributed to specific recruiting or by the rise of the Women's Movement, the enrollment of women in the School of Engineering rose dramatically in the 1970's. The Women's Movement occurred at around this same time, which is a very important factor for explaining the rise in numbers of female engineering graduates. Take a look at some of the data shown below for degrees awarded at Duke for undergraduates and graduates.

Table 2: Pratt School of Engineering BSE Degrees Awarded[29]

Year	Total Degrees Awarded	Women	Percentage of Women
1946 – 1974	-	23	-
74/75	105	3	2.857142857
75/76	116	9	7.75862069
76/77	113	27	23.89380531
77/78	144	31	21.52777778
78/79	151	33	21.85430464
79/80	175	47	26.85714286
80/81	182	41	22.52747253
81/82	294	52	17.68707483
82/83	196	41	20.91836735
83/84	225	56	24.88888889
84/85	227	66	29.07488987
85/86	222	60	27.02702703
86/87	204	43	21.07843137
87/88	173	40	23.12138728
88/89	176	42	23.86363636
89/90	256	49	19.140625
90/91	185	30	16.21621622
91/92	204	42	20.58823529

[29] Simmons, Connie. "School of Engineering: BSE Degrees Awarded to Women 1978 – 2006."

92/93	193	51	26.42487047
93/94	255	63	24.70588235
94/95	187	34	18.18181818
95/96	205	52	25.36585366
96/97	200	65	32.5
97/98	221	48	21.71945701
98/99	186	52	27.95698925
99/00	201	54	26.86567164
00/01	203	48	23.6453202
01/02	184	46	25
02/03	180	38	21.11111111
03/04	235	60	25.53191489
04/05	253	60	23.71541502
05/06	244	59	24.18032787

