

# Retention and Recruitment Programs for Female Undergraduate Students in Engineering at The University of Toledo, Ohio, USA

Matthew Franchetti, Tina Ravn, Vickie Kuntz

The University of Toledo

## Introduction

Women in the field of engineering remain an under-represented group. Women comprise approximately 45% of the workforce in the United States, but only 16% of the engineers and scientists [1]. In the United States, between 1983 and 2002, the percentage of women among bachelor degree recipients went from 13.3% to only 20.9% [2]. In addition, the retention rates for female engineering students are substantially lower than their male counterparts [2]. This demonstrates a strong need to attract and retain female students in the engineering disciplines. Several colleges have developed programs to address this issue. Many of these programs focus on all under-represented groups, such as African Americans, Hispanics, and Native Americans in all Science, Technology, Engineering and Mathematics (STEM) fields. Some notable examples are the Wright Science Technology and Engineering Preparatory Program (STEPP) at Wright State University in Ohio [3] and the Northwest Engineering Transfer Talent Expansion Partnership (NW-ETEP) at Seattle Central Community College [4]. The purpose of these programs is centered on improving recruitment and retention through providing hands on experience, mentoring, developing problem solving skills, and increasing awareness of career opportunities.

At The University of Toledo, Ohio, USA, the percentage of female students in engineering was 10% and the retention rate for female engineering was 52% from the freshman to sophomore year in 2003. In 2007, the percentage of female students enrolled increased by 3% to 13% and the retention rate increased by 21% to 73%. To achieve these improvements, The College of Engineering at The University of Toledo (UT) developed a package of interrelated programs and initiatives to address the recruitment and retention of female students in engineering. These programs/initiatives include (1) The WISE Mentoring Program, (2) The Society of Women Engineers, (3) The hiring of female faculty and staff, (4) Co-op programs, and

(5) the Eberly Center for Women. This article provides an analysis of these programs, including an overview of the engineering curriculum, commentary from a current female engineering student at UT, and the results and implications of these programs. These programs and initiatives strive to help female students choose majors freely, not attempt to recruit as many female students as possible into engineering, one of the major pitfalls identified in a 2008 study [5].

As Mary Mattis, as Senior Program Officer at the National Academy of Engineering, describes, the need to enhance opportunities for women engineers in higher education has intensified as the incidence of women starting high tech businesses has dramatically increased over the past decade [6]. Additionally, a study conducted in the United Kingdom, identified that gendered expectations and processes within organizations constitute the real dilemma for women's careers in technology, not a female engineer's lack of skill [7]. These programs strive to recognize and address these dilemmas at the college level through education.

## Curriculum Overview

The standard engineering curriculum at The University of Toledo is a 128 credit hour program that includes three mandatory semester long co-op experiences. The College of Engineering offers six Bachelor of Science (BS) degree programs in Engineering: (1) Bioengineering, (2) Chemical Engineering, (3) Civil Engineering, (4) Computer Science and Engineering, (5) Electrical Engineering, and (6) Mechanical Engineering. The semester credit hour requirements for the BS in degrees are:

- 32 hours in Math plus Science
- 15 hours in Humanities, Social Science and Multi-Cultural courses
- 6 hours in English [Composition and technical writing]
- 63 hours in required engineering subjects
- + 12 hours in technical elective courses
- 128 hours total

## Abstract

This paper summarizes the findings of a five year study aimed at improving both recruitment and retention of female students pursuing careers in engineering. The study analyzed a series of five programs implemented at the College of Engineering at The University of Toledo in Ohio, USA. The effectiveness of the programs over time is measured from the rates of female enrollment and retention rates over the five year time frame. These programs may serve as models for other colleges interested in improving opportunities and success rates for female engineers. A senior female engineering student also provides commentary regarding her experiences and opinions of the programs.