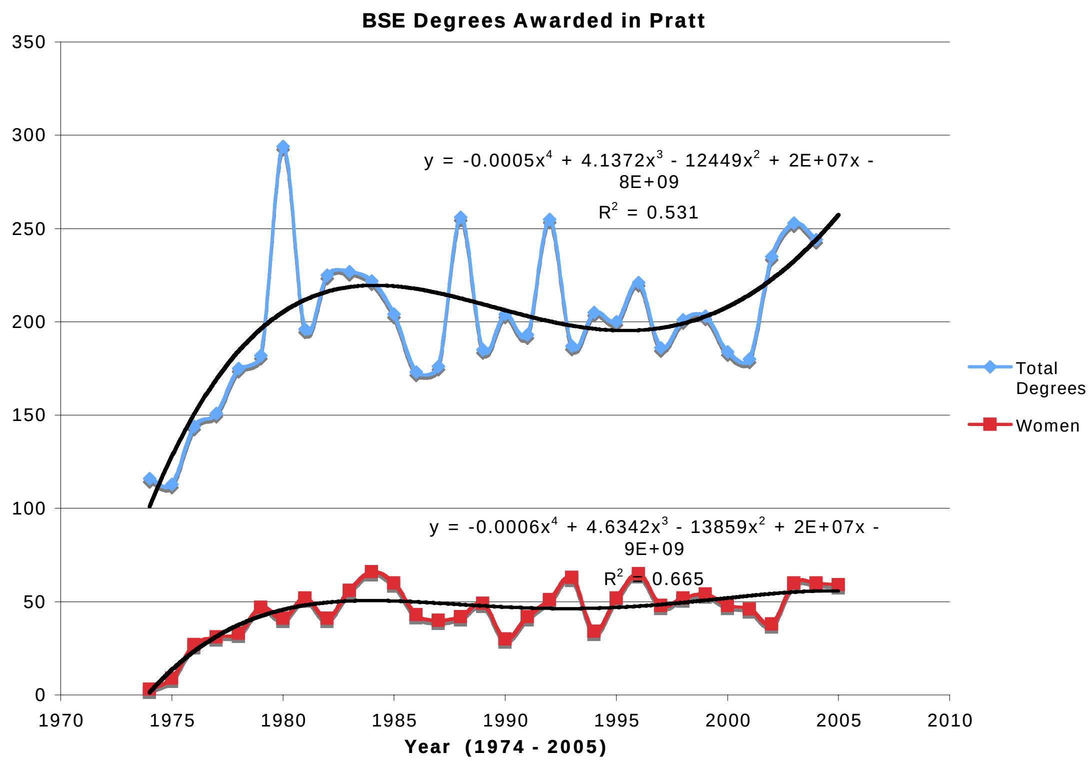

Figure 3: Pratt School of Engineering – BSE Degrees Awarded 1974 – 2005

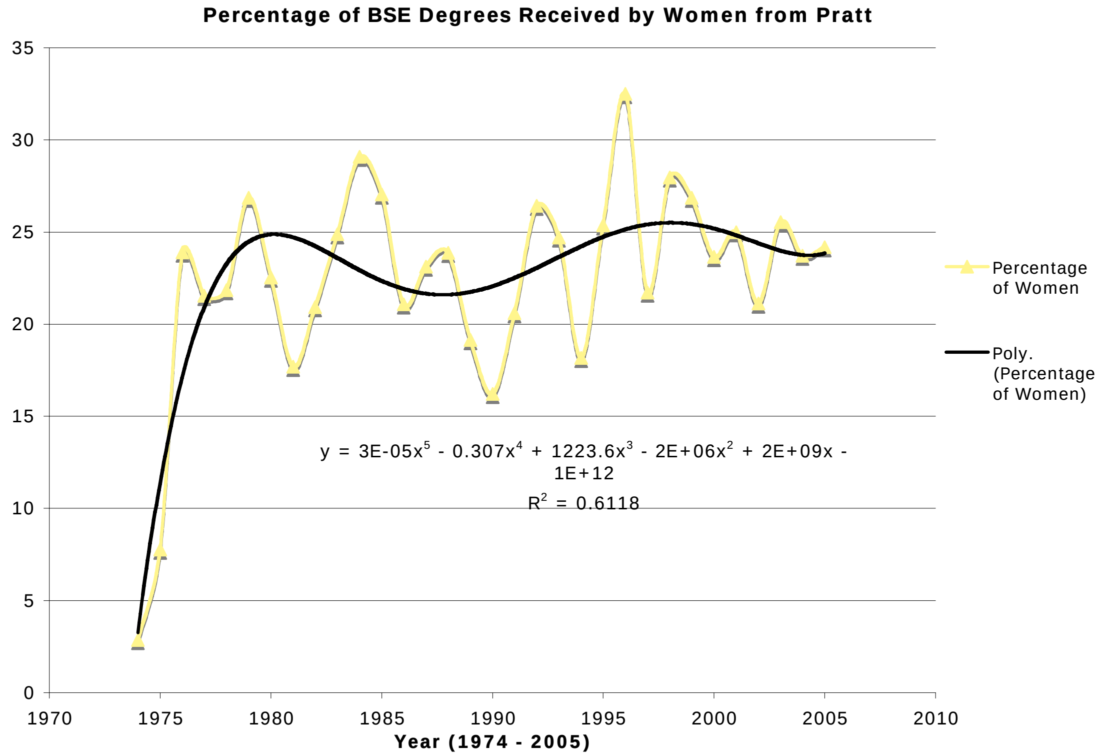

Figure 4: Pratt School of Engineering – Percentage of BSE Degrees Awarded to Women 1974 – 2005

As can be seen in both the table and both figures 3 and 4 above, there is a sharp rise in the number of women in Pratt in the late 1970’s that brings the percentage of women from below 5% up to around 25%, where it has currently leveled off. The female graduate student numbers and percentages also show a rise in the late 1970’s.

Table 3: Master’s Degrees Awarded to Women in Pratt

Year	Total	Women	Percentage
1978	22	2	9.090909091
1979	18	2	11.11111111
1980	19	6	31.57894737
1981	22	2	9.090909091
1982	27	8	29.62962963
1983	24	5	20.83333333
1984	36	8	22.22222222
1985	34	9	26.47058824
1986	39	9	23.07692308

1987	55	11	20
1988	43	9	20.93023256
1989	35	8	22.85714286
1990	47	12	25.53191489
1991	39	7	17.94871795
1992	51	6	11.76470588
1993	63	8	12.6984127
1994	39	11	28.20512821
1995	39	10	25.64102564
1996	41	8	19.51219512
1997	49	11	22.44897959
1998	41	11	26.82926829
1999	53	10	18.86792453
2000	65	16	24.61538462
2001	56	14	25
2002	69	12	17.39130435
2003	59	20	33.89830508
2004	80	19	23.75
2005	84	25	29.76190476
2006	103	23	22.33009709

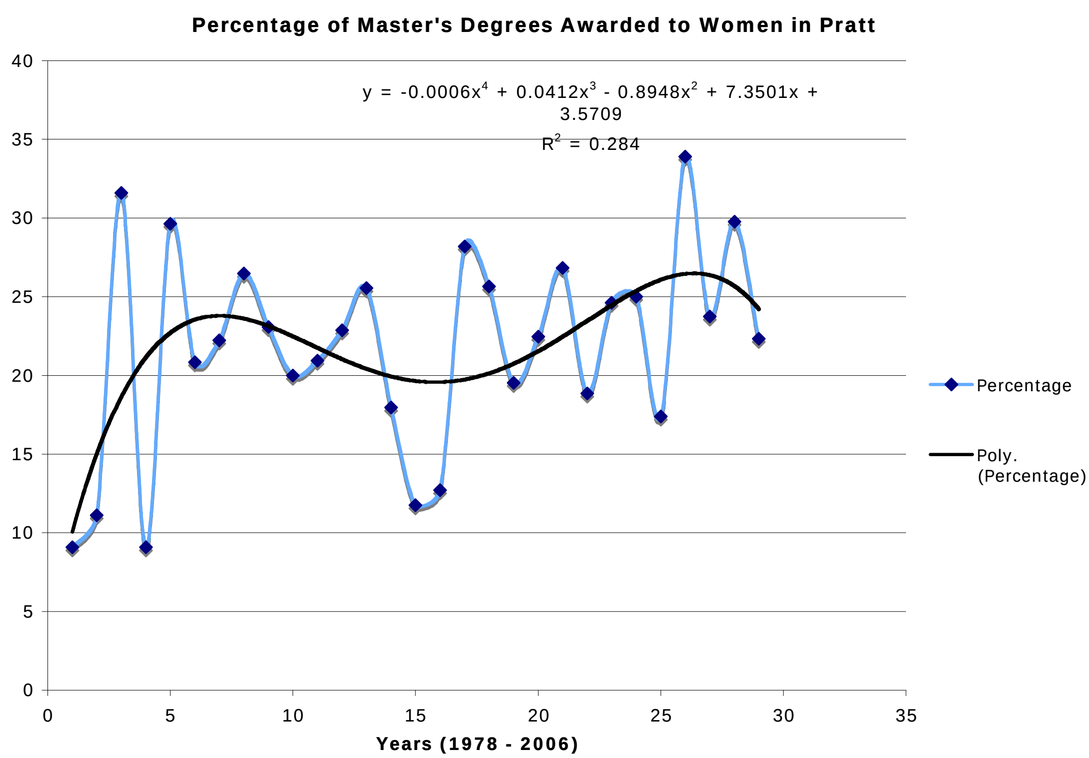

Figure 5: The Percentage of Master’s Degrees Awarded to Women in Pratt

Table 4: Ph.D. Degrees Awarded to Women in Pratt

Year	Total	Women	Percentage
1978	8	0	0
1979	8	0	0
1980	10	1	10
1981	13	2	15.38461538
1982	9	3	33.33333333
1983	10	0	0
1984	9	0	0
1985	14	4	28.57142857
1986	12	1	8.333333333
1987	12	4	33.33333333
1988	13	4	30.76923077
1989	24	4	16.66666667
1990	15	1	6.666666667
1991	30	4	13.33333333
1992	27	4	14.81481481
1993	27	1	3.703703704
1994	35	7	20
1995	36	6	16.66666667
1996	23	4	17.39130435
1997	48	8	16.66666667
1998	32	4	12.5
1999	34	8	23.52941176
2000	33	10	30.3030303
2001	37	9	24.32432432
2002	21	4	19.04761905
2003	29	6	20.68965517
2004	33	10	30.3030303
2005	39	13	33.33333333
2006	47	10	21.27659574

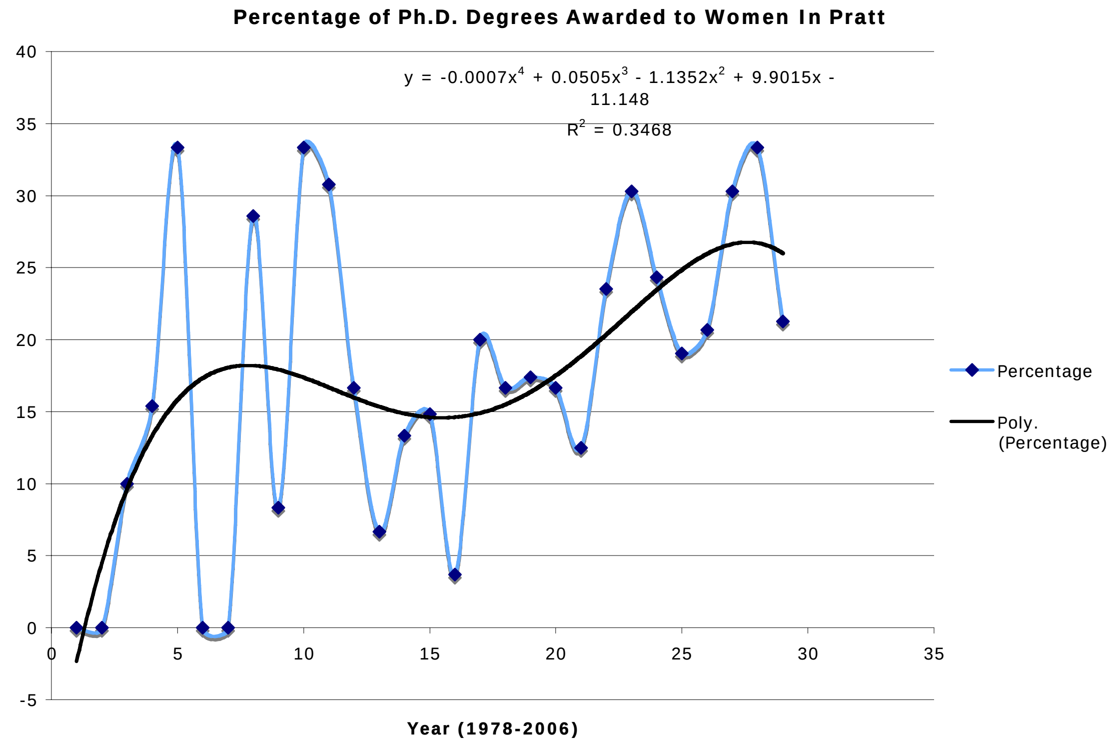

Figure 6: The Percentage of Ph.D. Degrees Awarded to Women in Pratt

Both the Master's degrees and the Ph.D. degrees awarded to women start to significantly increase in the late 1970s, but the Ph.D. degrees take a little bit longer to rise up. This data can be compared with the National Data collected by the Engineering Workforce Commission.