The engineering undergraduate programs prepare students for professional careers in engineering-related fields and/or for graduate study. The BS in Engineering programs are geared toward daytime students and most can be successfully completed (with the co-op requirement) in 4.5 years on a full-time basis (including summers). The College of Engineering also offers four BS degree programs in Engineering Technology: (1) Computer Science and Engineering Technology, (2) Construction Engineering Technology, (3) Electrical Engineering Technology, and (4) Mechanical Engineering Technology. The four-year BS programs in Engineering Technology include several courses in mathematics and physical sciences. These courses, in addition to technical and design courses, stress application rather than theory. The four-year BS programs in Engineering Technology are geared toward daytime students as well as part-time, evening students. The BS in Engineering Technology programs can be completed in four years on a full-time basis. Engineering Technology courses are offered both during the day and evening. Part-time Engineering Technology students can successfully complete the BS program in 6 years.

All engineering programs are fully accredited. The College of Engineering BS programs in Bioengineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering and Computer Science and Engineering are accredited by the Engineering Accreditation Commission (EAC) of ABET. The Computer Science and Engineering program is also accredited by the Computing Accreditation Commission (CAC) of ABET. The College of Engineering curricula in Computer Science Engineering Technology, Construction Engineering Technology, Electrical Engineering Technology and Mechanical Engineering Technology are accredited by the Technology Accreditation Commission (TAC) of ABET. The CSET program is also CAC/ABET accredited. It is the first (and remains the only) such program with both TAC and CAC accreditation. The IT program was just coming on-line at the time of the last ABET visit 5 years ago. The plan is to seek CAC accreditation for this program and there is ongoing discussion regarding the feasibility of seeking TAC accreditation as well. If so, this program will also be unique in that it will be dually accredited.

All students in the BS in Engineering programs are required to complete a cooperative (co-op) education component in order to earn their degree. Co-op is the integration of class-

room and practical experience in an organized program. The hands-on opportunity with high-tech equipment in industry not only integrates classroom theory with practical experience, it also provides the engineering student with financial assistance to help offset the cost of their education. Additionally, the co-op requirement allows the engineering student to develop a viable network with industry professionals. In many cases, co-op leads to employment upon graduation. To satisfy the co-op requirement, a student must complete a minimum of three semesters of co-op experiences, with the option to complete as many as five co-op experiences.

Students enrolled in the BS Technology programs are not required to complete cooperative education assignments as part of their curricular requirements. However, co-op is an option that they can choose to integrate into their curriculum and many do.

Figure 1 on the following page displays the curriculum by semester for mechanical engineering at The University of Toledo, including the co-op rotations. Other engineering curriculums at The University of Toledo are similar.

## Retention Programs

The College of Engineering has established several programs to enhance the student experience and improve retention among all students, including females. The key programs and college initiatives that are specifically aimed at females are (a) the Women in STEM Excelling (WISE) Mentoring Program, (b) Society of Women Engineers (SWE), (c) the hiring of female faculty and staff, (d) co-op program support group and peer mentoring for females, and (e) the Eberly Center for Women.

### *The Women in STEM Excelling (WISE) Mentoring Program*

WISE links women science students with mentors, academic support, and a peer community during their first year of study. The primary goal is to ensure that all women students interested in a STEM degree will receive the necessary support and encouragement to have a successful career at UT and beyond. The WISE mentor program helps women science students achieve balance between their academic work and their participation in the broader University community. In addition it provides a peer, graduate student, faculty or professional mentor to undergraduate women enrolled in the program and also links students to tutoring services and academic support if