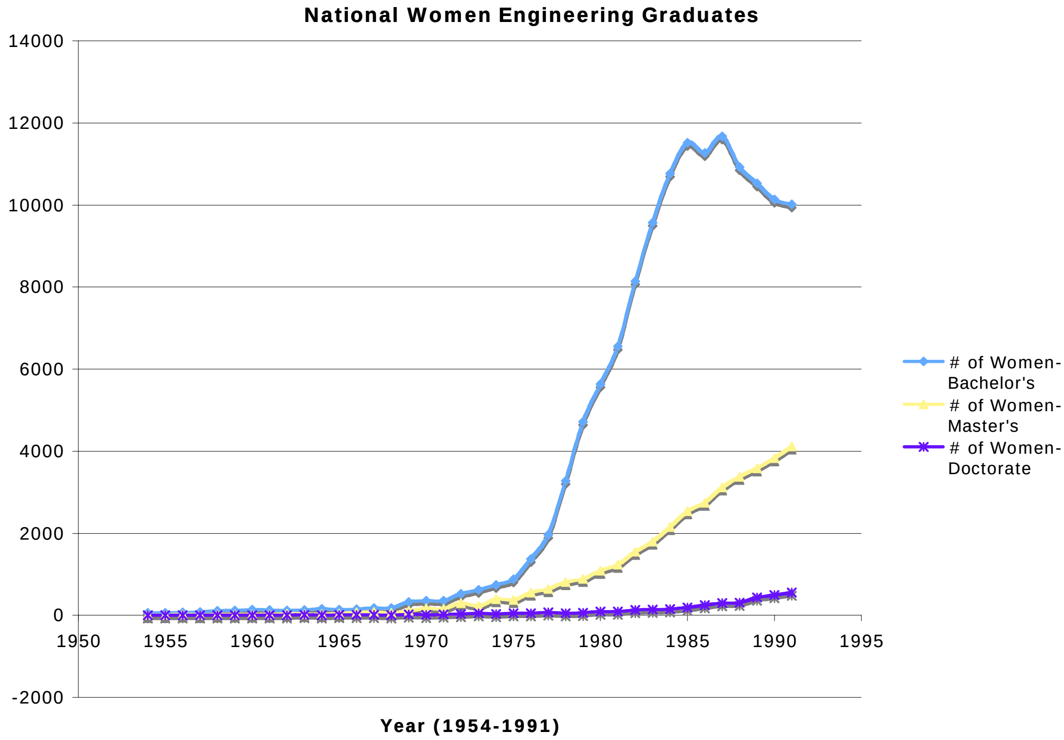

Figure 7: National Women Statistics for Engineering Graduates

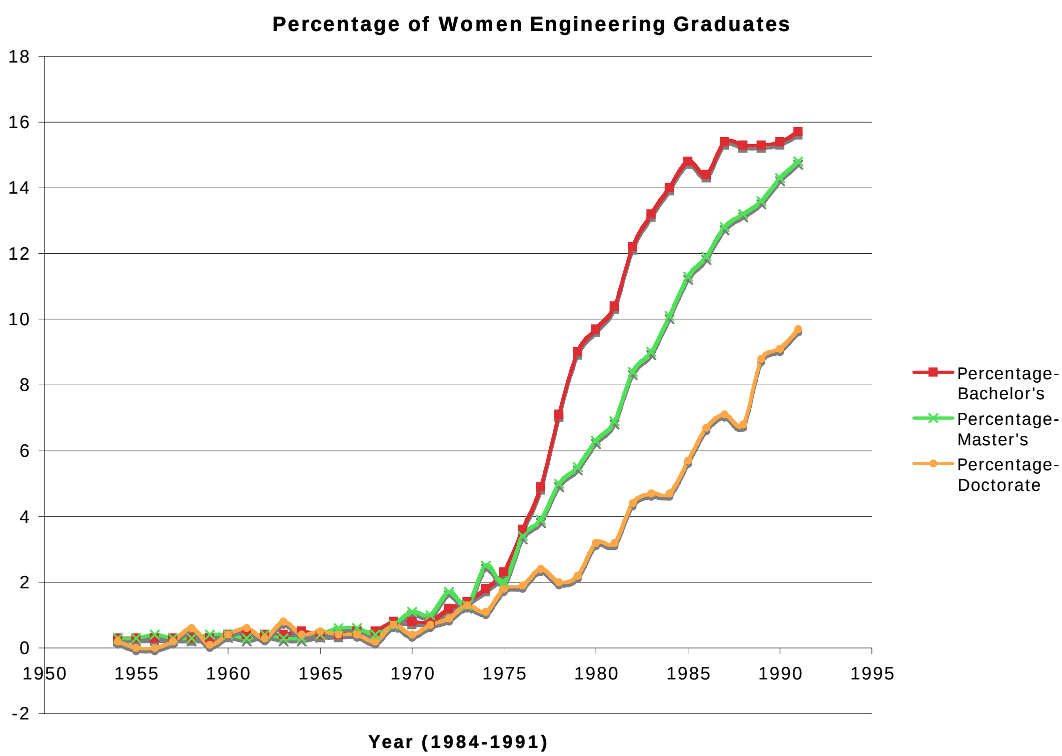

Figure 8: National Percentages of Women Engineering Graduates

Based on the numbers, Duke has consistently remained ahead of the national curves. This is an illustration of how well recruitment efforts went during the initial rise after the Women's movement began and how more women engineers being successful sets an example for younger women. For example, the Alumni notes listed in *The DukEngineer* during the 70's and 80's start to show many of the women engineer alumni are becoming successful in their careers. This coupled with the increased efforts from the University and from the Society of Women Engineers to encourage more women to stay with the program may have contributed to Duke's ability to stay ahead of the national curve.

1999 – Present: A New Era Under Dean Johnson

Having Dean Kristina Johnson take over in 1999 was a very big step for the recognition of successful women in engineering at Duke. Dean Johnson is the #3 Dean in the U.S. to lead a major research institution (following #1 Denise D. Denton in 1996 at University of Washington and Ilene Busch-Vishniac in 1998 at Johns Hopkins University). According to Dean Johnson, there are currently about 15-20 female engineering deans across the country out of a total of 300 engineering schools. This is a great illustration of Duke acting at the forefront of the national norm since it was one of the first few institutions to chose a woman to be its academic leader and this has set Duke apart in a positive manner.

Since Dean Johnson has been in charge of Pratt, she has been working very hard to recruit female faculty to fill the vacant spots in the departments through a program called Targeted Opportunity Recruiting. This involves trying to attract diverse faculty, including women, underrepresented minorities, and diverse thinkers. When Dean Johnson arrived in 1999, there were only 5 other female faculty members on the staff. The first female faculty member came to Duke in 1983, Dr. Alician Quinlan, and the numbers had stayed very low until Dean Johnson arrived. Now, women make up 20% of the engineering faculty and contribute significantly to research and teaching efforts.[30] Although she is still trying to recruit women, there are not as many spots available any more since most of them have been filled so the numbers will likely level off and plateau for the time being. This increase in the number of female faculty members should hopefully encourage more women to consider engineering and cause an increase over the next couple of years.

Despite Dean Johnson's great success with the faculty members during her term so far as dean, the overall percentages for women in engineering have remained relatively constant since her arrival, hovering around 25% women. The engineering school has even been undergoing an expansion by accepting 50 more freshman engineers each year until the undergrad enrollment is 200 higher than it originally was a couple of years ago. Despite the greater recruitment efforts, it appears that the same proportion of women is being maintained, which indicates that special attention will be needed for there to be any improvement in the future.

Another important aspect of the undergraduate engineering distribution to consider is the division of students within the four departments of engineering. The following figures show the break-up of the BSE degrees by the department they are given in. It is clear that the women are not evenly distributed among the different fields of engineering.

Table 5: BSE Degrees Awarded to Women by Department in Pratt[31]

Year	Total	Women	BME	CE	ECE	EE	ME
77/78	144	31	8	6	-	3	10
78/79	151	33	9	11	-	3	8

[30] Johnson, Kristina. Telephone Interview. 8 Dec 2006.
[31] Simmons, Connie. "School of Engineering: BSE Degrees Awarded to Women 1978 – 2006."

79/80	175	47	14	8	-	2	23
80/81	182	41	12	6	-	7	16
81/82	294	52	21	10	-	1	20
82/83	196	41	17	7	-	9	8
83/84	225	56	15	1	-	22	18
84/85	227	66	18	5	-	28	15
85/86	222	60	20	8	-	18	14
86/87	204	43	10	6	-	21	6
87/88	173	40	19	2	-	14	5
88/89	176	42	17	7	-	14	4
89/90	256	49	24	12	-	11	2
90/91	185	30	16	3	-	7	4
91/92	204	42	18	9	-	7	8
92/93	193	51	21	11	-	13	6
93/94	255	63	25	19	-	10	9
94/95	187	34	17	8	-	4	5
95/96	205	52	24	17	-	8	3
96/97	200	65	20	22	-	13	10
97/98	221	48	18	18	-	4	8
98/99	186	52	24	17	-	6	5
99/00	201	54	27	12	-	8	7
00/01	203	48	24	9	-	8	7
01/02	184	46	25	10	-	8	3
02/03	180	38	16	9	-	8	5
03/04	235	60	34	6	3	8	9
04/05	253	60	33	10	3	2	11
05/06	244	59	34	16	0	6	3