Course / work experience	Cr	Course / work experience	Cr	Course / work experience	Cr
<b>Freshman / Fall</b>		<b>Freshman / Spring</b>		<b>Freshman / Summer</b>	
CHEM 1230 General Chemistry I	4	ENGL 1930 Technical Writing for Engineers	3	Best advice is to make up deficits in English, Math, Physics	
ENGL 1110 College Composition	3	MATH 1860 Single Variable Calculus II	4		
MATH 1850 Single Variable Calculus I	4	MIME 1010 Professional Development	1		
MIME 1000 Orientation to ME and IE	3	MIME 2600 Engineering Economics	3		
MIME 1100 Introduction to CAD	2	PHYS 2130 Engineering Physics I	5		
<b>Total</b>	<b>16</b>	<b>Total</b>	<b>16</b>		
<b>Sophomore / Fall</b>		<b>Sophomore / Spring</b>		<b>Sophomore / Summer</b>	
CIVE 1150 Engineering Statics	3	CIVE 1160 Mechanics of Materials	3	MIME 3940-001 Co-op Experience 1	
MATH 2850 Elem Multivariable Calculus	4	MATH 3860 Differential Equations	3		
MIME 1650 Materials Science & Engrg	3	EECS 2340 Elect Circuits for Non-Majors	3		
PHYS 2140 Engineering Physics II	5	MIME 2300 Engineering Dynamics	3		
		MIME 2650 Manufacturing Processes	3		
<b>Total</b>	<b>15</b>	<b>Total</b>	<b>15</b>		
<b>Pre-Junior / Fall</b>		<b>Pre-Junior / Spring</b>		<b>Pre-Junior / Summer</b>	
MIME 2000 Measurements Laboratory	2	MIME 3310 Mechanical Design I	3	MIME 3940-002 Co-op Experience 2	
MIME 3300 Design Anal of Mech. Systems	3	MIME 3330 Mechanics Laboratory	1		
MIME 3370 Mechanical Vibration	3	MIME 3380 Modeling and Control	3		
MIME 3360 Vibration Laboratory	1	MIME 4000 Engineering Statistics I	3		
MIME 3400 Thermodynamics I	3	Hum/SocScience Elective	6		
MultiCultural Elective	3				
<b>Total</b>	<b>15</b>	<b>Total</b>	<b>16</b>		
<b>Junior / Fall</b>		<b>Junior / Spring</b>		<b>Junior / Summer</b>	
MIME 3320 Mechanical Design II	3	MIME 3440 Heat Transfer	3	MIME 3940-003 Co-op Experience 3	
MIME 3410 Thermodynamics II	3	MIME 3450 Energy Laboratory	1		
MIME 3420 Fluids Laboratory	1	Technical Elective	3		
MIME 3430 Fluid Mechanics	3	Hum/SocScience Elective	3		
Technical Elective	3				
<b>Total</b>	<b>13</b>	<b>Total</b>	<b>10</b>		
<b>Senior / Fall</b>		<b>Senior / Spring</b>		<b>Senior / Summer</b>	
MIME 4200 Senior Design Projects	3	If necessary, this semester may be used to take Business Minor courses, or make up remaining course deficits, or begin graduate study.		Courses with credit hours in a border must be taken in the same semester, such as =>	3 1
Technical Electives	6				
MultiCultural Dbl-Dip Elective	3				
<b>Total</b>	<b>12</b>				

Figure 1. Mechanical Engineering Curriculum at The University of Toledo

needed. The program also provides opportunities for entering women students to meet accomplished women scientists from departments throughout the university. Support groups are a key element of this program. It provides regular opportunities for women STEM majors to come together, share experiences and support each other in their first year of study and provides opportunities for women UT students in the sciences to serve as mentors to high school girls thinking about studying science or math in college. Dr. Isabel Escobar, an Associate Professor of Chemical and Environmental Engineering, is the WISE Program Coordinator and she has been in the role for four years.

The process to 'link' incoming female students with mentors occurs through the UT College of Engineering orientation process and follow-up emails/letters. When the female students attend a new student orientation session,

Dr. Escobar or a peer mentor meets individual with each student to discuss the WISE Program and its benefits. The peer mentor gathers contact information from the incoming student and schedules a meeting with the student during the first week of classes. Usually the students have lunch together during this meeting and discuss the challenges and opportunities for female students in engineering and science courses. One of the primary benefits of this interaction is that it allows the student to connect and identify with a like minded person on campus.

Meghan Chrzan, a female mechanical engineering student that started at UT in the fall of 2008, participated in the program and commented, "The WISE program allowed me to connect immediately with someone in engineering. When I first started classes, I felt somewhat alone and did not really know many people. To compound things, most of my classmates were

males. To have a female student that I could call, text, or email at any time really made a difference, especially during the first month or so. She gave me great advice on classes, co-ops, and even places to eat near campus. We are still friends and stay in touch”.

The WISE Program is also highlighted by the UT College of Engineering recruiting team during high school visits. When feasible, a WISE peer mentor will travel with the team to the high school visits to present briefly on the program and answer any questions from the students. This exposure for the female high school students gives them first hand contact with a successful female in the engineering and science field and helps to break some false perceptions that only male students study engineering.