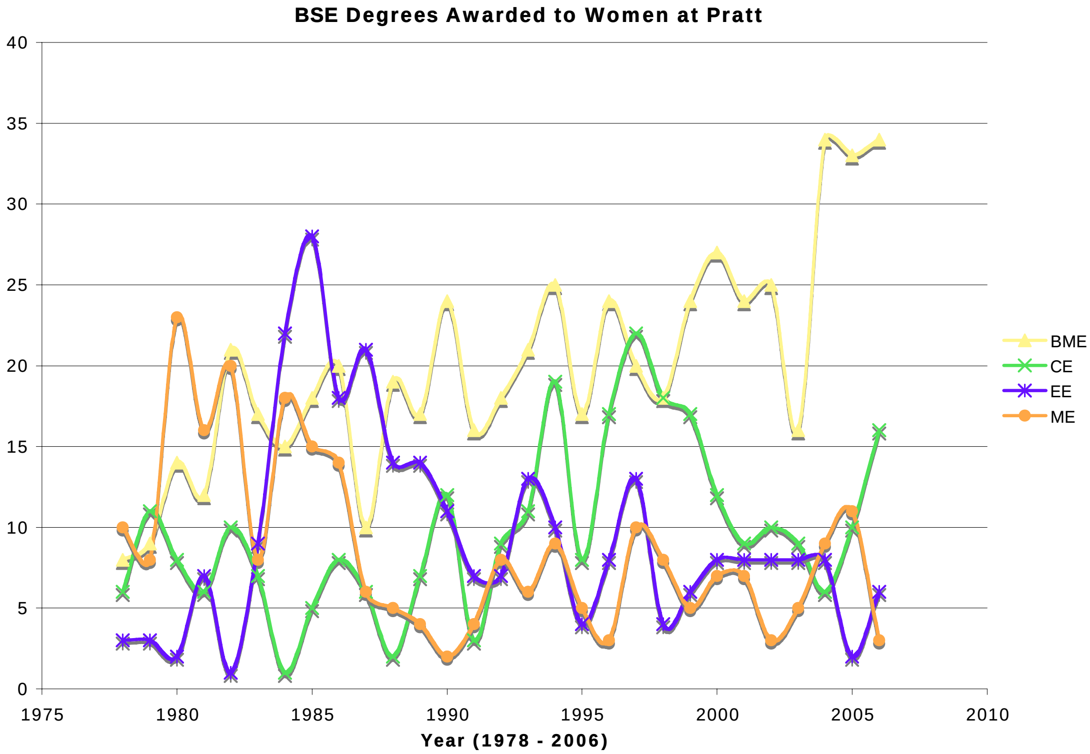

Figure 9: BSE Degrees Awarded to Women by Department in Pratt 1978 – 2006

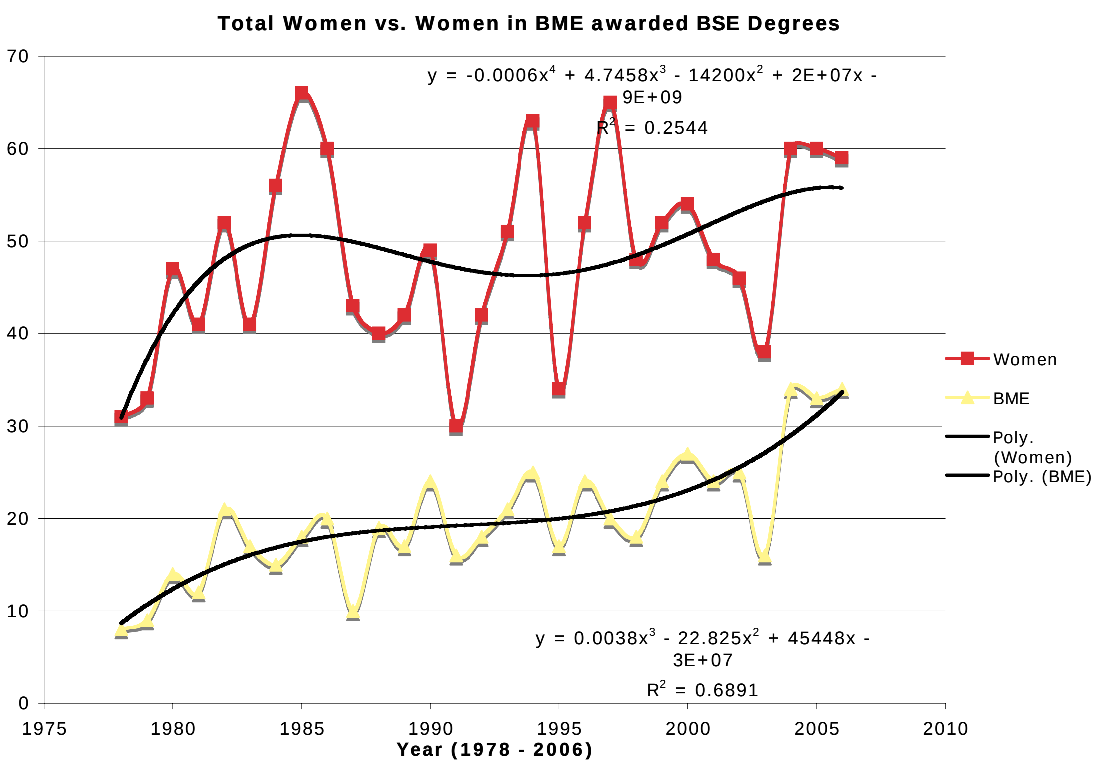

Figure 10: BSE Degrees Awarded to Women in BME in Pratt 1978 – 2006

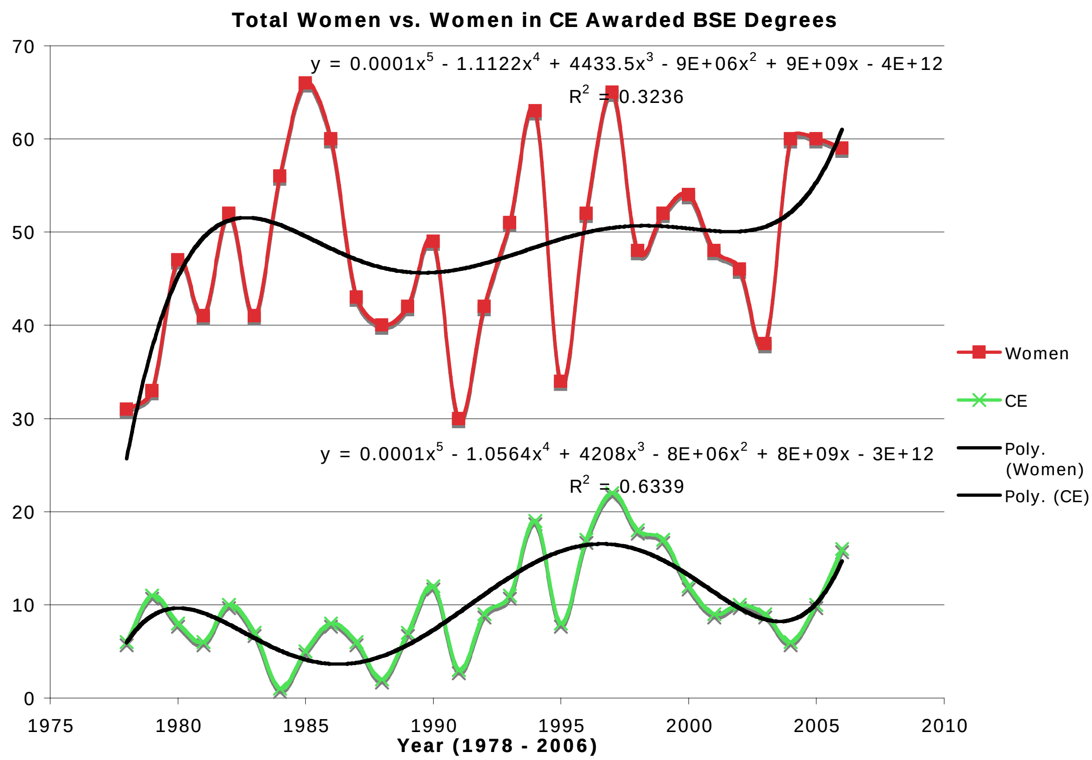

Figure 11: BSE Degrees Awarded to Women in CE in Pratt 1978 – 2006

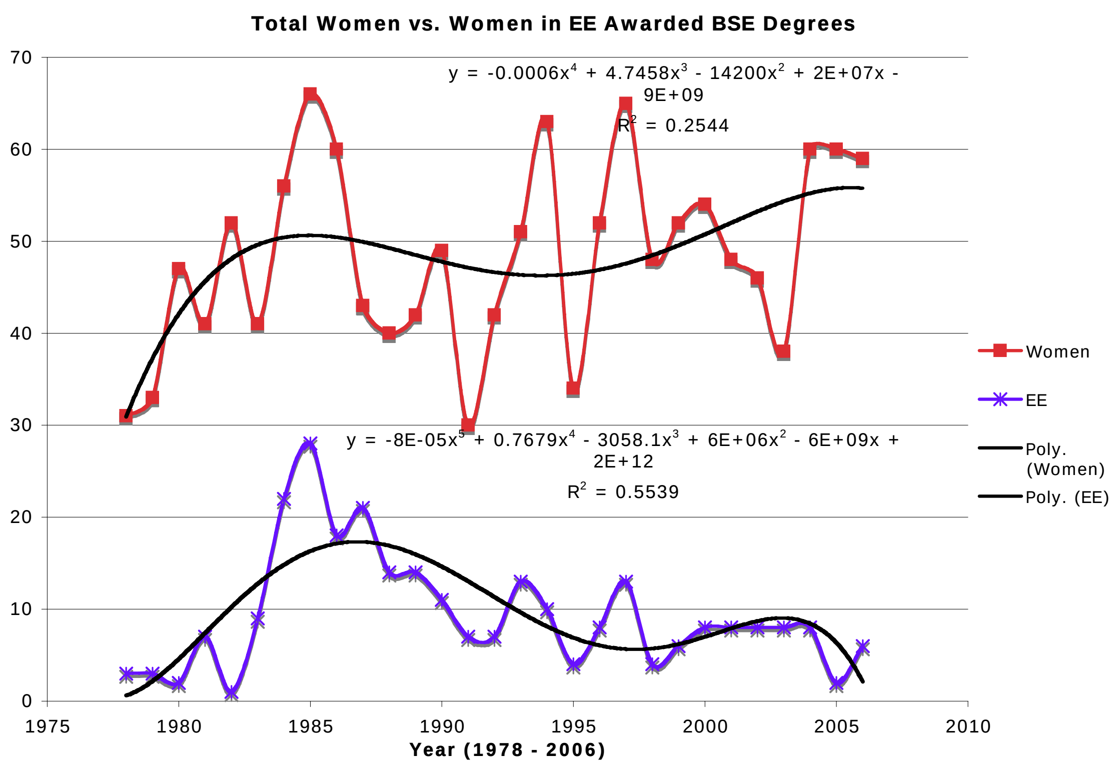

Figure 12: BSE Degrees Awarded to Women in EE in Pratt 1978 – 2006

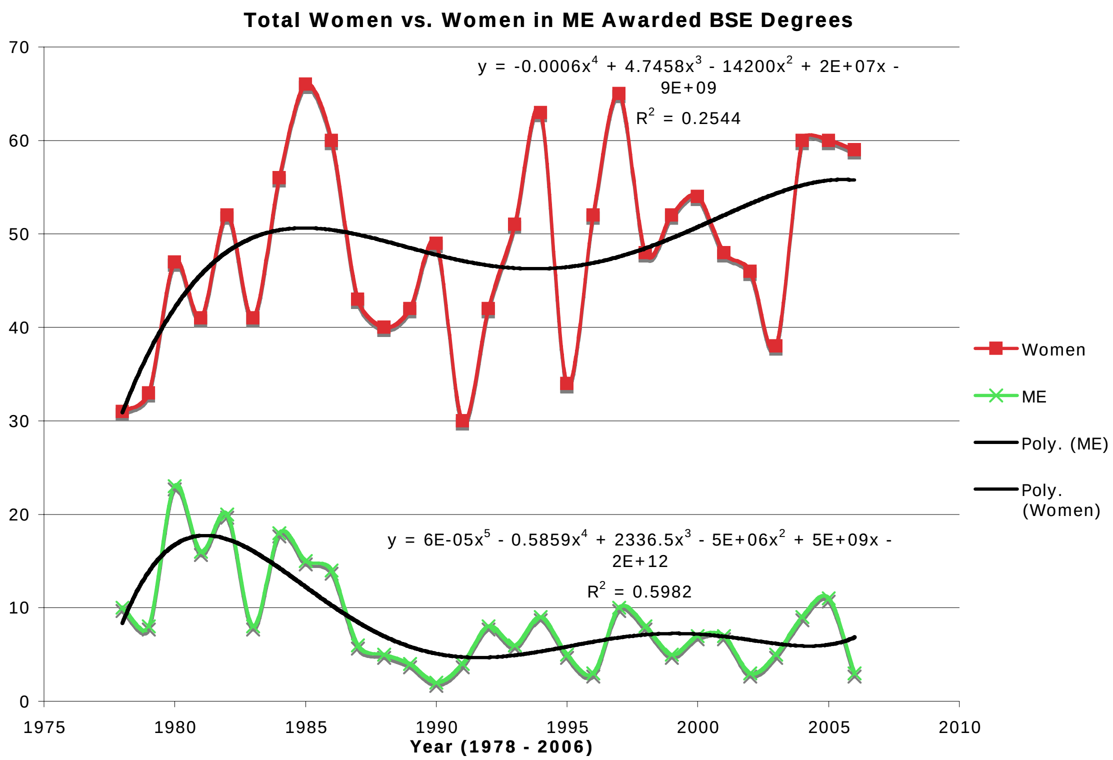

Figure 13: BSE Degrees Awarded to Women in ME in Pratt 1978 – 2006

It is clear based on these figures that the distribution between the four departments is more heavily favored in BME and CE and less favored in ME and EE/ ECE. Even though there has not been an in depth analysis about this fact, it is clear that Duke is not trying to remedy the problem by recruiting more engineers to ME and EE because it has not improved over the past 30 years. In many of the departments, there seems to be significant variation from year to year with each class of engineering