### *Society of Women Engineers (SWE)*

SWE is a non-profit educational service organization dedicated to making known the need for women engineers and encouraging young women to consider an engineering education. The organization’s four objectives are as relevant today as they were more than 50 years ago; (1) To inform young women, their parents, counselors, and the public in general of the qualifications and achievements of women engineers and the opportunities open to them, (2) to assist women engineers in readying themselves for a return to active work after temporary retirement, (3) to serve as a center of information on women in engineering, and (4) to encourage women engineers to attain high levels of educational and professional achievement.

The UT chapter of SWE was formed in 1972 and currently has 55 members (63% of the female engineering student population). The chapter officers give brief presentations at each engineering orientation class to advertise the group and encourage enrollment. Dr. Maria Coleman, a Professor of Chemical and Environmental Engineering, is the Faculty Advisor for this group. She commented that the chapter allows female students to network with other female students while participating in activities that are of interest to them. For example, each year the Toledo SWE Chapter holds a wine and cheese tasting demonstration for the community and raises money for Toys for Tots. In addition, the group invites practicing female engineers to their monthly meetings to present on their experiences and career paths as female engineers.

### *Hiring of female faculty and staff*

UT has made a strong commitment to di-

versity, including nine separate diversity offices. The College of Engineering currently has 7 female faculty members (19% of total faculty) and 13 female support staff members (65% of total staff). Adding female faculty and staff provides additional networking opportunities for female students and demonstrates that females can be very successful in engineering and science. For example, Dr. Lesley Berhan, a female Assistant Professor of Mechanical Engineering at UT, has been assigned to teach a freshmen level engineering course. One goal of this assignment is to demonstrate to both male and female students that women are very successful in this field. This also gives UT’s freshmen engineering students an additional opportunity to connect with a female engineer first hand. Many female students maintain this connection after completing the class and consult with her for advice.

UT has an equal opportunity employment policy, but does place special emphasis on hiring female faculty. For example, when a search committee is formed to hire a new faculty member, UT requires that a female is assigned to this committee. In addition, when a female applies for a faculty position, a campus visit is arranged to allow her to connect with the current female faculty and staff.

### *Co-op program support group and peer mentoring for females*

UT offers extended services and support for female engineering students. A cornerstone of this support was hiring a female as the Director for Engineering Career Management, Dr. Vickie Kuntz. As a woman, she can offer special insights to female students and assist in quickly identifying and resolving common issues for these students. As part of her job, she requires each of her staff to meet individually with every student to discuss career goals. Her office staff offers insights to female students and matches female students beginning their first co-op with other female students that have completed co-ops. The purpose of these meetings is to answer any questions, provide peer-to-peer advice, and lower students’ levels of anxiety.

The most common and overarching issues that Dr. Kuntz has identified with female engineering students relative to co-op are 1) the role of co-op in choice of major and retention, 2) the role of external support in choice of major and retention, 3) the role of the social construction of gender in stereotypical male roles assumed by females, the chilly environment, including a sense of isolation, sexual harassment, and

generational differences relative to the perception of women in engineering, and 4) the role of relationships.

Dr. Kuntz commented that these issues exemplify the importance of the mandatory co-op program relative to females choosing engineering, as well as females persisting in engineering. Numerous female engineering students have offered insight into how the mandatory co-op program either impacted her choice to pursue engineering and/or how co-op impacted her decision to persist in engineering. The feedback provided from these students clearly demonstrates the positive effect of the mandatory co-op program on both choice to pursue engineering and persistence in engineering. One female student commented that she was looking at other colleges, and “they didn’t have anything like this where you were required to go out and work for semesters,” and this was a deciding factor for her in choosing to enroll at the University of Toledo, College of Engineering. For this student, as well as many others, the opportunity to gain work experience was important. Dr. Kuntz also noted the significant impact the mandatory co-op program had on female students’ decisions to persist with their engineering coursework. Significant statements were made to support the argument that the mandatory co-op program positively influenced their decision to persist in engineering. The female students made statements such as how prior to co-opping, they seriously considered changing their major. In addition, female students commented how co-op helped them to gain a better idea and understanding of what they were learning. The students spoke of how co-op made them want to finish the program because they were actually doing the things they were learning about, and that encouraged them to broaden what they were learning because the material became more interesting, and they could see the results. They spoke of co-op providing them with a new respect and appreciation for what they were learning in class. They also spoke of how co-op taught them to be more engaged in class as they became more interested in the lectures of their professors after returning from co-op.

### *Eberly Center for Women*

The Catharine S. Eberly Center for Women (ECW) is an integral component of the University of Toledo under the Office of the Provost for Academic Affairs. Its purpose is to serve the women of the University and the larger Toledo communities by advocating for women’s equity

in education, work, and health. As reported in a 2005 United Kingdom study, such centers are a critical part in restoring and promoting women’s confidence in their abilities and by actively developing women’s careers [8].

## **Female Engineering Students’ Perspective**

This section provides a firsthand perspective from a current mechanical engineering student at UT. This section was written by Tina Ravn, a senior mechanical engineering student at UT.

“As a high school student there were many things to contemplate regarding my future. There were so many choices to make, such as whether to attend college, join the military, or go straight to work. Upon entering my junior year of high school I had already decided to attend college. I was undecided between biomedical and mechanical engineering. If I had chosen the path of biomedical engineering, I would have pursued medical school in which I would not have been a minority. Instead I chose mechanical engineering and will continue to pursue the automotive industry (where females are a minority)”.

“I had anticipated being a minority in the academic world and I felt I would be accepted being of a younger generation. However, I did not anticipate being accepted in the field where I would be surrounded by an older generation. Once classes began, I had an awakening as to how my male counterparts treated me. After proving time and time again that my abilities were equal if not surpassing of those who judged me, their acceptance slowly began. I am not one to care what others think, but I felt I had an obligation to change their perceptions because they are part of our future. Upon beginning my first co-op session I was received in a manner that caught me off guard. Not only was I treated with respect without bias, I was treated like an engineer. There was at least one female engineer in each department I worked in, besides the administrative assistants. The only negative experiences I have had while working in the engineering field were from a select few inappropriate union workers. UT has begun several programs geared towards female students in STEM and it is the first step in the right direction. However, the major hurdle that most students, including myself face is the financial aspect of college. Universities need to offer more scholarships and grants to women if they wish to increase female enrollment”.

"In terms of a solution to promoting opportunities for females in engineering, I do not see a single answer or short fix. At this point it is about the effort to incite change in the engineering community. It comes down to an encompassing plan to attempt to resolve the issue of women lacking in the engineering world. I believe if we start with: (a) getting young women involved with actual field projects in high school and middle school to show them that math and science can be fun (from personal experience I can say that I hated math until I was actually able to apply it to everyday situations), (b) giving financial incentives to college bound women to reduce the stresses associated with being in college, (c) educating young men so they are able to understand that women are intellectually equal to them, and (d) implement the WISE program to the fullest extent.

"When it comes to resolving this issue, change has to occur at every level. Certain companies are doing their part to encourage change in the industry. One company went as far as requiring a five-day workshop for their senior managers to help them understand a woman's difficulties in the engineering profession. When it comes to children, Diane Matt, the Executive Director of Women in Engineering Programs & Advocates Network (WEPAN), states that studies have shown students actually listen more to their parents than their guidance counselors. This puts a great deal of emphasis on the impact a parent's words and actions can have on their children" [9].

## Results and Implications

The recruitment and retention programs have had a positive impact on female students pursuing engineering degrees. Female students have accepted the programs with positive attitudes and based on the data from 2003 through 2007, the programs have had an effect on: (a) increasing female enrollment in engineering and (b) increasing female retention rates in engineering.

Table 1 shows the enrollment percentages of male versus female engineering students at UT from 2003 through 2007. Eighty-eight female students were enrolled in the college of engineering in 2007, this is up 14% since 2003 and the ratio of male to female students has also risen by 3%.

As shown in Table 2, through the programs, the average female retention rate has increased to 73%. This data indicates that these programs serve as a good model to recruit and retain female engineering students.