students, which explains why the R^2 value for the fits of the curve are not very high (therefore, it does not follow a specific trend very closely). One reason there is a slight drop observed over the last couple of years is that the School of Engineering has been undergoing an expansion and there are still proportionately more males than females in the entering engineering classes. Since BME is the most popular major by far for both men and women, this discrepancy shows up in a similar proportion for the last couple of years. But, BME still has the highest percentage of women (closer to 30%) out of all 4 departments.

Discussion

Through in-depth research of the School of Engineering at Duke from the 1940s to the present day, it has become clear that Duke has come a long way in its attitude towards women as engineers. Starting out by just ignoring the presence completely and going all the way to being the third major research institution to have a woman engineering dean is a major turn-around. But, Duke is still not perfect as shown by the still unequal numbers for all students and faculty and by the inequal distribution between the different departments. As mentioned earlier, it is extremely crucial that the misconceptions about women in engineering get broken down so that young girls view it as an attractive career option. The best way to increase the numbers in engineering is to recruit more women engineers and to retain the ones we have. Duke has been doing a fairly good job at maintaining a steady rate of 25% women students. But, doubling recruitment efforts over the next couple of years could be just what the school needs to break through the plateau and keep moving towards 50/50 equality in all aspects of the engineering school. Although Duke has not reached the perfect state yet for women in engineering, it is working hard under the leadership of Dean Johnson to move in the right direction and has come a long way from the attitudes it held towards women when Marie and Muriel first entered the school.

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