The impact of UT's programs geared towards female engineering students on the nation's engineering workforce is significant in the following ways: (a) they benefit under-represented female engineering students by increasing recruitment and retention through quality programs; (b) they demonstrate the importance of multiple, integrated programs to succeed in engineering fields; (c) they prepare female students for careers in engineering by

	Fall 2003		Fall 2004		Fall 2005		Fall 2006		Fall 2007	
Female	77	10%	59	10%	69	11%	77	12%	88	13%
Male	708	90%	504	90%	538	89%	584	88%	590	87%
Total	785	100%	563	100%	607	100%	661	100%	678	100%

Table 1. Enrollment of new undergraduate students in the College of Engineering by gender

	Fall 2003	Fall 2004	Fall 2005	Fall 2006	Fall 2007
Female	52%	55%	62%	70%	73%
Male	76%	75%	76%	76%	75%
Total	73%	72%	74%	74%	74%

Table 2. Undergraduate student retention rates for the freshmen to sophomore year in the College of Engineering by gender

valuing diversity; and (d) they enhance communication between female students, faculty and staff. The results of this five year study added to the UT knowledge base and aided the university in gauging the effectiveness of these programs focused on the female engineering student experience. These programs may also serve as models for other colleges interested in improving opportunities and success rates for female engineers.

## References

- [1] S. Kleiman, "Social Identification in a Computer-Mediated Group for Women in Science and Engineering", *Science Communications*, vol. 21, No. 4, pp. 344-366, 2000.
- [2] G. Sonnert, M. Fox, and K. Adkins, "Undergraduate Women in Science and Engineering: Effects on Faculty, Fields, and Institutions over Time", *Social Science Quarterly*, vol. 88, pp 1333-1342, Dec. 2007.
- [3] K. Yelamarthi and P. Mawasha, "A Pre-Engineering Program for Under-Represented, Low-Income and /or First Generation College Students to Pursue Higher Education", *Journal of STEM Education*, vol. 9, Issue 3, pp. 5-11, July 2008.
- [4] S. Starobin and F. Laanan, "Broadening Female Participation in Science, Technology, Engineering, and Mathematics: Experiences at Community Colleges", *New Directions for Community Colleges*, no. 142, pp. 37-46, 2008.
- [5] M. Bouville, "On Enrolling More Female Students in Science and Engineering", *Science & Engineering Ethics*, vol. 12, Issue 2, pp. 279-290, 2008.
- [6] M. Mattis, "Women entrepreneurs: out from under the glass ceiling", *Women in Management Review*, vol. 19, No. 3, pp. 154-163, 2004.
- [7] J. Evetts, "Managing the technology but not the organization: women and career in engineering", *Women in Management Review*, vol. 13, No. 8, pp. 283-290, 1998.
- [8] C. Donovan, B. Hodgson, E. Scanlon, and E. Whitelegg, "Women in higher education: Issues and challenges for part-time scientists", *Women's Studies International Forum*, vol. 28, pp. 247-258, 2005.

**Dr. Franchetti** is a Lecturer of Mechanical, Industrial and Manufacturing Engineering and the Director of Undergraduate Studies of the Mechanical and Industrial Engineering Programs at The University of Toledo. Dr. Franchetti received his Ph.D. in 2003 and MBA in 2000 from The University of Toledo. He has worked as an industrial engineer and technical manager for the U.S. Postal Service in Washington DC, Pittsburgh, PA, and Columbus, OH and has published over 50 research papers, books, chapters, and conference proceedings.



**Tina Ravn** is currently pursuing a Master of Science Degree in Mechanical Engineering from The University of Toledo. She graduated from The University of Toledo with a Bachelor of Science in Mechanical Engineering the summer of 2009 and was awarded the outstanding mechanical engineering undergraduate award. During her undergraduate studies she completed three aerospace co-op rotations with Hamilton Sundstrand in Rockford, IL .



**Dr. Vickie L. Kuntz**, Director, Engineering Career Management, College of Engineering, joined the University of Toledo in 1996. Dr. Kuntz holds a Ph.D. in Higher Education at the University of Toledo. She also holds a M.Ed. in Counseling & School Psychology, and a B.S. in Human Resource Services. Dr. Kuntz was instrumental in gaining national recognition for the College of Engineering's mandatory co-op program which has been named the "Best of Co-op" by the National Commission for Cooperative Education. Prior to joining the College of Engineering, Dr. Kuntz gained over 16 years of industry experience, of which eight years were spent specifically as a career management professional.



- [9] D. Matt, "Encouraging women to join and stay in the engineering field", *Hydrocarbon Processing*, October 2007, pp. 29-31.